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A Speculative Efficiency Analysis of the London Metal Exchange in a Multi-Contract Framework

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Abstract

We analyze the speculative efficiency of the six base metals traded at the London Metal Exchange (LME) for the post-Tin Crisis period from 1991-2008. Especially the influence of different futures contracts on the one side and different underlyings on the other side provides economic insights for market participants like hedgers and speculators. We focus on the 3-month and 15-month futures contracts for all six base metals and conduct single-contract test for every base metal applying an ARMA process. This system is expanded to the multi-contract case, modeling the forecast error as an ARMAX process, where we analyse the interaction of 3-months and a 15-month futures contracts for a single market and the interaction of all six base metals. We find a strong influence of the 3-month futures contract on the 15-month futures contracts. Market participants trading the 15-month contracts should therefore consider the information provided by the 3-month futures contracts.

Keywords: London Metal Exchange, LME, Speculative Efficiency, Futures markets, Commodities

JEL classification: G14**,** G15, Q30

1. Introduction

The efficient market hypothesis (EMH) has been tested extensively on different stock, commodity and currency markets and their derivatives. A market is said to be efficient if the market prices fully reflect all currently available information [Fama (1970)]. The efficiency of a market is of strong interest, as market participants can trade on efficient markets without extensive and expensive information research. The EMH is a joint hypothesis composed of the thesis that market participants form their expectations based on the rational expectations hypothesis and have the opinion that the equilibrium process generates no excess returns.

Commodity markets are mainly based on the coexistence of spot and futures contracts with different maturities. A spot contract obliges the buyer and the seller to fulfil their commitments immediately. In contrast, a futures contract obliges both parties to fulfil their contractual commitment at a stipulated future prompt date. The difference between the actual spot and futures price reflects the expectation of market participants, benefit of consuming the commodity immediately and expenses for warehousing and insurance. One way to test the EMH for futures markets has been the hypothesis that the futures price $F_{t,n}$ is the best unbiased predictor of the future spot price S_{t+n} [i.e. Hansen and Hodrick (1980) and King (2001)]. The forecast error $e_{t,n} = S_{t+n} - F_{t,n}$ has zero mean and is serially uncorrelated under the null hypothesis that the EMH is true.

Bilson (1981) shows that best unbiased forecasting using the forward price is not a necessary component of either rational expectations or an efficient markets approach by constructing examples of markets in which market expectations are rational but in which futures prices are not equal to the future spot price because of transaction cost and risk aversion. Furthermore, he presents the possibility of constructing a framework in which markets are efficient in the sense of removing any opportunity for riskless excess returns but which are predictably biased in the futures price forecast. We join Bilson in clarification of the unbiased predictor hypothesis as the speculative efficiency hypothesis.

As Canarela and Pollard (1986) show one possible way to empirically test the speculative efficiency hypothesis with overlapping data is the application of an autoregressive moving average (ARMA) process for the forecast error term. We analyze the speculative efficiency of the six industrially used non-ferrous base metals copper, aluminium, zinc, nickel, lead and tin traded at the London Metal Exchange (LME) in a multi-contract framework for the post-Tin Crisis period of 1991-2008.

There has been some research on the LME for the base metals copper, lead, tin and zinc but the markets for aluminium and nickel have so far mostly been neglected. In addition, the majority of studies focus on the pre-Tin Crisis period [e.g. Goss (1985)]. As the Tin Crisis in 1986 nearly caused the collapse of the LME and led to the complete restructuring of the LME rulebook and trading regulations, a revision of former results is useful and necessary. Furthermore, all studies have only analyzed the most liquid 3-month futures contract, although there are other contracts, e.g. the 15-month futures contract. The second section explains the general function and characteristics of the LME in comparison with other commodities futures markets. The literature on commodity futures market efficiency with emphasis on the base metals is reviewed in Section 3. We demonstrate the applied

statistical model selection and specification in Section 4. Our objective is the analysis of dependencies between the six base metal markets and futures contracts with different maturities. We use three different test settings for our analysis. We conduct a single-market and single-contract test for the 3-month as well as the 15-month futures of all six base metals, where the forecast error is based on an ARMA process. This system is expanded to the multi-contract case, modeling the forecast error as an ARMA with a distributed-lag (ARMAX) process. We first analyze the interaction of 3-month and 15-month futures contracts for a single market. Finally, the interaction of all six base metals using the 3-month and 15-month futures contracts in a multi-contract and multi-market test will be analyzed. We also compare our findings to these of other studies analyzing the pre-Tin Crisis period and using different methodologies. We finalize the paper with a discussion of our results in Section 5.

2. General Function and Characteristics of the LME

The LME, founded in 1877, is the world's oldest metallurgical exchange. It is the most liquid non-ferrous base metal exchange, with a trading volume of $7.41 billion in 2009. It offers a 24hour trade by a three-stage system of open outcry during four "ring" sessions, where every single metal is traded for a five-minute period, the "LME Select" electronic platform and the "Inter-office" telephone market. There are three primary functions performed by the LME. First, a hedging facility against price fluctuations in world base metal markets is provided. Second, settlement prices determined by the LME price committee are used internationally as a valuation reference for any base metal-related activity. Third, a warrant-based storage and physical delivery system allows markets participant to directly trade approved base metal brands. It provides cash, futures and option contracts for the six base metals with prompts up to 123 months forward. Furthermore, the LME has introduced futures contracts on aluminum alloys for the automotive industry, plastic (both polypropylene and polyethylene) and steel billets. Contracts for the minor metals cobalt and molybdenum will be introduced in 2010.

The most liquid and most important contract of all underlyings is the daily rolling 3-month futures contract. Unlike other commodity markets, which are usually based on monthly prompt dates, LME futures contracts run on a daily basis for a period of three months. The use of daily prompt dates is an important difference between the LME and other futures exchanges (e.g., the New York Mercantile Exchange and the Shanghai Metal Exchange). Within the rolling three-month period, every weekday can be traded as a prompt date. After the three-month period, daily prompts for forward trading are reduced to weekly prompts for a period of up to six months and the reduced to monthly prompt dates. Furthermore, most LME brokers provide the ability to trade non-LME prompt dates via OTC contracts.

The most important trading session is the second ring session. At the end of this trading session the LME price committee determines the official daily settlement price for the cash contracts and for the 3-months, 15-months and 27-months futures. (Note 1) For our analysis, the settlement prices will be used. Brokers also offer a hedging technique called pricings, which provides market participants the ability to trade on the basis of monthly average prices. Therefore a market participant predetermines the settlement month and the quantity of futures. The futures are settled on the basis of the monthly average settlement price (MASP) at the end of the predetermined period. These pricings permit the use of average monthly prices in our analysis, as these average prices are actually tradable for a predetermined month.

Another important distinction from other futures exchanges is the physical delivery of all traded base metals based on a warrant system. The warrants are issued by LME-approved warehouses. Cash settlement of due contracts, as provided by other futures exchanges, is not possible. The system can be interpreted as a major concession to physical metal traders rather than as one to financial investors.

When a delivery date falls due, the LME price will naturally converge with the spot price. In reality, physical delivery occurs only in a very small percentage of less than 1% for base metal contracts, as most market participants use the exchange for hedging purposes and close open futures contracts before they fall due [Crabbe (1998)].

As the LME does not oblige members to clear the contracts with LCH.Clearnet, the LME's clearinghouse, the LME should be considered a "principal-to-principal" market. (Note 2) Gilbert (1986) has therefore argued that the LME should not be regarded as a futures market but as an organized forward market that performs many of the functions of a futures market.

3. Literature Review

As pointed out by Samuelson (1965) and Fama (1970) independently, a financial market can be considered efficient if prices fully reflect all available information. The agents form their expectations rationally, and any possible excess returns will be arbitraged away. Most studies focusing on the efficiency of futures markets appeal either to the unbiasedness hypothesis by Hansen and Hodrick (1980) or to the speculative efficiency hypothesis by Bilson (1981). The main idea of both approaches is the hypothesis that the futures price is the best unbiased predictor of the future spot price. If economic agents are risk neutral, the costs of transaction are zero, information is used rationally, and the market is competitive, the market will be efficient in the sense that the expected rate of return to speculation in the futures market will be zero. Fama (1991) points out that market efficiency involves testing a joint hypothesis of efficiency and the asset pricing model, in this case the analysis of the joint hypothesis of market efficiency and unbiasedness in futures prices.

There are some studies that focus on the LME. Taylor (1980) tests the random walk hypothesis on spot prices for copper for the period 1966-1978 and for zinc, lead and tin for the period 1970-1978. His results reject the random walk hypothesis for all base metals but tin. Goss (1981) analyzes the relationship between futures and spot prices for the copper, zinc, lead and tin markets for the period 1971-1978. His results show a bias in the futures prices for lead and tin. Bird (1985) uses filter techniques to test for the weak-form efficiency of the LME prices for the same metals for the period 1972-1982. His results showed evidence of market inefficiency for copper, lead and zinc and no evidence for tin. Goss (1985) applies a joint test for the same metals for the sample period of 1966-1984. His results could reject the EMH for copper and zinc, but failed to reject the EMH for lead and tin. Canarella and Pollard (1986) test the hypothesis that the futures price is an unbiased predictor of the future spot price using both overlapping and non-overlapping data for copper, lead, tin and zinc contracts covering the period 1975-1983. Using three different estimation methods, they confirm the speculative efficiency hypothesis. MacDonald and Taylor (1988) test for cointegration for four metals in the LME for the period of 1976-1987. They conclude that the copper and lead futures markets can be considered efficient but reject the EMH for tin and zinc. Gross (1988) examines unvaried LME prices on the mean square error criterion for the period of 1983-84 in order to test the semi-strong EMH for copper and aluminium futures. He provides evidence that the semi-strong EMH cannot be rejected for both base metals. Moore and Cullen (1995) analyze the proposition that forward rates are unbiased predictors of future spot rates for base metal prices on the LME for all six base metals between 1985 and 1989 in a single-market and single-contract framework. They showed that the possibility of long-run speculative efficiency cannot be rejected. Lucey (2003) examines the daily seasonal patterns in the returns of aluminium, copper, zinc, lead and nickel for the period of 1989-2002. His results indicate the existence of daily seasonality, particularly Monday and Thursday returns. Kenourgios and Samitas (2004) analyze the LME copper futures contracts with 3-month and 15-month maturities for the period of 1989-2000. He tests for both long-run and short-run efficiency using cointegration and an error correction model. His results suggest that copper futures market is inefficient.

In summary, there has not been consensus about the efficiency of the LME. One reason for the heterogeneous results are the different test setups. In particular, some of the pre-Tin Crisis studies have been criticized for using incorrect econometric methodology. (Note 3) Moreover all studies have analyzed the LME from a single-market perspective, whereas a multi-market perspective should be the natural choice, as producers of base metals, physical metal traders and even financial investors take the economic interrelation of the base metals into account when making trading decisions. (Note 4) Furthermore all of the studies, with the exception of Kenourgios and Samitas (2004), focus only on the 3-month daily rolling futures contract; other futures contracts are not considered.

4. Statistical Methodology

As discussed, speculative efficiency hypothesis implies under the condition of risk neutrality and zero transaction cost

$$S_{t+n} = F_{t,n} + e_{t,n} \tag{1}$$

Equation (1) outlines that the futures price $F_{t,n}$ with maturity in n periods quoted at a point in time t is the best unbiased predictor of the future spot price S_{t+n}, when the futures contract falls due, given the information framework available at point in time t and given that the forecast error term e_t has zero mean and is serially uncorrelated. We will base our analysis on this basic pricing model. Furthermore, we take the random and unpredictable appearance of new information in an efficient market into consideration. Accordingly, there is no methodical relationship between the present and any previous forecast error of the own or other base metals. These implications for speculative efficiency can be written as

$$E\left(S_{t+n} - F_{t,n} \mid S_t - F_{t-n,n}\right) = 0$$

At first, we analyze the six base metals considering the 3-month and 15-month futures contracts in a single-market context. Our sample database consists of the monthly average second-ring prices as published by the LME for the cash and futures contracts for the period between July 1991 to March 2008. There has been some discussion in the literature regarding the EMH in futures markets, that using averaged data may result in spurious conclusions [e.g., Gilbert (1986), Gross (1988)]. The main argument against testing EMH on averaged data is the synthetic character. Under normal circumstances, it is not possible to use averaged data as an underlying basis for futures trading, and argumentation based on this database proves nothing, due to the lack of arbitrage possibilities required for the speculative efficiency. This argument is correct for most futures exchanges, as they do not provide pricings, instruments with which to trade futures on the basis of an average price for a predetermined period. The LME offers the trading on basis of the monthly average settlement price (MASP). Market participants can predetermine a settlement month and quantity of futures. At the end of the period, the future contracts are settled on basis of the MASP. Therefore the application of averaged data for our analysis is feasible. Using the methodology of Canarella and Pollard (1986), we consider three models:

$$s_{t+n} - f_{t,n} = e_{t,n} \tag{2}$$

$$s_{t+n} - f_{t,n} = a_0 + e_{t,n} \tag{3}$$

$$\begin{aligned} s_{t+n} - f_{t,n} &= a_0 + a_1\left(s_t - f_{t-n,n}\right) + a_2\left(s_{t-1} - f_{t-n-1,n}\right) + a_3\left(s_{t-2} - f_{t-n-2,n}\right) \\ &+ a_4\left(s_{t-3} - f_{t-n-3,n}\right) + e_{t,n} \end{aligned} \tag{4}$$

where s_{t+n} is the natural logarithm of the spot price S_{t+n} and $f_{t,n}$ is the natural logarithm of the futures price $F_{t,n}$.

As Hodrick (1987) points out, ordinary least squares (OLS) is not a valid estimation approach, due to the existence of a lagged dependent variable in Equation (4). Furthermore, if the database consists of overlapping data ($n > 1$), the forecast error follows a moving average process of order $(n-1)$ [Hansen and Hodrick (1980), Hsieh and Kulatilaka (1982)]. The moving average process is generated by the inflow of new information during the futures contract life cycle. As OLS would bias the estimated standard errors downwards and induce incorrect results regarding speculative efficiency, one approach is the utilization of non-overlapping data. We discard this approach because the analysis of the long-term 15-month futures contract reduces our sample to a featureless level.

We favor a procedure, such as the ARMA approach, that accounts for the existence of the moving average process for the forecast error term; we reason that, by not taking into account the MA structure, participants use future information, that they do not have access to, when making their decisions.

All parameters are computed by maximum-likelihood estimation. Diagnostic checking of the appropriateness of these models is undertaken in two ways. First, we check all forecast error time series for stationarity using the Augmented Dickey-Fuller (ADF)-test and KPSS-test. We failed to reject the null hypothesis of stationarity for all times series. Second, we check the constraint of white noise of the residuals by implementing the Ljung-Box test with Q-levels of 12 and 24 lags on the 3-month futures contact and 24 and 48 lags on the 15-month contract. We failed to reject the white-noise null hypothesis for all residual time series. As demonstrated by Galbraith and Galbraith (1974), we also consider the standard errors of the moving average coefficients. These should be of the same magnitude for a well-specified model. This condition is satisfied by all models in consideration of the quantity of parameters.

The single-market analysis is performed using the Wald test and the likelihood ratio test. The Wald test is used to test whether an independent variable has a statistically significant relationship with a dependent variable [Wald (1943)]. The test statistic used for testing the speculative efficiency is:

$$F = \frac{\left(\tilde{u}'\tilde{u} - u'u\right)/q}{\tilde{u}'\tilde{u}/N-k} \tag{5}$$

where $\tilde{u}'\tilde{u}$ is the restricted sum of squared residuals, $u'u$ is the unrestricted sum of squared residuals, q is the number of restrictions implied, N is the number of observations and k is the total unrestricted number of parameters. F will be central $F(q, N-K)$ distributed [Cameron and Trivedi (2005)]. The Wald test has been extensively analyzed for it's suitability for ARMA processes and is widely accepted. [e.g., Galbraith and Zinde-Walsh (1997)].

Speculative efficiency implies that none of the right-hand side terms of the three models contains any explanatory power; we thus test three hypotheses using the Wald test, where H_1 is related to equation (3) and H_2 and H_3 are related to equation (4):

$$H_1 : a_0 = 0$$

$$H_2 : a_1 = a_2 = a_3 = a_4 = 0$$

$$H_3 : a_0 = a_1 = a_2 = a_3 = a_4 = 0$$

We also test H_3 by means of a likelihood ratio test of the form $LR = -2\log\frac{Lr}{Lu}$, where Lr is the maximum value of the restricted likelihood function. In this case, the forecast error follows only an MA procedure of order $(n-1)$, and Lu is the maximum value of the unrestricted likelihood function. The likelihood ratio test statistic LR follows a chi-square distribution with a degree of freedoms equal to the number of restrictions. With these tests, two dimensions are tested simultaneously. The first dimension is the unbiased prediction hypothesis. Furthermore it is a test of the degree that the forecast errors can be explained by the covariates. Next, we expand our framework to a multi-contract framework. We therefore extend our model to the ARMAX specification and include the forecast

error $e_{ij} = (s_t^{ij} - f_{t-n,n}^{ij})$ of the 3-month futures contract's corresponding 15-month contract for the underlying base metal and vice-versa. Due to trading usances, brokers normally calculate the futures prices based on the most liquid 3-month futures contract. The futures contract is then either adjusted by carry trades or settled with other open contracts on the broker's trading card. Thus we expect influence of the corresponding futures contracts and expand out model:

$$\begin{aligned} s_{t+n} - f_{t,n} &= a_0 + a_1(s_t - f_{t-n,n}) + a_2(s_{t-1} - f_{t-n-1,n}) + a_3(s_{t-2} - f_{t-n-2,n}) \\ &+ a_4(s_{t-3} - f_{t-n-3,n}) + b_{ij}(s_t^{ij} - f_{t-n,n}^{ij}) + e_{t,n} \end{aligned} \tag{6}$$

where s_t^{ij} is the natural logarithm of the spot price S_{t+n}^{ij}, $f_{t-n,n}^{ij}$ is the natural logarithm of the futures price $F_{t,n}^{ij}$, i is the underlying parameter where 1 is aluminum (Al), 2 is copper (Cu), 3 is nickel (Ni), 4 is lead (Pb), 5 is tin (Sn) and 6 is zinc (Zn) and j is the contract parameter where 1 is the 3-month futures contract and 2 is the 15-month futures contract.

We check the hypothesis using the Wald as well as the likelihood ratio test:

$$H_4 : a_0 = a_1 = a_2 = a_3 = a_4 = b_{ij} = 0$$

Finally we expand our framework to a multi-market and multi-contract framework. These additional covariates might contain additional information due to three facts. First the base metals can substitute each other for some production processes. Second, most mines contain more than one base metal and metal producing companies take different base metal prices into account for extraction processes. Third, trading companies and brokers normally trade all base metals simultaneously in the same department and trading desk. Hence trading decisions are normally based on a comprehensive market analysis of all base metals. Therefore we analyze the model

$$\begin{aligned} s_{t+n} - f_{t,n} &= a_0 + a_1(s_t - f_{t-n,n}) + a_2(s_{t-1} - f_{t-n-1,n}) + a_3(s_{t-2} - f_{t-n-2,n}) + a_4(s_{t-3} - f_{t-n-3,n}) \\ &+ \sum_{i=1}^{6}\sum_{j=1}^{2} b_{ij}(s_t^{ij} - f_{t-n,n}^{ij}) + e_{t,n} \end{aligned} \tag{7}$$

As the b_{ij} terms only consist of the exogenous forecast errors of the other base metals, we exclude the endogenous forecast error, already considered for a_1. We check the hypothesis using the Wald and the likelihood ratio test:

$$H_5 : a_0 = a_1 = a_2 = a_3 = a_4 = b_{11} = b_{12} = b_{21} = \ldots = b_{62} = 0$$

By reason of the multitude of parameters considered, we focus on the likelihood ratio tests. As robustness check, we also rerun all Wald and likelihood-ratio tests using winsorized data with cut-off points at the 1st and 99th percentile to avoid the effect of outliers. Furthermore we analyze the development of speculative efficiency using two subperiods before and after 2000, which roughly coincide with, first, the bull market in equities and weak commodity prices in the 1990s and, second, the period of relatively greater commodity strength after 2000.

4. Empirical Results

The tables present the results for the different test settings. Tables 1 to 6 present the model's coefficients, standard errors, and Ljung-Box Q-Statistics and the results for the Wald test setups H_1 to H_4 for the 3-month contracts. Tables 7 to 12 contain the 15-month contracts. The multi-market analysis is presented in Tables 13. The results of the likelihood ratio test are demonstrated in Table 14.

Furthermore test result using winsorized data with cut-off points at the 1st and 99th percentile are presented in Table 15. Test results for the two subperiods before and after 2000 are demonstrated in Table 16.

The first hypothesis proposes the basic statement of the speculative efficiency, that the futures price is the best predictor of the future spot price. Other information, such as the past forecast error, is not considered. We failed to reject the null hypothesis for all forecast errors based on the 3-month futures contracts at a 5 % level of significance. These findings coincide with former studies [e.g., Canarella and Pollard (1986), Moore and Cullen (1995)]. For the 15-month contracts, we failed to reject the null hypothesis for all base metals except for lead and tin. Interestingly Goss (1981) notices the same bias for both metals for the period of 1971-1978 when analyzing the forecast error of the 3-month contract. A possible explanation might be the fact that the contracts based on the two base metals are considered to be illiquid. (Note 5) As the concept of speculative efficiency implies the principles of arbitrage, sufficient liquidity is required for market efficiency.

H_2 focuses only on past forecast errors. For the 3-month contracts, we failed to reject the null hypothesis for all but tin and for the 15-month contracts for all but aluminium, tin and zinc.

Regarding H_3, we analyze the present and past forecast errors. As shown by Agresti (2007), likelihood ratio tests are more reliable with small samples and an increasing number of parameters than the Wald test. We put our main focus on the results of the likelihood ratio tests, which are mainly confirmed by the results of the Wald test. We reject the null hypothesis only for the 3-month contracts of copper and zinc, and for the 15-month contracts of lead and tin. These findings support the results of Goss (1985), Kenourgios and Samitas (2004).

By extending our analysis to the multi-contract framework, we cannot find any additional explanatory power for the 3-month contracts by adding 15-months forecast error to the models. Our findings regarding speculative efficiency for all six base metals remain unchanged. Inversely, the 3-month forecast errors add explanatory power to models based on the 15-month contract. In addition to tin, which had already been rejected in the single-contract framework, we reject the null hypothesis of speculative efficiency for the 15-month contracts of copper, nickel and zinc based on the results of the likelihood ratio test.

By adding the forecast error of the corresponding 3-month contracts to the framework, we reject the speculative hypothesis for the three base metals. These findings are indeed contrary to the results of existing EMH studies of the LME, which only focus on 3-month contracts. A possible explanation for the one-way influence of the 3-month forecast error on the 15-month contract might be the business practices of most LME brokers and speculators to trade all futures contract maturities on the basis of the 3-month futures contract and to either adjust the underlying contract by carry trades or take the risk of a shifting forward curve. Another explanation might be the shift of trading volume to the exchange's electronic trading platform, LME Select. In spite of the possibility of trading all maturities for all underlyings on LME Select, only the spot and 3-month futures contracts are considered to be liquid and actively traded. Therefore market participants using LME Select have to adjust their contracts to the appropriate prompt date via carry trades. Among the supply and demand of carry trades, the borrowing or lending rates of the "3's to maturity" carry trades are affected by past forecast errors. Furthermore, as many risk-controlling systems take the past forecast errors for the calculation of the Value-at-Risk into account, LME brokers have to consider these figures for managing the maturity structure of their trading cards.

The extension of our analysis to the multi-contract and multi-market framework results in the additional rejection of the null hypothesis for the 3-month futures contracts of nickel and tin. As demonstrated for tin, we have already found some explanatory power for the past forecast error of the same contract using the Wald test but have found none for the present. These findings were not supported by the likelihood ratio test under the single-market and multi-contract framework, but they were under the multi-market framework. As a robust check, winsorized data with cut-off points at the 1st and 99th percentile has been analyzed. In most instances, the avoidance of outliers does not influence the test results. Regarding the likelihood ratio tests winsorized data rejects additionally H(3) and H(4) for the 3-month nickel contract. In general, winsorization biases our findings to rejection of the null hypotheses of speculative efficiency. In addition to the complete sample period, we analyze the two subperiods before and after 2000. Especially for the period after 2000, we find a broad-based reduction of speculative efficiency in comparison to the pre-2000 period. In particular, speculative efficiency reduced significantly for both copper and nickel contracts and the 15-month contract of lead and zinc. A reason for the decline of speculative efficiency might be the increasing activity of speculative investors like hedge funds in commodity markets after the burst of the dotcom bubble in 2000.

In summary, we reject the null hypothesis of speculative efficiency for all base metals except for both aluminum and the 3-month lead contract in a multi-contract, multi-market framework. In particular, the additional analysis of the corresponding contract for the same base metal added explanatory power to the analysis. The consideration of other base metals also added informative value to the speculative efficiency analysis, a fact that has so far been neglected by studies concerning the LME. A reason for the efficiency of the aluminum contracts might that it has become the most liquid contract of the LME. Moreover, the price of aluminum became, in addition to copper, a leading economical indicator for the commodities markets, which also attracted speculators such as hedge funds and commodity trading advisors (CTA).

From an academic point of view, the test for speculative efficiency of the LME is especially interesting in reference to the efficient-market hypothesis. As we reject the speculative efficiency hypothesis for all base metals except for both aluminum and the 3-month lead contracts, the futures prices do not fully reflect all available information. Hence these results rebut the original efficient-market hypothesis by Fama for base metal commodity markets and should be an interesting contribution to the general discussion of market efficiency and behavioural finance. Further studies regarding market efficiency of base metals should focus on the different interaction of futures contracts of different commodities markets, such as the New York Mercantile Exchange and the Shanghai Metal Exchange. Moreover, studies analysing the information content of key data, such as warehouse stocks and open interest, might be especially enlightening.

Furthermore, these findings should be especially of interest for hedgers, speculators and market regulators. Hedgers use the LME futures contracts to offset exposure to price fluctuations of an underlying physical metal contract, to minimise the unwanted price risk. Principally, hedgers are interested in an efficient market because prices always fully reflect available information. In the case of market-efficiency, hedgers do not have to analyze market data for their

hedging decisions. Therefore, aluminum can be hedged efficiently without an expensive market analysis. For the other base metals, hedgers should take the additional price-generating influence of futures contracts with different maturities into account to optimise their hedging strategies.

Speculators try to generate excess returns by forecasting base metal prices and take a corresponding futures position. Most forecasting systems are based on market inefficiencies and speculators analyze market data to establish excess, generating trading strategies. As speculative efficiency hypothesis is not appropriate for all base metals, there might be some opportunities for speculators to generate excess returns. Further studies should test if these inefficiencies can be used for real-life trading strategies.

Market regulators observe base metal futures prices in order to find evidence of market manipulation and insider trading. An inefficient market complicates the monitoring because regulators cannot verify precisely the occurrence of market manipulation, as any market anomaly might be based on the market inefficiency. As speculative efficiency hypothesis can be rejected for all base metals except aluminum, the monitoring of market manipulation and insider trading need sophisticated models to take the interaction of different futures contracts into account.

5. Summary and Conclusion

We analyzed the speculative efficiency of six base metals traded at the LME using the 3-month and 15-month futures contracts. We focused on the influence of the present and past forecast error of these futures as well as corresponding futures with different maturities. We extended our analysis to the multi-market framework and implemented the forecast errors of the other base metals in our analysis for speculative efficiency.

In contrast to former studies regarding the LME, we reject the speculative efficiency hypothesis for all base metal contracts except for both aluminum and the 3-month lead contract. Furthermore, speculative efficiency reduces significantly for the period after 2000.The main reason for this discrepancy might be the fact that all relevant studies have only focused on the 3-month futures contract. Furthermore, none of the studies applies the possibility of trading monthly averaged prices via the LME's pricings. As nearly all of the studies have used the pre-Tin Crisis period as sample basis, another reason might be a change in market efficiency following the Tin Crisis.

We see the main reasons for efficiency in the aluminum market in the high level of liquidity, the outstanding general economic importance and the increased activity of speculative traders. Our main conclusion is that hedgers, traders and market regulators should take the influence of different contracts for the same underlying and their interaction into account. In particular, the liquid and generally accepted LME 3-month contract added explanatory power to the 15-month contract. However, the rest of the base metal markets also have an impact on the price-generating process of the underlying futures contract. Therefore, potential interactions between different commodities, due to trading usances or other economic reasons, should be considered when analyzing market efficiency. Furthermore, efficient hedging strategies should also include any given interaction between different contracts and markets.

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Notes

Note 1. Tin contracts can only be traded with prompt dates up to 15-months.

Note 2. The Tin Crisis and the collapse of the International Tin agreement could have been prevented, if the LME had been cleared in the manner of a standard futures market.

Note 3. For example, Gilbert (1986) criticizes Goss (1981) for using non-tradable monthly averaged data.

Note 4. To quote an example, zinc mines also contain some amount of lead, and copper mines also contain some amount of tin.

Note 5. The 10-year average open interest was about 18.600 lots for tin and about 54.000 lots for lead. By comparison, copper showed number of 208.000 lots, and aluminium showed about 416.000 lots

Table 1. 3-month aluminium futures

	Equation 2	Equation 3	Equation 4	Equation 6
a0		0.0020	0.0027	0.0035
		(0.0096)	(0.0101)	(0.0102)
a1			0.1034	0.1418
			(0.1073)	(0.1154)
a2			-0.0853	-0.0772
			(0.095)	(0.0952)
a3			0.0423	0.0474
			(0.0912)	(0.0912)
a4			0.1354	0.1685
			(0.0909)	(0.0986)
Al15				-0.0449
				(0.0552)
Q(12)	8.0609	8.0625	5.6420	6.7511
	[0.623]	[0.623]	[0.844]	[0.749]
Q(24)	14.2320	14.2350	10.8280	11.0660
	[0.893]	[0.893]	[0.977]	[0.974]
R^2	0.6586	0.6587	0.6656	0.6670
H(1):a0=0			F=0.0685	[0.7938]
H(2):a1=a2=a3=a4=0			F=0.8812	[0.4766]
H(3):a0=a1=a2=a3=a4=0			F=0.7181	[0.6107]
H(4):a0=a1=a2=a3=a4=Al15=0			F=0.7235	[0.6312]

Table 2. 3-month copper future

	Equation 2	Equation 3	Equation 4	Equation 6
a0		0.0240	0.0159	0.0198
		(0.0182)	(0.0141)	(0.0141)
a1			0.1377	0.1884
			(0.0830)	(0.0857)
a2			-0.0193	0.0117
			(0.08488)	(0.0852)
a3			0.1533	0.1565
			(0.08534)	(0.0838)
a4			0.0675	0.1294
			(0.0832)	(0.0880)
Cu15				-0.0658
				(0.0336)
Q(12)	9.7459	9.7170	6.6642	13.4390
	[0.371]	[0.374]	[0.672]	[0.200]
Q(24)	15.5450	15.4690	12.8410	23.6010
	[0.795]	[0.799]	[0.914]	[0.368]
R^2	0.7849	0.7871	0.7941	0.7951
H(1):a0=0			F=1.0661	[0.3034]
H(2):a1=a2=a3=a4=0			F=2.2461	[0.0664]
H(3):a0=a1=a2=a3=a4=0			F=2.4211	[0.0379]
H(4):a0=a1=a2=a3=a4=Cu15=0			F=2.7308	[0.0149]

Table 3. 3-month nickel futures

	Equation 2	Equation 3	Equation 4	Equation 6
a0		0.3570	0.0283	0.0331
		(0.0224)	(0.0181)	(0.0185)
a1			0.1535	0.2252
			(0.0886)	(0.1035)
a2			0.0371	0.0185
			(0.0918)	(0.0935)
a3			-0.0932	-0.03
			(0.0900)	(0.0930)
a4			0.1572	0.2113
			(0.0862)	(0.0983)
Ni15				-0.0822
				(0.0536)
Q(12)	10.047	9.9522	9.5718	11.315
	[0.436]	[0.445]	[0.479]	[0.333]
Q(24)	21.4310	21.2520	21.5630	20.0340
	[0.494]	[0.505]	[0.486]	[0.581]
R^2	0.7511	0.7548	0.7526	0.7554
H(1):a0=0			F=2.4342	[0.1207]
H(2):a1=a2=a3=a4=0			F=1.8328	[0.1250]
H(3):a0=a1=a2=a3=a4=0			F=2.2409	[0.0528]
H(4):a0=a1=a2=a3=a4=Ni15=0			F=1.9667	[0.0734]

Standard errors in parentheses. Marginal significance levels in brackets.
Q(12) and Q(24) are the Ljung-Box Q-statistics for lags 12 and 24.

Table 4. 3-month lead futures

	Equation 2	Equation 3	Equation 4	Equation 6
a0		0.0185	0.0188	0.0189
		(0.0137)	(0.0143)	(0.0144)
a1			0.0967	0.1020
			(0.0803)	(0.0945)
a2			-0.1023	-0.1007
			(0.0797)	(0.0814)
a3			0.0733	0.0735
			(0.0787)	(0.079)
a4			0.0674	0.0720
			(0.0796)	(0.0907)
Pb15				-0.0054
				(0.0503)
Q(12)	13.9110	13.8720	10.5080	10.8370
	[0.177]	[0.179]	[0.397]	[0.370]
Q(24)	25.7440	25.7310	19.6360	20.1460
	[0.263]	[0.263]	[0.606]	[0.574]
R^2	0.7351	0.7380	0.7429	0.7429
H(1): a0=0			F=1.7201	[0.1915]
H(2): a1=a2=a3=a4=0			F=1.2376	[0.2971]
H(3): a0=a1=a2=a3=a4=0			F=1.3662	[0.2397]
H(4): a0=a1=a2=a3=a4=Pb15=0			F=1.1335	[0.3453]

Table 5. 3-month tin futures

	Equation 2	Equation 3	Equation 4	Equation 6
a0		0.0119	0.0112	0.0117
		(0.0115)	(0.0118)	(0.0118)
a1			0.1808	0.2218
			(0.0816)	(0.092)
a2			-0.0791	-0.0632
			(0.0822)	(0.0822)
a3			-0.0402	-0.0382
			(0.0823)	(0.0847)
a4			0.1816	0.2226
			(0.0814)	(0.0902)
Sn15				-0.0479
				(0.0468)
Q(12)	16.7940	16.8580	10.0980	11.6670
	[0.079]	[0.078]	[0.432]	[0.308]
Q(24)	27.8950	27.9680	21.1470	21.2410
	[0.179]	[0.177]	[0.512]	[0.506]
R^2	0.7342	0.7359	0.7466	0.7481
H(1):a0=0			F=2.4342	[0.1207]
H(2):a1=a2=a3=a4=0			F=1.8328	[0.1250]
H(3):a0=a1=a2=a3=a4=0			F=2.2409	[0.0528]
H(4):a0=a1=a2=a3=a4=Ni15=0			F=1.9667	[0.0734]

Table 6. 3-month zinc futures

	Equation 2	Equation 3	Equation 4	Equation 6
a0		0.0050	0.0045	0.0466
		(0.0173)	(0.0173)	(0.0863)
a1			0.0855	-0.2215
			(0.1365)	(0.1133)
a2			0.0943	0.0640
			(0.1142)	(0.0740)
a3			-0.0381	-0.1160
			(0.0939)	(0.0742)
a4			0.0786	-0.0002
			(0.1018)	(0.0864)
Zn15				-0.3654
				(0.1164)
Q(12)	16.8520	16.8320	11.0950	13.1470
	[0.051]	[0.051]	[0.269]	[0.156]
Q(24)	24.1270	24.0910	16.4890	19.9050
	[0.287]	[0.289]	[0.742]	[0.527]
R^2	0.7512	0.7513	0.7557	0.7620
H(1): a0=0			F=1.7201	[0.1915]
H(2): a1=a2=a3=a4=0			F=1.2376	[0.2971]
H(3): a0=a1=a2=a3=a4=0			F=1.3662	[0.2397]
H(4): a0=a1=a2=a3=a4=Pb15=0			F=1.1335	[0.3453]

Table 7. 15-month aluminium futures

	Equation 2	Equation 3	Equation 4	Equation 6
a0		0.0513	0.0457	0.0512
		(0.0459)	(0.0463)	(0.0439)
a1			0.0516	0.1189
			(0.0732)	(0.0998)
a2			0.0463	0.0177
			(0.0751)	(0.0761)
a3			0.1017	0.0677
			(0.0776)	(0.0819)
a4			0.1670	0.1026
			(0.0719)	(0.0999)
Al3				-0.1043
				(0.0796)
Q(24)	15.8550	17.6990	13.0960	12.74
	[0.104]	[0.0603]	[0.218]	[0.239]
Q(48)	41.2320	43.3620	32.6790	29.433
	[0.184]	[0.13]	[0.532]	[0.691]
R^2	0.9449	0.9482	0.9544	0.9533
H(1): a0=0			F=0.9765	[0.3248]
H(2): a1=a2=a3=a4=0			F=3.3274	[0.0123]
H(3): a0=a1=a2=a3=a4=0			F=4.4316	[0.0009]
H(4): a0=a1=a2=a3=a4=Al3=0			F=4.2903	[0.0005]

Standard errors in parentheses. Marginal significance levels in brackets.

Q(12), Q(24) and Q(48) are the Ljung-Box Q-statistics for lags 12, 24 and 48.

Table 8. 15-month copper futures

	Equation 2	Equation 3	Equation 4	Equation 6
a0		0.1451	0.1126	0.2116
		(0.1065)	(0.1164)	(0.1777)
a1			-0.1093	-0.2068
			(0.0810)	(0.0854)
a2			0.1286	0.0630
			(0.0793)	(0.0741)
a3			0.0705	0.0565
			(0.0812)	(0.0738)
a4			-0.0142	-0.1641
			(0.0764)	(0.0834)
Cu3				-0.2424
				(0.0815)
Q(24)	9.8257	10.8210	9.7223	10.2050
	[0.365]	[0.288]	[0.373]	[0.334]
Q(48)	31.6250	32.4840	33.6840	32.6530
	[0.536]	[0.493]	[0.434]	[0.484]
R^2	0.9704	0.9710	0.9718	0.9728
H(1): a0=0			F=0.9352	[0.3352]
H(2): a1=a2=a3=a4=0			F=1.4754	[0.2130]
H(3): a0=a1=a2=a3=a4=0			F=1.3455	[0.2489]
H(4): a0=a1=a2=a3=a4=Cu3=0			F=4.8221	[0.0002]

Table 9. 15-month nickel futures

	Equation 2	Equation 3	Equation 4	Equation 6
a0		0.1507	0.2150	0.2493
		(0.1409)	(0.1246)	(0.1675)
a1			-0.1577	-0.0833
			(0.0842)	(0.0957)
a2			-0.0957	0.0709
			(0.0898)	(0.0769)
a3			-0.0626	-0.0263
			(0.0882)	(0.0813)
a4			0.0373	-0.3213
			(0.0861)	(0.1055)
Ni3				-0.6000
				(0.1092)
Q(24)	8.9583	8.6532	7.0136	7.6356
	[0.536]	[0.565]	[0.724]	[0.664]
Q(48)	23.9580	23.5400	24.3450	27.7720
	[0.899]	[0.911]	[0.889]	[0.664]
R^2	0.9652	0.9654	0.9657	0.9655
H(1): a0=0			F=2.9756	[0.0868]
H(2): a1=a2=a3=a4=0			F=1.4106	[0.2337]
H(3): a0=a1=a2=a3=a4=0			F=1.2925	[0.2707]
H(4): a0=a1=a2=a3=a4=Ni3=0			F=7.4019	[0.0000]

Table 10. 15-month lead futures

	Equation 2	Equation 3	Equation 4	Equation 6
a0		0.2333	0.1387	0.1647
		(0.1031)	(0.0554)	(0.0782)
a1			0.0575	0.1386
			(0.0937)	(0.1351)
a2			-0.1323	-0.0429
			(0.0795)	(0.0880)
a3			0.1059	0.082
			(0.0879)	(0.0951)
a4			0.1903	0.1623
			(0.0871)	(0.1219)
Pb3				-0.0106
				(0.1131)
Q(24)	14.0460	15.0371	17.2850	15.775
	[0.171]	[0.131]	[0.068]	[0.106]
Q(48)	35.0120	41.4990	35.2490	37.66
	[0.420]	[0.176]	[0.409]	[0.305]
R^2	0.9722	0.9732	0.9738	0.9733
H(1): a0=0			F=6.2578	[0.0135]
H(2): a1=a2=a3=a4=0			F=2.2169	[0.0703]
H(3): a0=a1=a2=a3=a4=0			F=6.4294	[0.0000]
H(4): a0=a1=a2=a3=a4=Pb3=0			F=2.1286	[0.0539]

Table 11. 15-month tin futures

	Equation 2	Equation 3	Equation 4	Equation 6
a0		0.1397	0.2148	0.1276
		(0.0847)	(0.0901)	(0.1344)
a1			-0.3153	-0.1327
			(0.0912)	(0.0811)
a2			0.0976	0.1175
			(0.0784)	(0.0759)
a3			0.1254	0.1284
			(0.0759)	(0.0754)
a4			0.2309	0.0749
			(0.0753)	(0.0803)
Sn3				-0.2367
				(0.0537)
Q(24)	16.5520	16.3090	7.1646	8.452
	[0.085]	[0.091]	[0.710]	[0.585]
Q(48)	33.6030	33.5420	22.4130	30.024
	[0.487]	[0.490]	[0.936]	[0.663]
R^2	0.9731	0.9736	0.9723	0.9757

H(1): a0=0 F=5.6856 [0.0185]

H(2): a1=a2=a3=a4=0 F=6.7706 [0.0001]

H(3): a0=a1=a2=a3=a4=0 F=5.9239 [0.0001]

H(4): a0=a1=a2=a3=a4=Sn3=0 F=7.2043 [0.0000]

Standard errors in parentheses. Marginal significance levels in brackets.

Q(24) and Q(48) are the Ljung-Box Q-statistics for lags 24 and 48

Table 12. 15-month zinc futures

	Equation 2	Equation 3	Equation 4	Equation 6
a0		0.0684	0.0299	0.0752
		(0.1181)	(0.3319)	(0.1663)
a1			-0.5163	-0.4106
			(0.0954)	(0.1350)
a2			0.0604	0.0362
			(0.0986)	(0.0865)
a3			-0.0495	-0.0200
			(0.0932)	(0.0857)
a4			-0.1727	0.1511
			(0.0917)	(0.1177)
Zn3				0.1390
				(0.1212)
Q(24)	13.2010	13.0370	7.6362	6.6953
	[0.213]	[0.222]	[0.664]	[0.754]
Q(48)	24.6480	24.4060	21.5750	18.335
	[0.880]	[0.887]	[0.951]	[0.987]
R^2	0.9754	0.9754	0.9760	0.9769

H(1): a0=0 F=0.3350 [0.5637]

H(2): a1=a2=a3=a4=0 F=8.9144 [0.0000]

H(3): a0=a1=a2=a3=a4=0 F=7.1836 [0.0000]

H(4): a0=a1=a2=a3=a4=Zn3=0 F=2.4328 [0.0289]

Table 13. Multi-market

	AL 3	Al 15	CU 3	CU 15	NI 3	NI 15	PB 3	PB 15	SN 3	SN 15	ZN 3	ZN 15
a0	-0.001	0.098	0.014	0.281	0.035	0.261	0.012	0.176	0.009	0.136	0.026	0.280
	(0.011)	(0.150)	(0.015)	(0.212)	(0.020)	(0.165)	(0.015)	(0.199)	(0.012)	(0.148)	(0.069)	(0.397)
a1	0.195	0.048	-0.031	-0.251	0.193	-0.147	0.213	-0.093	0.082	-0.125	-0.196	-0.252
	(0.148)	(0.144)	(0.121)	(0.103)	(0.107)	(0.126)	(0.113)	(0.144)	(0.098)	(0.110)	(0.140)	(0.170)
a2	-0.011	-0.095	0.032	0.039	-0.040	0.027	-0.043	0.105	-0.006	0.069	0.087	-0.047
	(0.094)	(0.085)	(0.089)	(0.074)	(0.082)	(0.083)	(0.083)	(0.086)	(0.076)	(0.071)	(0.079)	(0.084)
a3	0.058	-0.090	0.171	0.038	0.024	-0.071	0.033	-0.054	0.007	0.088	-0.083	-0.123
	(0.091)	(0.083)	(0.088)	(0.074)	(0.0810)	(0.081)	(0.082)	(0.096)	(0.078)	(0.067)	(0.078)	(0.088)
a4	0.160	-0.198	0.113	-0.216	0.236	-0.343	0.125	-0.099	0.177	-0.048	-0.004	-0.042
	(0.098)	(0.127)	(0.098)	(0.090)	(0.093)	(0.105)	(0.094)	(0.116)	(0.088)	(0.090)	(0.091)	(0.109)
AL 3		-0.128	0.189	0.107	0.107	-0.106	-0.158	-0.081	-0.080	0.057	-0.241	0.361
		(0.139)	(0.137)	(0.133)	(0.175)	(0.217)	(0.133)	(0.131)	(0.116)	(0.115)	(0.156)	(0.140)
AL 15	-0.145		-0.070	-0.162	-0.090	0.121	-0.114	-0.114	-0.005	-0.058	0.109	-0.382
	(0.1134)		(0.085)	(0.164)	(0.090)	(0.239)	(0.072)	(0.145)	(0.079)	(0.128)	(0.170)	(0.108)
CU 3	-0.078	-0.076		-0.415	-0.189	-0.104	0.187	0.211	-0.106	-0.104	-0.081	-0.001
	(0.096)	(0.080)		(0.130)	(0.160)	(0.132)	(0.121)	(0.089)	(0.097)	(0.065)	(0.106)	(0.086)
CU 15	0.010	-0.115	0.004		0.069	-0.184	0.036	-0.139	-0.055	-0.027	0.173	-0.201
	(0.064)	(0.078)	(0.061)		(0.072)	(0.145)	(0.055)	(0.094)	(0.051)	(0.071)	(0.095)	(0.076)
NI 3	-0.056	-0.061	0.001	0.064		-0.439	-0.019	-0.096	-0.053	-0.198	0.047	-0.110
	(0.064)	(0.046)	(0.080)	(0.064)		(0.118)	(0.080)	(0.052)	(0.066)	(0.054)	(0.072)	(0.058)
NI 15	0.050	0.034	0.032	-0.047	-0.138		0.013	-0.053	0.085	0.082	-0.107	0.064
	(0.041)	(0.047)	(0.047)	(0.074)	(0.069)		(0.047)	(0.052)	(0.037)	(0.059)	(0.076)	(0.056)
PB 3	0.112	0.007	-0.107	-0.102	-0.178	-0.230		-0.315	0.241	0.078	0.101	0.141
	(0.088)	(0.069)	(0.108)	(0.105)	(0.146)	(0.150)		(0.119)	(0.079)	(0.088)	(0.105)	(0.102)
PB 15	0.058	0.005	0.141	0.205	0.034	0.260	-0.092		-0.029	-0.025	0.005	-0.314
	(0.060)	(0.091)	(0.066)	(0.129)	(0.089)	(0.189)	(0.074)		(0.054)	(0.097)	(0.121)	(0.112)
SN 3	-0.033	-0.169	0.082	-0.197	0.266	0.275	-0.089	-0.290		-0.251	0.050	-0.105
	(0.097)	(0.070)	(0.121)	(0.104)	(0.162)	(0.155)	(0.128)	(0.086)		(0.122)	(0.111)	(0.104)
SN 15	-0.114	0.112	-0.095	0.121	-0.026	-0.238	0.054	0.244	-0.118		-0.025	0.284
	(0.062)	(0.090)	(0.063)	(0.107)	(0.078)	(0.180)	(0.061)	(0.105)	(0.059)		(0.115)	(0.084)
ZN 3	-0.078	0.087	0.190	0.113	0.306	-0.135	-0.150	-0.085	0.163	-0.031		-0.121
	(0.102)	(0.078)	(0.108)	(0.116)	(0.136)	(0.176)	(0.103)	(0.114)	(0.089)	(0.102)		(0.147)
ZN 15	0.039	-0.064	-0.154	-0.022	0.031	0.055	0.078	0.211	0.074	0.014	-0.409	
	(0.061)	(0.103)	(0.072)	(0.145)	(0.091)	(0.228)	(0.068)	(0.156)	(0.060)	(0.133)	(0.153)	
Q(12/24)	8.723	10.188	12.222	7.361	12.392	8.697	7.707	9.514	9.418	9.220	11.286	15.132
	[0.559]	[0.424]	[0.270]	[0.691]	[0.260]	[0.561]	[0.657]	[0.484]	[0.493]	[0.511]	[0.336]	[0.127]
Q(24/48)	15.160	32.049	24.322	31.567	23.451	36.494	18.570	31.950	23.800	25.165	20.804	28.572
	[0.855]	[0.564]	[0.331]	[0.587]	[0.377]	[0.354]	[0.672]	[0.568]	[0.358]	[0.864]	[0.533]	[0.731]
R^2	0.686	0.959	0.804	0.975	0.777	0.968	0.765	0.976	0.799	0.980	0.777	0.980
H(5):	0.835	3.494	1.661	3.199	3.171	2.198	1.831	5.199	3.702	15.847	3.044	9.103
	[0.644]	[0.000]	[0.060]	[0.000]	[0.000]	[0.009]	[0.032]	[0.000]	[0.000]	[0.000]	[0.000]	[0.0000]

Standard errors in parentheses. Marginal significance levels in brackets.

Q(12) and Q(24) are the Ljung-Box Q-statistics for lags 12 and 24 (3-month-contarcts) and for lags 24 and 48 (15-months contracts).

Table 14. Likelihood Ratio Tests

	Single Contract	Multi Contract	Multi Contract Multi Market
AL 3	3.4674	4.1618	14.2371
Prob.ChiSquare	[0.6283]	[0.6549]	[0.5811]
AL15	4.1303	4.6241	19.0975
Prob.ChiSquare	[0.5308]	[0.5928]	[0.2636]
CU 3	12.0290	16.0537	26.9724
Prob.ChiSquare	[0.0344]	[0.0135]	[0.0418]
CU 15	7.8469	13.5799	27.7643
Prob.ChiSquare	[0.1649]	[0.0347]	[0.0337]
NI 3	10.3580	12.2407	27.4864
Prob.ChiSquare	[0.0657]	[0.0568]	[0.0364]
NI 15	2.4550	29.3794	41.7869
Prob.ChiSquare	[0.7833]	[0.0001]	[0.0004]
PB 3	6.7030	6.7152	21.8213
Prob.ChiSquare	[0.2437]	[0.3480]	[0.1491]
PB 15	17.6178	12.0929	24.9717
Prob.ChiSquare	[0.0035]	[0.0599]	[0.0703]
SN 3	7.6216	8.5800	46.2949
Prob.ChiSquare	[0.1944]	[0.1986]	[0.0001]
SN 15	13.7932	16.2758	37.2208
Prob.ChiSquare	[0.0170]	[0.0123]	[0.0020]
ZN 3	14.0753	18.4743	22.9969
Prob.ChiSquare	[0.0288]	[0.0052]	[0.1138]
ZN 15	6.7113	15.3676	34.6597
Prob.ChiSquare	[0.2430]	[0.0089]	[0.0044]

Table 15. Winsorized data with cut-off points at the 1st and 99th percentile

	AL 3	AL 15	CU 3	CU 15	NI 3	NI 15	PB 3	PB 15	SN 3	SN 15	ZN 3	ZN 15
Wald Tests												
H(1)	0.027	0.490	2.676	1.518	2.554	1.327	1.414	5.130	1.064	4.621	0.097	0.242
	[0.870]	[0.485]	[0.103]	[0.220]	[0.112]	[0.251]	[0.236]	[0.025]	[0.304]	[0.033]	[0.756]	[0.624]
H(2)	1.113	3.907	**5.860**	1.665	2.043	1.768	1.172	1.916	3.815	3.766	11.966	9.024
	[0.352]	[0.005]	**[0.000]**	[0.162]	[0.091]	[0.139]	[0.325]	[0.112]	[0.005]	[0.006]	[0.000]	[0.000]
H(3)	0.902	5.221	5.272	1.546	2.246	0.175	1.314	2.418	3.266	4.011	9.623	7.269
	[0.481]	[0.000]	[0.000]	[0.180]	[0.052]	[0.127]	[0.261]	[0.039]	[0.008]	[0.002]	[0.000]	[0.000]
H(4)	0.846	4.986	5.115	6.909	**3.422**	4.729	1.091	**3.914**	2.637	8.300	7.054	2.393
	[0.536]	[0.000]	[0.000]	[0.000]	**[0.003]**	[0.000]	[0.370]	**[0.001]**	[0.018]	[0.000]	[0.000]	[0.031]
H(5)	0.784	2.286	**3.328**	1.894	2.494	5.940	4.364	5.392	5.724	22.180	3.141	12.109
	[0.701]	[0.005]	**[0.000]**	[0.025]	[0.002]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Likelihood Ratio Tests												
H(3)	4.193	7.178	21.243	7.316	**12.575**	5.376	6.571	12.324	7.553	15.698	14.557	6.133
	[0.522]	[0.208]	[0.001]	[0.198]	**[0.028]**	[0.372]	[0.255]	[0.031]	[0.183]	[0.008]	[0.012]	[0.294]
H(4)	4.688	7.297	26.675	23.339	**14.302**	22.503	6.587	11.570	8.551	17.781	21.505	16.462
	[0.584]	[0.294]	[0.000]	[0.001]	**[0.026]**	[0.001]	[0.361]	[0.072]	[0.128]	[0.022]	[0.002]	[0.012]
H(5)	13.566	21.847	44.454	26.541	26.536	29.074	23.057	25.809	51.870	35.595	23.550	31.847
	[0.631]	[0.148]	[0.000]	[0.047]	[0.047]	[0.023]	[0.112]	[0.057]	[0.000]	[0.003]	[0.100]	[0.011]

Marginal significance levels in brackets. Bold letters indicate signifcant deviation from origianl data.

Table 16. Subperiod Analysis

Panel 1: July 1991 - December 1999

	AL 3	AL 15	CU 3	CU 15	NI 3	NI 15	PB 3	PB 15	SN 3	SN 15	ZN 3	ZN 15
H(1)	0.107	0.103	0.001	0.026	0.001	0.034	0.975	0.545	0.118	1.785	0.791	0.387
	[0.744]	[0.750]	[0.974]	[0.873]	[0.977]	[0.854]	[0.326]	[0.463]	[0.732]	[0.186]	[0.377]	[0.536]
H(2)	1.501	1.439	1.496	2.633	48.520	2.125	1.524	3.908	3.051	6.301	0.336	5.832
	[0.208]	[0.232]	[0.212]	[0.043]	[0.000]	[0.090]	[0.204]	[0.008]	[0.022]	[0.000]	[0.853]	[0.001]
H(3)	1.186	0.915	2.752	1.942	48.567	1.897	1.222	6.190	3.207	4.923	0.313	4.876
	[0.324]	[0.478]	[0.025]	[0.101]	[0.000]	[0.110]	[0.307]	[0.000]	[0.011]	[0.001]	[0.903]	[0.001]
H(4)	1.009	1.604	3.635	4.550	1.052	9.514	1.324	1.882	2.190	6.322	1.479	2.487
	[0.426]	[0.163]	[0.003]	[0.001]	[0.399]	[0.000]	[0.258]	[0.100]	[0.053]	[0.000]	[0.198]	[0.031]
H(5)	1.360	28.815	1.215	5.821	1.648	11.294	2.804	4.037	3.167	11.176	1.401	4.951
	[0.188]	[0.000]	[0.280]	[0.000]	[0.082]	[0.000]	[0.002]	[0.000]	[0.001]	[0.000]	[0.167]	[0.000]
Likelihood Ratio												
H(3)	4.933	3.481	4.743	5.858	4.777	6.010	5.277	13.183	9.212	26.690	5.783	1.711
	[0.424]	[0.626]	[0.448]	[0.320]	[0.444]	[0.305]	[0.383]	[0.022]	[0.101]	[0.000]	[0.328]	[0.888]
H(4)	6.686	4.320	7.488	35.438	6.728	42.701	8.404	7.667	11.553	38.690	18.462	10.208
	[0.351]	[0.504]	[0.278]	[0.000]	[0.347]	[0.000]	[0.210]	[0.176]	[0.073]	[0.000]	[0.005]	[0.070]
H(5)	13.004	19.005	25.652	19.124	28.766	34.895	23.401	25.257	45.231	42.760	22.546	34.259
	[0.673]	[0.268]	[0.059]	[0.262]	[0.026]	[0.004]	[0.103]	[0.065]	[0.000]	[0.000]	[0.126]	[0.005]
Panel 2: January 2000 March 2008												
	AL 3	AL 15	CU 3	CU 15	NI 3	NI 15	PB 3	PB 15	SN 3	SN 15	ZN 3	ZN 15
H(1)	0.743	0.764	3.193	3.418	6.868	2.754	5.096	8.627	2.397	8.049	0.677	0.569
	[0.391]	[0.385]	[0.078]	[0.069]	[0.010]	[0.101]	[0.027]	[0.004]	[0.125]	[0.006]	[0.413]	[0.453]
H(2)	1.407	4.411	9.064	0.965	2.030	1.931	1.323	3.160	1.390	12.271	3.489	11.666
	[0.239]	[0.003]	[0.000]	[0.432]	[0.098]	[0.116]	[0.268]	[0.020]	[0.245]	[0.000]	[0.011]	[0.000]
H(3)	1.137	2.746	2.528	7.368	2.165	3.437	1.979	6.401	1.422	3.874	2.582	4.183
	[0.348]	[0.026]	[0.035]	[0.000]	[0.066]	[0.008]	[0.091]	[0.000]	[0.226]	[0.004]	[0.032]	[0.002]
H(4)	1.149	2.794	2.811	7.629	2.300	7.179	1.822	3.621	1.360	7.654	3.751	13.125
	[0.342]	[0.018]	[0.016]	[0.000]	[0.043]	[0.000]	[0.105]	[0.004]	[0.241]	[0.000]	[0.003]	[0.000]
H(5)	5.362	6.257	2.707	6.430	2.346	3.348	1.824	4.690	3.324	4.645	10.884	3.927
	[0.000]	[0.000]	[0.003]	[0.000]	[0.008]	[0.000]	[0.045]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Likelihood Ratio												
H(3)	4.695	5.942	12.805	7.789	10.616	19.107	9.609	18.345	7.350	20.819	14.494	12.144
	[0.454]	[0.312]	[0.025]	[0.168]	[0.060]	[0.002]	[0.087]	[0.003]	[0.196]	[0.001]	[0.013]	[0.033]
H(4)	5.596	7.857	14.486	32.895	13.694	17.086	10.735	2.885	8.549	19.633	12.988	20.459
	[0.470]	[0.164]	[0.025]	[0.000]	[0.033]	[0.004]	[0.097]	[0.001]	[0.201]	[0.002]	[0.043]	[0.001]
H(5)	14.172	19.028	29.273	45.255	37.180	45.933	23.682	45.754	42.407	55.103	20.282	38.276
	[0.586]	[0.267]	[0.022]	[0.000]	[0.002]	[0.000]	[0.097]	[0.000]	[0.000]	[0.000]	[0.208]	[0.001]

Marginal significance levels in brackets.

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Sustainable Withdrawal Rates of Retirees: Is the Recent Economic Crisis A Cause for Concern?

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Abstract

A sustainable standard of living at retirement is an issue of great importance for most retirees, and is certainly a major consideration in the allocation of client portfolios for private wealth managers. This study uses historical returns and incorporates boot strapping techniques to determine the safe withdrawal rates for retiring households between 1990 and 2005. This time period is chosen because it captures the market shock at the beginning of this millennium as well as the global economic downturn of 2007-2008. The results of this study indicate that while 3% and 4% withdrawal rates are sustainable in most cases, a 5% withdrawal rate is not sustainable for recent retirees given the conventional 60/40 asset allocation strategy.

Keywords: Asset allocation, Withdrawal strategies, Portfolio management

1. Introduction

As clients approach their retirement, one of the primary issues that concern their financial planners is the rate of withdrawal that can be applied to the initial value of clients' retirement portfolios, so that the periodic withdrawals from these portfolios can be sustained through the lifetime of their clients. This is an important decision that financial planners must help their clients make because if the withdrawal rate is too high, then the clients must lower their level of living later in retirement, or run out of money during their lifetime. Conversely, if the withdrawal rate is too low then the clients have unnecessarily reduced their standard of living over their lifespan. This issue of sustainable withdrawal rates has been addressed in a number of previous studies (Ameriks, Veres, & Warshawsky, 2001; Bengen, 1994, 1996, 1997; Cooley, Hubbard, & Walz, 1999, 2003). According to Ameriks et al., the amount (either in dollar terms or as a percentage) that can be withdrawn without exhausting a client's portfolio is a key component of dependable retirement planning advice that financial planners need to provide for their retiring clients. Although most financial planners have access to historical return data and simulation software programs that project future market returns, planners have neither the exact returns markets will generate in the future, nor the knowledge of exact inflation rates that will occur during the lifetime of their clients. Financial planners also have their own inherent cognitive biases (Laing, 2010). Thus, further data is required to form best practices for financial planners and wealth managers in their work to manage their clients' longevity risk and investment portfolios.

This paper explores the issue of sustainable withdrawal rates by examining several diversification strategies that can make the withdrawal process more stable and reliable over the lifetime of retirees. We extend the existing literature by including market returns through 2008. This period is particularly significant because it includes two recent financial market downturns— 2002 and 2008, and a brief period of significant market recovery 2003-2007. We apply a boot strapping technique to simulate separate future returns for stocks, bonds, and inflation rates instead of using a simplistic model comprising of mean portfolio return and standard deviation. The remaining components of this paper are comprised of a detailed review of literature, followed by a discussion of methods, results, and finally a brief discussion of our findings.

2. Literature Review

Extant research suggests that clients can sustain annual withdrawals of around four to six percent of their initial retirement portfolio, without prematurely running out of money during their lifetime (Ameriks, et al., 2001, Bengen, 1994, Cooley, Hubbard, & Walz, 1998, 2003; Guyton, 2004; Guyton & Klinger, 2006; Ho, Milevsky, & Robinson,

1994; Pye, 1999, 2000). Other studies further emphasize that a 4 percent withdrawal rate is sustainable when investors use a 60 percent allocation in stocks and 40 percent allocation in bonds (Polyak, 2005; Whitaker, 2005). When using monthly returns from 1930 through 2001, Ervin, Filer and Smolira (2004) find that a portfolio comprising of 60 percent domestic equity and 40 percent intermediate bonds can sustain withdrawal rates of 6 to 7 percent over a retirement span of 30 years. Cooley et al. (1999) study finds that a portfolio with 75 percent allocated in stocks and the rest allocated in corporate bonds can sustain 4 to 5 percent inflation adjusted annual withdrawals. In a follow up study (Cooley et al., 2003) the researchers find that when using market data up to 2001, some international diversification (25 percent) helps when the retirement pay out period is long. Hughen, Laatsch and Klein (2002) use historical data through 2000 to find that 100 percent allocation in equities can sustain annual withdrawal rates of up to 7 percent over 30 years of retirement life for a retiree.

Stout (2008) contends that a gradually increasing withdrawal rate from an optimized portfolio can help retirees sustain higher withdrawal rates and support an improved retirement lifestyle. Using a stochastic analysis approach (instead of the more popular Monte Carlo simulation) to project future returns, Milevsky and Robinson (2005) find that retirees who withdraw about two to three percent annually have much lower risk of running out of money during their lifetime, as compared to those who maintain a withdrawal rate of 4 percent Furthermore, Milevsky and Robinson suggest that individuals who withdraw five percent of their portfolio or higher have a high probability of running out of money during their lifetime.

Monte Carlo technique has been used in business and financial forecasting by several researchers and analysts over the past half century. Hertz (1964) has been among the first to suggest the application of Monte Carlo analysis for business forecasting applications. However, Lewellen and Long (1972) caution that Monte Carlo simulation may not always be accurate and analysts can arrive at the same conclusion by using simple point estimates. Philippatos (1973) suggests that dynamic optimization techniques can be used for forecasting and that Monte Carlo simulation must be used only as a last resort. According to the Pilippatos study, analysts need to first explore other simulation techniques such as sensitivity analysis, strategic or 'what if' analysis, and interactive or decision tree analysis before they apply the Monte Carlo analysis. Myers (1976) argues that Monte Carlo simulation works best in situations where analysts have no idea how a variable is going behave in the future. Rubinstein (1981) further extends Myers' suggestion by setting up a list of criteria appropriate for Monte Carlo simulation analysis. According to Rubinstein, Monte Carlo simulation can be used when it is either impossible or very expensive to obtain future data, or when the analysis is too complex and when it is difficult to obtain a solution using other methods. Rees and Sutcliffe (1993) also find that Monte Carlo simulation is useful when nothing else works. Evensky (2001) finds that Monte Carlo simulation is useful for explaining to people the uncertainty of risk, but he also observes that Monte Carlo simulation increases assumptions significantly since it uses guesswork to arrive at the estimates. Nawrocki (2001) finds that application of Monte Carlo analysis may lead to incorrect decisions at times. According to Nawrocki, one of the biggest short comings of this form of analysis is that it is very difficult to replicate the real world situations exactly using Monte Carlo simulation techniques. Additionally, the conditions for Monte Carlo analysis require that there is no serial correlation between successive periods of returns and if correlations exist they must be linear. If these conditions are not met then the analysis might generate incorrect results.

There have been a few basic methods that have been applied in previous studies for estimating future returns to determine a sustainable withdrawal rate over the lifetime of individuals. The earliest studies used a rolling period return or an overlapping return as a proxy for future market returns (Bengen, 1994; Hughen, et al., 2002); the second method simulates future returns using different iterations and probabilities, typically a Monte Carlo simulation, or a stochastic optimization using Monte Carlo (Pye, 1999; Stout, 2008), and a stochastic analysis without Monte Carlo (Milevsky & Robinson, 2005). In a recent study by Lemoine, Cordell and Gustafson (2010), the authors use Monte Carlo simulation to test the sustainability of portfolios with 50-50 stock bond allocation, 100 percent equity allocation, and a combination of fixed or variable annuities along with equity allocation. The authors find that using an equity portfolio with a fixed annuity component provides the highest chance of success, whereas the 50-50 equity and bond allocation offers the lowest chance of success at 5 percent rate of withdrawal. Although most previous studies have not taken into account the recent market downturn when calculating sustainable withdrawal rates, the results found using the above mentioned techniques have been remarkably similar, with most studies suggesting a sustainable withdrawal rate of 4-6 percent over a retirement life of 30-35 years.

3. Data and Methodology

Data used to perform the analysis was obtained from *Ibbotson Stocks, Bonds, Bills, and Inflation 2009 Classic Yearbook* (Ibbotson and Associates, 2009). Nominal monthly total returns were obtained for large company stocks and intermediate-term government bonds from January 1926 through December of 2008. Monthly and annual inflation rates for the same period were also recorded. Nominal monthly total returns for a constant portfolio allocation of 60% large company stocks and 40% intermediate-term government bonds were calculated.

Nineteen different hypothetical retirement distribution periods were simulated. The first distribution period started in 1990, and the nineteenth distribution period that was simulated started in 2008. In each of the nineteen distribution periods, withdrawals were made at the beginning of each month and adjusted for inflation annually. Each of the retirement distribution scenarios were modeled using actual inflation and portfolio return data, provided by Ibbotson

and Associates (2009), through the end of 2008. The period specific simulations represent a hypothetical retiree beginning retirement that year and commencing retirement withdrawals at the start of the first month of that year. For periods beginning in 2009, portfolio returns and inflation were simulated using bootstrap techniques. Historical monthly returns were randomly selected, with replacement, using an equal probability distribution function, to extend each of the 19 retirement distribution simulations to a period of 50 years. Each of the 19 retirement distribution period simulations is made up of 1,000 iterations. Thus, the hypothetical scenario for a retiree in 1990 extends beyond 2008, using bootstrap methods, to the year 2039, and the first nineteen years (1990 – 2008) of portfolio returns and inflation rates for each of the 1,000 simulated iterations are identical and only vary beginning in the year 2009.

Initial withdrawal rates were set at 5%, 4%, and 3% annually of the starting portfolio and were adjusted for inflation annually. One thousand simulated retirement distribution periods for each of the nineteen distribution periods and for each of three withdrawal rates were completed. For example, the hypothetical scenario for a retiree in 2000 consists of 1,000 simulations utilizing a 3% withdrawal rate, 1,000 simulations using a 4% withdrawal rate, and 1,000 simulations using a 5% withdrawal rate. Successful retirement distribution scenarios were determined by whether there was a positive balance of funds in the retirement portfolio at the conclusion of 40 years. The percent of successful retirement distribution simulations was determined for each withdrawal rate and for each of the nineteen simulated distribution periods. The average duration of positive distributions was also estimated for each withdrawal rate and distribution period was also calculated.

4. Results

4.1 Sustainable withdrawal rates

The first set of columns presented in Figure 1 are the estimated success rates for retirement portfolios utilizing 5%, 4%, and 3% distribution rates but are year neutral, meaning they do not start or end in a particular year, thus all monthly portfolio returns and inflation adjustments are randomly selected. The estimated success rate over a 40 year period for a 5% withdrawal rate, using entirely simulated data is 64.9%. The results (Figure 1) show that for hypothetical individuals who retired in 1990, a 5 percent withdrawal rate has a 97.4% success rate over a 40 year retirement life horizon. The estimated success rate for scenarios utilizing a lower initial withdrawal rate is even higher. Subsequently, beginning in the mid 1990s, the rate of ruin, or probability of failure, for 5 percent withdrawal rates increases substantially for the retirees. The increasing rate of failure continues through the year 2000. Among those hypothetical retirees that experienced the market crises of 2002 and 2008 very early in their retirement, the rate of ruin increases quite dramatically. For example, a hypothetical individual retiring in the year 2000, who begins retirement distributions at 5%, has an estimated success rate of 3.7%, or stated oppositely, he has an estimated failure rate of 96.3%. Beginning in 2001, success rates using a 5% initial withdrawal increase, but do not increase to the level observed in the early and middle 1990s.

Hypothetical retirees utilizing a more conservative 3% initial withdrawal are adversely affected by the market crises of 2002 and 2008; however, the success rate of such retirement portfolios has significantly less variation across the nineteen different scenarios. The lowest estimated success rate of 79.0% occurred for hypothetical individuals beginning retirement in 2000. Similarly, the rate of success for a 4% withdrawal rate remains high for hypothetical retirement distribution periods beginning in years prior to 1997, and then decreases sharply through 2000. The success rate again improves following 2000, however, the rate of success does not return back to the level estimated for the early 1990s.

For all three withdrawal rates, estimated success rates during the early 1990s are higher than the general success rate estimated without regard to specific years. In the late 1990s, success rates fall dramatically below the general success rate and stay below the general success rate throughout the remaining retirement distribution periods. Our results show that for individuals who have retired after the financial market downturn of 2001-2002, there is a 90 percent or higher chance of success in sustaining a withdrawal rate of 3 percent. The chance of ruin is very high and not sustainable at 5 percent withdrawal rate for the recent retirees. Among those who have retired in the first six years of the new millennium (2000-2005), the success rate is highest among the 2003 retirees, who experienced a significant market return in the first year of their retirement, while the probability of success is lowest for the 2000 retirees, who had to experience frequent and substantial market downturns (2001-2002 and 2008) very early in their retirement years.

4.2 Retirement Life Duration

Taking into account the prospect of increased longevity, we tested sustainable withdrawal rates over 50 year retirement period and estimated the average duration of the portfolios in Figure 2. The results show that even for a 50 year horizon, whereas 5 percent annual withdrawal rates are sustainable between 1990-1995, this withdrawal rates cannot be sustained for individuals who have retired post 1995. Also, as in the case of 40 year retirement life horizon, 4 percent withdrawal rates are sustainable between 1995 and 1997, but cannot be sustained for individuals who have retired after 1997. Beyond 1997, a 3 percent withdrawal rate is sustainable over a fifty year time horizon for individuals who have retired during 1998-2005. Among the more recent retirees (between 2000 and 2005), similar to the 40 year retirement life horizon, the chance of success is highest for the 2003 retirees, and lowest for

the 2000 retirees.

From the results of Figure 2, we find that although 5 percent withdrawal rates are sustainable over a 35 year retirement duration for those who have retired between 1990 and 1997, this withdrawal rate cannot be sustained over a 35 year retirement life duration for 1998-2002 retirees without prematurely exhausting their portfolios. Among those who have retired after 1997, a 5 percent withdrawal rate is only sustainable for 2003 retirees, who experienced a substantial increase in market returns in the first year of their retirement. Withdrawal rate of 4 percent is however sustainable for all individuals who have retired between 1990 and 2005 over a 35 year time horizon.

Similarly, for 30 year retirement duration, the Figure 2 shows that while 5 percent withdrawal rates are sustainable for 1990-1998 retirees, this withdrawal rate cannot be sustained for those who retired at the turn of the millennium (1999-2001). 5 percent withdrawal rate is however sustainable over a 30 year period, for individuals who have retired between 2002 and 2005. As in the case of 35 year retirement duration, those retirees who have a 30 year retirement duration can sustain 4 percent withdrawal rate through out their lifetime, without exhausting their retirement portfolio prematurely.

5. Discussion

This paper adds to the existing body of literature on sustainable withdrawal rates by incorporating the financial market returns between 2001 and 2008 in the sustainable withdrawal rates analysis. We also address the issue of increasing longevity by calculating sustainable withdrawal rates among recent retirees over 40-50 years of retirement duration. The results are striking and the findings of this study challenge the conventional 4-6 percent withdrawal rates that financial planners typically recommend for their clients. The results show that in a typical 60-40 portfolio allocation, individuals who have retired after 1997 cannot sustain 5 percent withdrawal rates over a 35 year retirement life horizon, with the sole exception of 2003 retirees. This is primarily because the more recent retirees had to face two significant market downturns very early in their retirement. Previous studies have pointed out that due to the effect of time value of money, individuals who face significant market down turns in the early years of their retirement face the risk of exhausting their portfolio quicker than others at conventional withdrawal rates (Bengen, 1994). Conversely, the 2003 retirees are better off in this group, because they experienced substantially high market returns in the first year of their retirement unlike the 2000-2002 retirees.

The results of this study show that although 5 percent withdrawal rates are sustainable for recent retirees with a retirement horizon of 35 years or less, this withdrawal rate cannot be sustained for 1999-2001 retirees, even with reduced retirement life duration. However, the 1999-2001 retirees can still sustain 4 percent withdrawal rates over 35 year retirement life duration (with the exception of 2000 retirees) and they can sustain 4 percent withdrawal rates over a retirement duration of 30 years. One can therefore conclude from this that individuals who retired late in their lives and have a shorter retirement life expectancy (30 years or less) can sustain higher withdrawal rates even after facing two substantial market downturns very early in their retirement, whereas those who have retired early and have a longer retirement life expectancy will have to withdraw at a much lower rate in order to sustain their portfolio over life time. This might result in lowering standard of living expectations in the retirement life for the early retirees.

Estimated portfolio duration and success are important to consider when setting up a retirement distribution plan. However, one time estimations, based on general market data, can lead to irrelevant assumptions about the portfolios expected duration. Planners routinely meet with clients, typically at least annually, and update the client's profile, investment performance, and other changes pertinent to the client's financial goals. During these meetings initial estimates of portfolio sustainability should be revisited and recalculated. Particularly, financial planners' clients who began distributions in the late 1990s and early 2000s, may be overly aggressive in their distribution planning if withdrawal rates were set at 5% and not readjusted as a result of the market turmoil of the 2000s.

6. Conclusion

This paper illustrates the need to revisit sustainable withdrawal rates with clients on an annual basis, well after such distribution patterns have begun. Such reevaluations should include the portfolio performance experienced thus far by the client, and how such preexisting performance strengthens or weakens the probability of sustained distributions, given initial and current withdrawal rates. While not tested in this paper, the authors believe that modest adjustments to initial distribution plans in response to adverse market conditions may substantially improve the sustainability of the portfolio and is an area in need of additional research.

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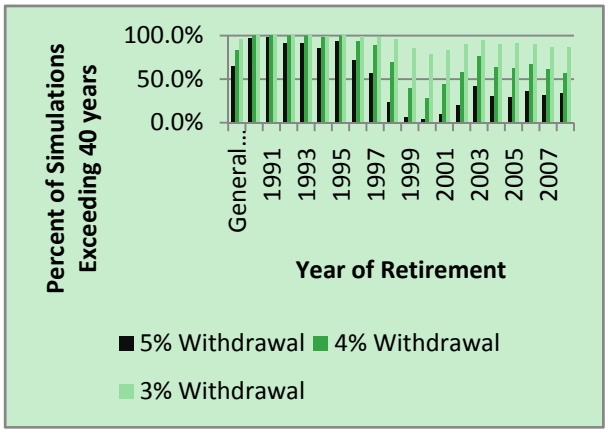

Figure 1. Portfolio safety by year of retirement

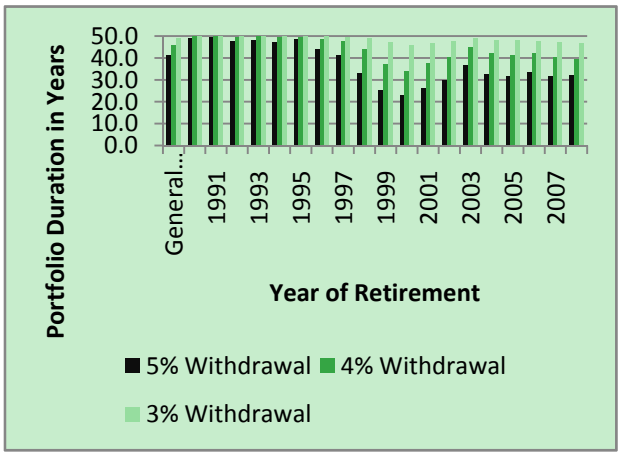

Figure 2. Portfolio Duration by Year of Retirement

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The Intraday Behaviour of Bid-Ask Spreads, Trading Volume and Return Volatility: Evidence from DAX30

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Abstract

This paper undertakes a fresh empirical investigation of key financial market variables and the theories that link them. We employ high frequency 5-minute data that include transaction price, trading volume, and the close bid and ask quote for the period May 5, 2004 through September 29, 2005. We document a number of regularities in the pattern of intraday return volatility, trading volume and bid-ask spreads. We are able to confirm the reverse J-shaped pattern of intraday bid-ask spreads with the exception of a major bump following the intraday auction at 13:05 CET. The aggregate trading volume exhibits L-shaped pattern for the German blue chip index, while German index volatility displays a somewhat reverse J-shaped pattern with two major bumps at 14:30 and 15:30 CET. Our empirical findings show that contemporaneous and lagged trading volume and bid-ask spreads have numerically small but statistically significant effect on return volatility. Our results also indicate asymmetry in the effects of volume on conditional volatility. However, inclusion of both measures as proxy for informal arrival in the conditional volatility equation does not explain the well known volatility persistence in intraday stock returns.

Keywords: Intraday, Conditional volatility, Trading volume, Bid-ask spread, Asymmetry

1. Introduction

Many studies have supported the conjecture that price volatility and trading volume are jointly determined. Clark (1973), Epps and Epps (1976) and Tauchen and Pitts (1983) argue that volume and volatility are jointly endogenous variables that covary in response to external order or information shocks. The mixture of distribution hypothesis (MDH) developed by Clark (1973) implies that the volume-volatility relation is dependent upon the rate of information flow into the market. The theory assumes that all traders simultaneously receive the new price signals and immediately shift to a new equilibrium. Thus, both volatility and volume change contemporaneously in response to the arrival of new information.

Other researchers relate the observed relationship of volume and volatility to private information. Copeland (1976) and Jennings, Starks and Fellingham (1981) develop models based on the sequential information arrival hypothesis (SIAH). In these models, an individual trader receives a signal ahead of the market and trades on it, thereby creating volume and price volatility. As a result, volatility and volume move in the same direction.

Many recent papers have examined the empirical relationship between price volatility and trading volume. Using intraday data for 30 stocks in the Dow Jones Industrial Average (DJIA), Darrat et al. (2003) report that high trading volume causes high return volatility in accordance with SIAH hypothesis. Darrat et al. (2007) test for intraday lead-lag relationship between trading volume and volatility of large and small NYSE stocks in two cases: with and without identifiable public news. Their results generally support SIAH which assumes that the information comes in sequence and thus traders react to this new information sequentially, suggesting that in the presence of public information, volume and volatility may Granger-cause each other. Floros and Vougas (2007) examine the relationship between daily trading volume and return volatility in the Greek stock index futures market. They find evidence of contemporaneous and lagged effect of trading volume on absolute returns for the Greek blue chip index (FTSE/ASE20). However their analysis does not reveal any significant relationship between trading volume and absolute returns for the mid-cap index (FTSE/ASE40).

In line with the microstructure theory, some researchers have also examined the role of bid-ask spread on price change volatility. (Note 1) Rahman et al. (2002) estimate GARCH model for a sample of 30 NASDAQ stocks using intraday 5-minute returns. After including contemporaneous and lagged volume and bid-ask spreads, proxied for the rate of information flow as exogenous variables, they find positive and statistically significant but numerically very small effect of both variables on conditional volatility. Furthermore, their results suggest that none of the exogenous variables significantly reduce volatility persistence effects for their sample returns. Worthington and Higgs (2003) measure the role of information arrival proxied by contemporaneous and lagged bid-ask spread and volume on intraday return volatility for individual stocks in the Australian stock market. They conclude that the influence of bid ask on volatility is relatively larger, while the effect of volume is more general but relatively small. Wang and Yau (2000) using data on future markets show that trading volume, bid-ask spread and price volatility are jointly determined. With regard to volatility estimation, their results indicate a positive relationship with bid-ask spread and a negative relationship with lagged trading volume.

The objective of this paper is twofold. Firstly, it explores intraday regularities in key financial markets' variables of stock return variability, trading activity, and liquidity measure. The proportional bid-ask spreads (PABS) are used to proxy the market liquidity, while the trading volume is used as a measure of trading activity. Secondly, this study examines the intraday relationship between stock market volatility, trading activity and liquidity using aggregate data on DAX30 constituents. .

Numerous empirical models have been proposed to test the relationship between return volatility and information arrival. Many papers have examined the dynamic volume-volatility relation based on the mixture of distribution hypothesis, which assumes a joint dependence of volatility and volume on the underlying information flow. However, the models based on MDH have some limitations. For example, they do not allow for serial dependence in return volatility conditional on the underlying information flow [(Rahman et al. (2002)]. Accordingly, in this paper, we examine the role of trading volume and bid-ask spreads (as proxies for information flow) on return volatility in a GARCH type setting. It is important to note that we treat both trading volume and bid-ask spreads as mixing variable in return volatility equation as we study the relationship between return volatility and information arrival in one direction.

This paper presents a number of improvements over earlier studies of the same kind. First, it takes into account the strong intraday seasonal pattern in return variability before attempting to model the conditional volatility. Second, we split the volume into expected and unexpected components. The unexpected volume is believed to capture deviations in the relative participation rate of informed traders. Furthermore, we also examine whether the price volatility responds asymmetrically to volume shocks depending on whether the volume is above or below its expected level. Third, our model allows for serial dependence in return volatility conditional on the underlying information flow. Finally, this study provides additional intraday evidence on the relationship between return volatility, trading activity and market liquidity variables at the aggregate level for DAX30 constituents.

The main findings of this paper are as follows: We are able to confirm the reverse J-shaped pattern of intraday bid-ask spreads with the exception of a major bump following the intraday auction at 13:00 CET. The aggregate trading volume exhibits L-shaped pattern for the German blue chip index (DAX30), while German index volatility displays a somewhat reverse J-shaped pattern with two major humps at 14:30 and 15:30 CET. These findings are contrary to the U-shaped pattern found in previous studies [e.g., (Wood, McInish, and Ord (1985), McInish and Wood (1990a) and Harris (1986)]. Furthermore, our empirical findings suggest that the intraday return volatility is inversely related with contemporaneous and lagged expected trading volume, and positively related with unexpected volume. While we find a significant and positive relationship between the return volatility and both, the contemporaneous and lagged bid-ask spreads. Our results also indicate asymmetry in the effects of volume on conditional volatility. However, our findings demonstrate that the introduction of contemporaneous or the lagged trading volume and bid-ask spreads do not significantly remove GARCH effects in intraday return volatility.

The rest of the paper proceeds as follows: Section two describes the data used in this study. Section three explores intraday patterns in return volatility, trading volume and bid-ask spreads. The empirical methodology is presented in section four. Section five reports the major findings of this study and the paper is summarized in Section six.

2. Data

This paper employs an aggregate data on DAX30 constituents, which enables us to undertake a fresh empirical investigation of key financial market variables and the theories that link them. We obtain time stamped intraday transaction data including the bid and ask quotes at the time of the trade for each of the DAX30 constituents. The data contains transaction price, trading volume, and the close bid and ask quote for each 5-minute period. The analysis covers the period from May 5, 2004 to September 29, 2005.

The DAX30 index measures the performance of 30 largest German companies in terms of order book volume and market capitalization. The index is based on prices generated in the electronic trading system Xetra and its calculation starts at 09:00 and ends at 17:30 CET. (Note 2) Thus each trading day is divided into 102 successive 5-minute intervals.

After filtering the data for outliers and other anomalies, the continuously compounded returns are calculated as $r_{i,t} = 100 \times [\log(P_t) - \log(P_{t-1})]$, where $P_{i,t}$ represents the price level in market i at time t.

The 5-minute proportional bid-ask spreads were calculated as BAS=ASK-BID/ [(ASK+BID)/2]. These 5-minute proportional spreads were then averaged across all the stocks in the sample. Next, the trading volume represents the total number of shares traded for each stock in each 5-minute interval. The aggregate volume series (Vol) was then generated by combining the volume across all DAX30 stocks. A few missing observations were interpolated to obtain a continuous series. (Note 3)

The intraday transaction data files contained raw data. We use a number of filters to clean the data to ensure the accuracy of the calculated variables. (Note 4) The intraday prices, trading volume and bid-ask spreads were then matched for each time interval, and for each day in order to obtain a contemporaneous and continuous time series data. Graphical results are reported using the carefully calculated variables as mentioned above.

Following Andersen et al. (2003), intraday return volatility is calculated as absolute measure of returns. Summary statistics for intraday 5-minute returns and their absolute measure are presented in Table 1. The average return for DAX30 is almost zero. The return series exhibits deviation from normality as the excess kurtosis and skewness are clearly significant. Furthermore, returns displayed small negative but statistically significant (at 5% level) return autocorrelation signaling market microstructure effects. (Note 5) Whereas, absolute returns display a positive and statistically significant serial correlation at all reasonable levels, which can be viewed as an indication of volatility clustering typically found in financial markets, where large changes tend to be followed by large changes of either sign.

2.1 Cross Correlations

Table 2 presents the correlation matrix of return volatility, trading volume and Bid-ask spreads for the whole sample. (Note 6) The three variables are positively correlated. The correlation coefficient between trading volume and return volatility is 0.43, indicating contemporaneous relation among variables. While the correlation coefficient (0.29) between return volatility and bid-ask spread also indicates a positive but relatively small contemporaneous relationship. However, the association between trading activity and liquidity measures is 0.19, which do not represent any potential problem arising from multicollinearity in econometric modeling.

3. Intraday Patterns

Voluminous research has documented the existence of intraday periodicities in returns, return volatility, bid-ask spreads and trading volume, in both equity and foreign exchange markets. Among the earlier studies, intraday U-shaped pattern in return variance were demonstrated by Wood, McInish, and Ord (1985), McInish and Wood (1990a) and Harris (1986). Jain and Joh (1988), McInish and Wood (1990b) reported intraday U-shaped patters in trading volume. Brock and Kleidon (1992) report that bid-ask spreads tend to be higher at the beginning and the end of the trading day, thus follow a U-shaped pattern during the day.

There are different explanations for intraday regularities observed in key financial markets' variables. Admati and Pfleiderer (1988) relate the U-shaped (also sometimes referred as reverse J shaped) pattern in volume and volatility with the private information. They argue that high volume in a particular time segment reveals the presence of asymmetric information as noise traders camouflage the activities of the informed traders, and this gives rise to the volatility. Therefore, volume and volatility move in the same direction. In contrast, Brock and Kleiden (1992) argue that trading halts and different trading strategies at the open and close of the markets form these volume patterns. Since, in their model, high volume is associated with the high liquidity demand at the open and close of the trading day, spreads will also follow a U-shaped pattern during the day. We take a fresh empirical look at the intraday patterns in return volatility, trading volume and bid-ask spread using the aggregate data on DAX30 constituents.

3.1 Intraday return volatility

Researchers have found compelling evidence that intraday return volatility exhibits U-shaped pattern. This pronounced U-shaped pattern in equity markets has been reported by, among others, McInish and Wood (1990), Werner and Kleiden (1996) and Abhyankar et al. (1997). Figure 1 displays the average intraday absolute returns for the DAX30 index. Contrary to earlier evidence of distinct U-shaped pattern in the intraday volatility of price changes, we find a pattern close to reverse J-shape for the DAX30 index. This finding is in line with Harju and Hussain (2010), who report similar pattern for four major European stock market indices, FTSE100, DAX30, SMI and CAC40. The intraday return volatility is highest at the beginning of the trading day, before falling rapidly until 14:30 CET. After 14:30, the intraday volatility demonstrates a clear level shift and three major jumps at 14.35, 15.35, and 16.05. Harju and Hussain (2010) convincingly related this level shift and rise in volatility to the U.S. scheduled macro news announcements at 14:30 and 16.00, and the opening of NYSE at 15:30. However, it is interesting to note that volatility is highest for the first ten minutes of morning trading. When we leave out the first two observations, the distinct early volatility spike disappears. Harju and Hussain (2010) empirically show that following 09:15, the intraday volatility pattern would resemble U-shape after controlling for the NYSE opening and major scheduled U.S announcements.

3.2 Intraday Volume

The aggregate trading volume for each 5-minute period averaged across all the trading days is shown in Figure 2. We find a L-shaped pattern in intraday volume which is in contrast to earlier findings, such as Chan, Christie and Schultz (1995) and Abhyankar et al. (1997) who report U-shaped and M-shaped pattern for NASDAQ and the UK stocks, respectively.

In line with earlier studies, volume is found to be highest during the first ten minute period of the trading day. However, it is interesting to note that it does not increase towards the end of business hours. When we drop the first two observations, volume does not exhibit any systematic pattern during the day. Though trading activity increases moderately after 13:30 and remains quite stable for the rest of the day, it does not rise near the end of trading day as have been reported in earlier studies. This contrasts with the U-shaped pattern for NYSE stocks reported by Brock and Kleidon (1992) and McInish and Wood (1990).

We conjecture that some measurement errors may have caused this unusual pattern in aggregate intraday trading volume. We investigate this by examining the number of stocks traded for each time interval. Our investigation

reveals that the highest numbers of stocks were traded during the first five minute period. After departing from the morning peak, trading activity for individual stocks remains stable until 12:00 before declining sharply until 13:30. Though the numbers of stocks traded picked up again after 13:30, the trading activity was recorded for fewer stocks after 16:00. In accord with our intuition, the aggregate intraday volume pattern coincided with the number of stock traded per time interval. We infer that the infrequent trading for individual securities significantly affected the intraday pattern in volume aggregated across all the trading days in our sample. (Note 7) We further examine this by looking at the intraday volume patterns for individual stocks. (Note 8) Most of the individual stocks generally exhibit typical U-shaped or inverted J-shaped pattern, thus confirming the earlier results for equity markets.

3.3 Intraday bid-ask spread

Figure 3 shows the intraday pattern of the proportional bid-ask spreads for the DAX30 index, measured at each five minute interval across all 360 trading days in our sample. The average spread declines sharply in the first ten minutes of the trading day and then remains constant with the exception of 13:00 CET when it sharply rises for a five minute period following the call auction for the DAX30 stocks. (Note 9)

Although the average spreads tend to slightly increase near the end of the trading day, we do not find evidence supporting typical U-shaped pattern for intraday spreads reported in e.g., Brock and Kleidon (1992), Ahn et al. (1999) and Ahn et al. (2002). However, our finding of a rather reverse J-shaped pattern in intraday spreads follows closely that of reported by Theissen and Freihube (2001) (Note 10), Abhyankar et al. (1997) and McInish and Wood (1992).

4. Methodology

We develop a set of empirically testable hypotheses to explore the impact of trading volume and bid-ask spreads on the conditional volatility of intraday returns. We divide trading volume into two components; expected and unexpected trading volume. (Note 11) Unexpected trading volume is closely related with informed trading [Easley and O' Hara (1992)]. Because investors are sensitive to unexpected information, they will adjust their position to respond to any new information, making the impact of unexpected trading volume different than that from expected volume. Accordingly, this paper empirically examines whether surprises in trading volume convey more information and, thus measures the precise effect of surprise in trading activity. We hypothesize that price change volatility is positively related to unexpected volume and negatively related to expected volume. In addition, we examine the impact of introducing the bid-ask spread in conditional variance equation. We conjecture that the bid-ask spread is another measure of information flow into the market. We hypothesize that an information arrival would be expected to induce an increase in volatility.

Before attempting to model return volatility, we examine the pronounced pattern typically found in intraday return variability measures. The correlogram of absolute returns is depicted in Appendix A1 (Appendix A). As can be clearly noticed, high autocorrelations were clustered around the opening and closing of each trading day. The source for this characteristic is the intraday seasonal volatility pattern depicted in Figure 1, i.e., high volatilities at the opening and closing of the trading day caused the autocorrelation pattern to behave in a cyclical fashion. These patterns are so distinctive that there is a strong need for taking them into account before attempting to model the dynamics of intraday return volatility. Andersen and Bollerslev (1997) note that standard ARCH models imply a geometric decay in the return autocorrelation structure and simply cannot accommodate strong regular cyclical patterns. Following Andersen and Bollerslev (1997, 1998), the returns were filtered from intraday seasonalities using Flexible Fourier Form (FFF) transformation. (Note 12) Intraday averages of absolute filtered returns are also shown in Appendix A2 (Appendix A). The results confirm that FFF is a successful technique in removing the seasonal pattern in intraday volatility.

Table 3 presents summary statistics for 5-minute filtered and absolute filtered returns. The average return for DAX30 remains to be almost zero with a small negative, though statistically insignificant return autocorrelation. The filtered return series exhibit significant skewness and excess kurtosis, again violating the normality condition. The first and second order autocorrelation coefficients of absolute returns are significant and even more pronounced when compared to raw returns. These significant serial correlations in absolute returns again point to volatility persistence typically observed in stock returns. The correlation matrix for the filtered volatility measure, trading activity and liquidity is shown in Table 4. It is important to notice that the contemporaneous correlations are considerably smaller compared to those calculated with raw absolute returns.

Furthermore, before employing the variables in econometric modeling, we check the stationarity condition for the time series of stock returns, trading volume and bid-ask spreads using the augmented Dickey-Fuller (ADF) test. Our results (not shown here) reveal that all three time series can be considered stationary.

As shown in Table 3, the serial correlation does not indicate any predictable component of filtered returns. Hence, we define the returns as a mean model:

$$r_t = a_0 + e_t \,, \tag{1}$$

where

$$e_t \sim N(0, h_t). \tag{2}$$

The residual series e_t is expected to be uncorrelated since no autocorrelation is observed in 5-minute filtered return series. Now we move on to modeling return volatility in the next sub section.

4.1 Conditional Volatility Model

We use contemporaneous trading volume and bid-ask spread as explanatory variables in the variance equation. The volume-volatility relation is a well documented empirical fact found for most types of financial contracts, including stocks, Treasury bills, currencies and various futures contracts [Girard and Biswal (2007)]. The main theoretical explanation for the relation is that the arrival of new information makes prices adjust to new equilibria over time. Since trading volume is the reflection of the process through which information is incorporated into stock prices, one way of proxying the arrival of this trade information is to introduce the volume of trade into the conditional volatility equation. Lamoureux and Lastrapes (1990), for example showed that the introduction of the contemporaneous and lagged volume reduces the GRACH effect in the U.S stock return data. However Chen, Firth, and Rui (2001) report that the persistence in volatility is not eliminated when lagged or contemporaneous trading volume level is incorporated into the GARCH model, a result contradicting the findings of Lamoureux and Lastrapes (1990). Arago and Nieto (2005) argue that it is more appropriate to split trading volume into two components: the expected volume and the other, termed unexpected volume motivated by the unpredictable flow of information to the market. They find that although the effects of the unexpected volume on volatility are much greater than those of total volume, inclusion of unexpected volume in the variance equation does not reduce the persistence of volatility or GARCH effects. Bessembinder and Seguin (1993) also investigate whether the effect of volume on volatility is homogeneous by separating volume into expected and unexpected components. They find that unexpected positive volume shocks produce larger effects on price volatility than negative shocks, pointing to the asymmetric effects of trading volume. Moreover, Rahman et al. (2002), beside trading volume, introduce a bid-ask spread as a measure of information that flows into the market with the argument that bid-ask spread narrows when information flow increases and widens when information flow decreases. Their results show a positive and statistically significant but numerically small effect of both variables on conditional volatility. However, none of the exogenous variables significantly reduce volatility persistence effects for their sample returns. Overall, there exists a rather inconclusive evidence in previous literature with respect to the volatility persistence parameter when mixing variables are included in volatility equation. This motivates us to model the volatility dynamics in the presence of information arrival proxies using aggregate data on DAX30 constituents.

Following Nelson (1991), we use an exponential GARCH model (EGARCH) to estimate the conditional volatility equation for filtered returns. The EGARCH model offers greater flexibility over other GARCH type models, as it imposes no positivity constraints on estimated parameters and explicitly accounts for asymmetry in asset return volatility. Furthermore, we introduce contemporaneous trading volume and bid-ask spreads as mixing variable for information arrival in volatility equation. In addition to looking at the contemporaneous effects, we also examine if mixing variable have any significant effect on the volatility persistence parameter as reported by Lamoureux and Lastrapes (1990). (Note 13) The model can be written as:

$$logh_t = \gamma_0 + \gamma_1 logh_{t-1} + \delta g(Z)_{t-1} + \theta_1 ExpVol_t + \theta_2 UnexpVol_t + \theta_3 logSBAS_t \quad (3)$$

Where

$$g(Z)_{t-1} = \emptyset_1[(Z)]_{t-1} + \emptyset_2[(|Z_{t-1}|) - E(|Z_{t-1}|)] \quad (4)$$

and

$$z_t = \mu_t / \sqrt{h_t}$$

where $\gamma_1$is the volatility persistence parameter of the filtered returns. The parameters θ_1 and θ_2 measure the impact of the expected and unexpected volume on the volatility of equity returns. While $\theta_3$measures the impact of bid-ask spread on conditional volatility.

We expect θ_1 to be negative as expected volume is unlikely to be private information driven and thus should lead to decreased return volatility. In other words, the increased liquidity trading is associated with lower volatility. However, the coefficient θ_2 is expected to be positive if unexpected volumes are largely asymmetric information driven. Similarly, the return volatility will rise in response to an increase in bid-ask spreads, thus parameter θ_3 is expected to be positive. In summary, an information arrival would be expected to induce an increase in volatility.

The function $g(.)$ contains two parameters which define the `size effect' and the `sign effect' of the shocks on volatility. The first is a typical ARCH effect while the second is an asymmetric effect, usually described as the leverage effect. The term $\emptyset_2[(|Z_{t-1}|) - E(|Z_{t-1}|)]$determines the size effect and the term $\emptyset_1[(Z)]_{t-1}$ determines the sign effect. The parameter $\emptyset_2$ is typically positive and $\emptyset_1$ is negative. If $\emptyset_1 = 0$, large innovations increase the conditional variance if $[(|Z_{t-1}|) - E(|Z_{t-1}|)] > 0$ and decrease the conditional variance if$[(|Z_{t-1}|) - E(|Z_{t-1}|)] < 0$.

If the parameters θ_1, θ_2 and $\theta_3$are significantly non-zero, the results will indicate exogenous effects of trading activity and liquidity on return volatility. These tests are for the null hypotheses of zero coefficients.

4.2 Asymmetric volume effect

An asymmetric volume effect on stock-return volatility is well documented [see for example, Ying (1966), Karpoff (1987)]. The common finding is that the return volatilities are higher following an increase in trading volume.

We also test asymmetric reactions of volatility in response to changes in volume by including a dummy variable in equation (3) that equals one for a positive change and zero for a negative change in unexpected volume. The following equation formally tests whether return volatility reacts to changes in trading volume in an asymmetric fashion.

$$logh_t = \gamma_0 + \gamma_1 logh_{t-1} + \delta g(Z)_{t-1} + \theta_1 ExpVol_t + \theta_2 UnexpVol_t + \theta_3 logSBAS_t + \theta_4 dumUnexpVol_t \quad (5)$$

The parameter θ_4 measures the asymmetric effect of trading volume on return volatility. The estimated coefficient for $\theta_4$is expected to be positive to prove the positive asymmetric effect.

4.3 Lagged Effects

Rahman et al. (2002) and Darrat et al. (2003) report that trading volume in stock markets contains relevant information for predicting future volatility. Accordingly, we also check if lagged trading activity and liquidity variables have significant effect on subsequent return volatility. The trading volume and bid-ask spreads exhibit significant first order serial correlation. (Note 14) Thus, in order to avoid any potential problem of simultaneity bias, we separately test for the lagged effects of trading volume and bid-ask spread in the following equation:

$$\log h_t = \gamma_0 + \gamma_1 \log h_{t-1} + \delta g(Z)_{t-1} + \theta_1 \log(ExpVol)_{t-1} + \theta_2 \log(SBAS)_{t-1} \quad (6)$$

The parameters θ_1 and θ_2 measure the impact of the lagged expected trading volume and bid-ask spreads on the volatility of equity returns.

5. Empirical Findings

Table 5 reports the coefficient estimates of the benchmark EGARCH model. All the coefficients are highly significant. The parameter measuring the asymmetry is negative and significant, suggesting the presence of a leverage effect. The volatility persistence parameter amounts to 0.96 for intraday XDAX 30 returns. This supports the common finding that high frequency data exhibits long-memory volatility dependencies in intraday equity returns. Nonetheless, though the degree of volatility persistence is high in the DAX30 filtered returns, it is mean reverting, indicating an eventual return to a normal level.

The estimated coefficients of intraday volatility equation (3) are presented in Table 6. There is a significant and positive relationship between the return volatility and the contemporaneous bid-ask spreads. This finding is consistent with the results reported in Wang and Yau (2000), who argue that the positive relation between bid-ask spreads and price volatility indicates that an increase in liquidity (narrowing spreads) will reduce price volatility.

Moreover, as expected, the intraday return volatility is inversely related with expected volume, and positively related with unexpected volume. These findings demonstrate the importance of dividing the total trading volume into informed and liquidity based trading. Our results suggest that return volatility will rise contemporaneously with the increase in informed trading. While, the increase in liquidity trading will decrease the volatility.

Another interesting finding is that the inclusion of contemporaneous trading activity and liquidity measures in the volatility equation has not remarkably reduced the volatility persistence parameter in comparison with the benchmark model. This finding supports the results of Najand and Yung (1991), Foster (1995) and Rahman et al. (2002) and contrary to those of Lamoureux and Lastrapes (1990).

Table 7 reports the estimation results of equation (5) that allows the effects of unexpected changes in volume on conditional volatility to vary with the sign of shock by introducing dummy variable that equals 1 for positive unexpected shock and zero otherwise.

The estimated coefficient θ_4 is positive and statistically significant, which is consistent with the argument that the impact of positive unexpected volume shocks is larger than the impact of negative shocks. This finding is consistent with Bessembinder and Seguin (1993) and Watanabe (2001), who report similar results for futures markets.

The parameters estimating the lagged effects of expected trading activity and bid-ask spreads on conditional volatility (equation 6) are presented in Table 8. The estimates show that the increased liquidity trading will reduce the subsequent volatility, while the higher bid-ask spreads will increase the volatility in next period. (Note 15) These results are intuitive and confirm the earlier results of Rahman et al. (2002) who report positive and significant relationship between the return volatility and lagged bid-ask spread/ trading volume for most of the NASDAQ stocks. (Note 16)

Again, confirming the results of Rahman et al. (2002), there is actually no improvement with regard to the GARCH effects after the introduction of lagged trading volume and bid-ask spreads in the volatility equation.

6. Summary and Conclusion

This paper explores the widely observed empirical regularities in intraday return volatility, trading volume and bid-ask spreads using high frequency 5-minute aggregate data on DAX30 constituents for the period May 5, 2004 through September 29, 2005. Moreover, we also examine the effect of trading activity and liquidity measures as mixing variable on conditional return volatility.

We document a number of regularities in the pattern of intraday return volatility, trading volume and bid-ask spreads. We are able to confirm the reverse J-shaped pattern of intraday bid-ask spreads with the exception of a major bump following the intraday auction at 13:00 CET. We verify that the trading halt during the intraday call auction significantly induces higher bid-ask spread for the subsequent period. The aggregate trading volume exhibits L-shaped pattern for the DAX30 index, while for individual stocks, we generally find an intraday pattern close to a reverse J shape. The index volatility also displays a somewhat inverted J-shaped pattern with two major humps at 14:30 and the 15:30 CET. These findings are contrary to a U-shaped pattern found in previous studies [e.g., (Wood, McInish, and Ord (1985), McInish and Wood (1990a) and Harris (1986)].

In line with the results of Wang and Yau (2000) and Rahman et al. (2002), our empirical findings suggest a contemporaneous and positive relationship between the intraday return volatility, bid-ask spread and unexpected trading volume. Whereas, the expected trading volume is found to have a negative relationship with conditional return volatility. We also find that higher trading volume and bid-ask spreads increase subsequent volatility.

In general, these results confirm the role of trading volume and bid-ask spreads as proxies for information arrival in producing the intraday return volatility. However, in contrast with Lamoureux and Lastrapes (1990), GARCH effects remain significant even after the inclusion of contemporaneous and lagged trading volume and bid-ask spreads in the volatility equation. Our results also indicate asymmetry in the effects of volume on conditional volatility.

Overall, our findings suggest that key financial markets' variables; return volatility, trading volume and bid-ask spreads exhibit intraday seasonalities. We also show that contemporaneous and lagged trading volume and bid-ask spreads have numerically small but statistically significant effect on return volatility. However, inclusion of both measures as proxy for informal arrival in conditional volatility equation does not explain the well known volatility persistence in intraday stock returns. For future research, it would be interesting to incorporate other information variables in the volatility equation to see if they are able to reduce the ARCH effects. Furthermore, the use of contemporaneous variables in the volatility equation could be subject to a specification bias. As pointed out by Fleming et al. (2006), adding volume to the GARCH model implies that volume is treated as exogenous variable, which is contrary to most trading models including MDH. If the volume parameter is endogenous, problems arise in the estimation of the maximum likelihood making it hard to trust the significance of the results. One option for the upcoming research would be to run simultaneous tests including return volatility, trading volume and bid-ask spread.

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Notes

Note 1: Many market microstructure papers regard the bid-ask spread as a proxy for information asymmetry, such as Lee, Mucklow and Ready (1993).

Note 2: For DAX30, the continuous trading ends at 17:30 CET. However, the post trading continues until 20:30 CET for individual stocks. Please also note that hereafter, all the times are shown in central European times (CET).

Note 3: Total number of interpolated observations was 74.

Note 4: For example, we deleted the bid-ask quotes where bid price was greater than the ask price.

Note 5: These effects disappear when we leave out the first 10-minute observations.

Note 6: We also check the contemporaneous correlation among these three variables for the first 10 minute period. The correlation coefficients are higher for the first 10 minute period of the trading day. For example, the correlation coefficients amount to 0.59 and 0.38 between return volatility and trading volume, and return volatility and bid-ask spreads respectively.

Note 7: We also check this by calculating the correlation coefficient between the number of stocks traded and intraday average trading volume for each time interval. The estimated correlation coefficient is 0.91, which clearly indicates the intraday averages of aggregate volume are significantly affected by the number of stocks traded per time period.

Note 8: We pick 6 stocks from DAX30 constituents based on market capitalization. The first three stocks are selected from the companies with higher market capitalization, while the last three are picked from the low turnover companies. The intraday patterns for selected stocks in DAX30 are not shown here to save the space. However, the figures are available upon request from the author.

Note 9: The intraday call auction begins at 13:00 for DAX30 stocks. The intraday call auction is usually conducted between 13:00 and 13:02. However, on Eurex settlement days, the call phase of the intraday auction lasts 5 minutes for DAX stocks. We verify that temporary halt in trading activity during the intraday auction at 13:00 have significant impact on average bid-ask spreads. An independent sample T-test was conducted for equality of means for spreads recorded at 13:00 and 13:05. Using a one percent significance level, the null hypothesis of equal means was rejected. Consequently it seemed that the intraday call auction significantly induces higher bid-ask spread for the subsequent period.

Note 10: Theissen and Freihube (2001) show almost a similar pattern for DAX stocks. However, they delete the interval in which the intraday call auction is conducted beginning at 13:00 for DAX stocks.

Note 11: Two different methods of decomposing trading volume are discussed in Danielsson and Payne (2001). We use ARMA model to generate expected volume and use the residual as unexpected volume. The use of expected volume in return volatility equation also reduces the well known simultaneity bias [Board et al. (2001)].

Note 12: See Andersen and Bollerslev (1997, 1998) for practical details on FFF.

Note 13: In order to facilitate the comparison of volatility persistence parameters, we first estimate the standard EGARCH model of the following form:

$log h_t = \gamma_0 + \delta g(Z)_{t-1} + \gamma_1 log h_{t-1}$, Where $g(Z)_{t-1} = \emptyset_1[(Z)]_{t-1} + \emptyset_2[(|Z_{t-1}|) - E(|Z_{t-1}|)]$

Note 14: The first order serial correlation of trading volume and bid-ask spreads is 0.313 and 0.221 respectively.

Note 15: In order to check the consistency of our model, we also test the effects of lagged unexpected trading volume on subsequent return volatility. Our estimates yield the significant and negative coefficient, consistent with the results obtained with contemporaneous terms.

Note 16: Rahman et al. (2002) use total trading volume in their study of NASDAQ stocks. When we use total trading volume in equation 6, the results are similar to those obtained by Rahman et al. (2002). However, it deemed more meaningful to split the trading volume into expected and unexpected component.

Table1. Summary statistics for intraday 5-minute raw returns and absolute returns

	r	|r|
Mean	0.0006	0.0487
Minimum	-2.2865	0.0000
Maximum	1.8499	2.2865
Standard Deviation	0.0849	0.0695
Skewness	-0.9391	8.5289
Kurtosis	78.0200	146.3980
AC (1)	-0.0100	0.1510
AC (2)	-0.0010	0.1320
Observations	36720	36720

Notes: AC (1) and AC (2) are first and second order autocorrelation coefficients respectively.

Table2. Cross correlations of 5-minute absolute returns, trading volume and Bid-Ask spreads

	|r|	Vol	BAS
|r|	1		
Vol	0.43	1	
	(90.27)		
BAS	0.29	0.19	1
	(58.11)	(37.83)	

Table3. Summary statistics for intraday 5-minute filtered returns and absolute filtered returns

	r	|r|
Mean	0.0001	0.0133
Minimum	-0.2649	0.0000
Maximum	0.3915	0.3915
Standard Deviation	0.0195	0.0142
Skewness	-0.0417	4.0470
Kurtosis	19.0620	46.3350
AC (1)	-0.0070	0.1900
AC (2)	-0.0080	0.1670
Observations	36719	36719

Notes: AC (1) and AC (2) are first and second order autocorrelation coefficients respectively.

Table4. Cross correlations of 5-minute absolute filtered returns, trading volume and Bid-Ask spread

	|r|	Vol	BAS
|r|	1		
Vol	0.12	1	
	(23.66)		
BAS	0.20	0.19	1
	(38.94)	(37.83)	

Table 5. The maximum likelihood estimates of benchmark EGARCH model

	Coefficient	Std. Error	z-Statistic	Prob.
γ_0	-0.4596	0.0075	-61.2078	0.0000
γ_1	0.9590	0.0008	1148.1210	0.0000
$\emptyset_2$	-0.0153	0.0013	-11.7416	0.0000

Notes: The maximum likelihood estimates were obtained using regularly spaced 5 minute filtered returns for the period May 5, 2004 to September 29, 2005. Each trading day is divided into 102 successive 5-minute intervals from 9:00 through 17:30 CET. The estimation was done assuming normal distribution for the following equation: $logh_t = \gamma_0 + \delta g(Z)_{t-1} + \gamma_1 h_{t-1}$

Where $g(Z)_{t-1} = \emptyset_1[(Z)]_{t-1} + \emptyset_2[(|Z_{t-1}|) - E(|Z_{t-1}|)]$

Table 6. The maximum likelihood estimates of conditional volatility equation

	Coefficient	Std. Error	z-Statistic	Prob.
γ_0	0.094011	0.027846	3.376057	0.0007
γ_1	0.918714	0.001509	608.6259	0.0000
θ_1	-3.48E-06	1.23E-07	-28.42173	0.0000
θ_2	7.96E-06	1.48E-07	53.93891	0.0000
θ_3	0.138753	0.005162	26.87766	0.0000
$\emptyset_2$	-0.001847	0.00194	-0.952046	0.3411

Notes: The maximum likelihood estimates were obtained using regularly spaced 5 minute filtered returns for the period May 5, 2004 to September 29, 2005. Each trading day is divided into 102 successive 5-minute intervals from 9:00 through 17:30 CET. The estimation was done assuming normal distribution for the following equation: $\log h_t = \gamma_0 + \gamma_1 h_{t-1} + \delta g(Z)_{t-1} + \theta_1 \text{ExpVol} + \theta_2 \text{UnexpVol} + \theta_3 \log\text{SBAS}$,where $g(Z)_{t-1} = \emptyset_1[(Z)]_{t-1} + \emptyset_2[(|Z_{t-1}|) - E(|Z_{t-1}|)]$

Table 7. The maximum likelihood estimates of conditional volatility equation

	Coefficient	Std. Error	z-Statistic	Prob.
γ_0	0.138794	0.030252	4.587869	0.0000
γ_1	0.903727	0.001816	497.6414	0.0000
θ_1	-3.98E-06	1.26E-07	-31.5619	0.0000
θ_2	6.02E-06	1.47E-07	40.86946	0.0000
θ_3	0.171317	0.005621	30.47732	0.0000
θ_4	0.096708	0.004675	20.68476	0.0000
$\emptyset_2$	0.002191	0.002101	1.042782	0.2970

Notes: The maximum likelihood estimates were obtained using regularly spaced 5 minute filtered returns for the period May 5, 2004 to September 29, 2005. Each trading day is divided into 102 successive 5-minute intervals from 9:00 through 17:30 CET. The estimation was done assuming normal distribution for the following equation:

$logh_t = \gamma_0 + \gamma_1 h_{t-1} + \delta g(Z)_{t-1} + \theta_1 ExpVol + \theta_2 UnexpVol + \theta_3 logSBAS + \theta_4 dumUnexpVol$, *where* $g(Z)_{t-1} = \emptyset_1[(Z)]_{t-1} + \emptyset_2[(|Z_{t-1}|) - E(|Z_{t-1}|)]$

Table 8. The maximum likelihood estimates of conditional volatility equation

	Coefficient	z-Statistic	Prob.
γ_0	-0.2848	-14.44	0.00
γ_1	0.9568	1066.82	0.00
θ_1	-0.0096	-9.67	-0.01
θ_2	0.017	4.62	0.02
$\emptyset_2$	-0.014	-10.05	0.00

Notes: The maximum likelihood estimates were obtained using regularly spaced 5-minute filtered returns for the period May 5, 2004 to September 29, 2005. Each trading day is divided into 102 successive 5-minute intervals from 9:00 through 17:30 CET. The estimation was done assuming normal distribution for the following equation: $\log h_t = \gamma_0 + \gamma_1 \log h_{t-1} + \delta g(Z)_{t-1} + \theta_1 \log(\text{ExpVol})_{t-1} + \theta_2 \log(\text{SBAS})_{t-1}$,where $g(Z)_{t-1} = \emptyset_1[(Z)]_{t-1} + \emptyset_2[(|Z_{t-1}|) - E(|Z_{t-1}|)]$.

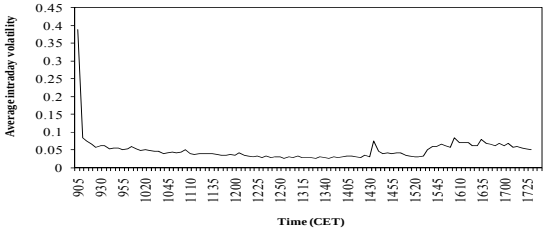

Figure 1. Average intraday volatility for the DAX 30 index

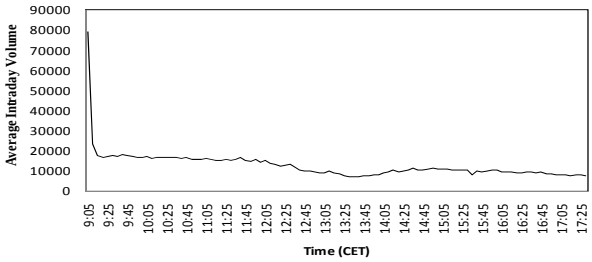

Figure 2. Average intraday volume for the DAX 30 index

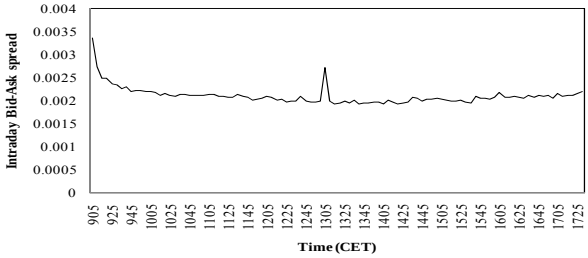

Figure 3. Average intraday spread for the DAX 30 index

Appendix A

The Figure A1 and A2 represent autocorrelation pattern of raw and filtered absolute returns and average intraday volatility pattern for each 5-minute interval respectively.

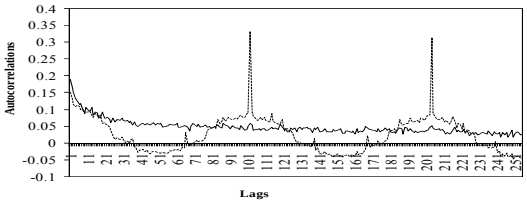

Figure A1. Autocorrelation pattern of 5-minute raw and filtered absolute return. The dashed and the solid line depict the autocorrelation coefficients for raw and filtered absolute returns for the DAX30 index respectively.

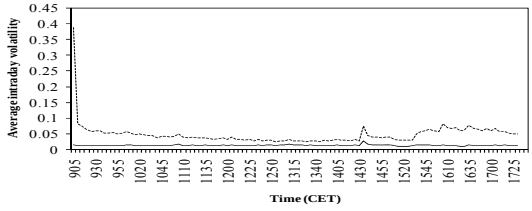

Figure A2. Average intraday volatility pattern for each 5-minute interval. The dashed and the solid line show the average raw and filtered absolute returns for the DAX30 index respectively.

Labor Contracts and Shirking in Cameroon

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Abstract

This paper evaluates and analyzes the effects of labor contracts on shirking in Cameroonian firms. This study uses the survey data collected in 2006 in Cameroonian manufacturing firms having more than 15 employees. Data processing produced a sample of 65 companies and 1809 employees. In addition to permanent or temporary distinctions, we considered the verbal aspect of labor contracts, affiliation to social security and promotion within the labor market. Econometric estimations take into account the endogeneity of the contractual trajectory of employees. Results are estimated in 2 stages. First, we evaluate the determinants of contract choice and the second; we estimate the degree in Cameroonian firms. This degree is measured by the level of effort deployed by workers. Results show that permanent employees after a verbal contract work harder than those who are permanent since their recruitment. In addition, the employees under short term contracts since their recruitment are more inclined to shirk as well as those who are permanent since their recruitment. Employees without social security are likely to cheat than those with social security and recruited permanently since the beginning.

Keywords: Labor contracts, Cameroon, Shirking, Logistic regression.

1. Introduction

Since the end of the 1980s, one of the most important characteristics of labor contracts is its duration, which can be specified or unspecified. The increase in the number of employees under a specified period contract has been subjected to many scientific works (Booth et al., 2002). However, the questions often treated by the researchers are relative on one hand to the macroeconomic impact of temporary contracts on unemployment and job creation (Cahuc and Postel-Vinay, 2002; and Blanchard and Landier, 2002) and on the other hand, the microeconomic effects of part-time employment on the output of the labor market such as wages, on-the-job training, or the transition from temporary contract to permanent contract (D' Addio and Rosholm, 2005; Güell and Petrongolo, 2007).

Papers which focus on the incentive behavior of temporary contracts in the Africa are rare. But elsewhere, by considering part-time jobs as a stepping stone towards a permanent employment, employees under temporary contracts are more willing to make efforts than those under permanent contracts (Engellandt and Riphahn in 2005), and this lecvel of effort falls when they are promoted to permanent contracts (Ichino and Riphanh, 2001; Booth et al., 2002). On the other hand, employees under temporary contracts are subjected to bad working conditions and have relatively weak wages compared to the holders of permanent contracts (D' Addio and Rosholm, 2005; Fomba Kamga, 2008). On this basis, the holders of a limited time contract are on the secondary segment of the labor market whereas those with a permanent contract are on the primary segment.

Under the efficiency wages framework related to shirking (Shapiro and Stiglitz, 1984), employees under temporary contracts are thus willing to provide less effort than those under permanent contracts. This analysis highlights the interest to study the impact of the contractual statutes of employees on their level of effort.

The present study contributes to the existing literature on several regards. First, it continues the micro-level analysis of temporary contracts initiated by Booth et al. (2002) (Note 1) and pioneers in developing countries, especially in Sub Saharan Africa. Second, beyond the distinction temporary and permanent contract the paper considers the specificities of the Cameroonian labor market by integrating the written or verbal character of the labor contract as well as the affiliation of the employee to social security. Moreover, this study integrates the transition on the labor market and can compare the shirking habits of employees who have been promoted (Note 2) and those employees who have not. On the methodological front, while several papers consider labor contracts as an exogenous variable, we take into account their endogenous character.

The rest of the paper is organized as follows. Section two briefly describes some institutional aspects of the Cameroonian labor market. Section 3 presents the data and specifies the methodology. Section 4 provides the estimation results before some concluding remarks in the last section.

2. Some institutional aspects

The 1992 Labor code built on the wind of liberalism which blew in Africa and in Cameroon since 1990. Its ambition was to improve the flexibility of the labor market and thus allow firms to be more competitive. Thus the specified period labor contract which was the exception in the Labor code of 1974 became as legal as employment form

different from the permanent contract (by duration, degree of attachment to the firm and number of renewals). From this framework, first, the employees working for the firm without being under its administrative responsibility can either be recruited by a drudge or sub-contractor company or temporary work companies. Second, employees working for the firm under its direct responsibility can either be recruited for an unspecified or for a specified period. Apart from the number of hours worked per day and/or week, relationships with the firm differ by the duration, the written nature of labor contract, the possibility of becoming permanent and the affiliation to social security (SS). These characteristics are summarized in table 1.

The intriguing feature in this table is the verbal character of some labor contracts, namely the UPC. Thus, the Labor code 1992 considers that any fixed duration contract that runs out without renewal is regarded as permanent. However, considering a verbal contract as UPC or automatically transforming a specified period contract into an UPC can bring up acute disparities in terms of wages, productivity, effort, etc. To put forward these disparities, the present study regards only duly signed contracts as UPC.

3. Data and modeling strategies

Data used in this study were field collected in 2006. The survey covered companies with at least 15 employees and located in the main Cameroon towns, namely Yaoundé and Douala. The method of quotas was used to determine the number of firms and employees to be surveyed in each city and each firm. The companies were selected from the directory of Cameroonian companies available at the National Institute of Statistics (NIS). After data processing, a sample of 65 companies and 1809 employees were retained. The questionnaire presented to the employees concerned socio-demographic indicators, the contractual trajectory of employees, the measurement of effort, etc.

3.1. Measurement of some key variables

The literature highlights objective and subjective measurements of effort. Objective measurements of effort have the characteristics of being observable and comparable. The mostly used indicators are absenteeism (Barmby, 2002; Johansson and Palme, 2002; Ichino and Riphahn, 2001; Riphahn and Thalmaier, 2001; Jimeno and Toharia, 1996), the intensity to work (Engellandt and Riphahn, 2005) or unpaid overtime. The main limit of this approach is the lack of the hidden aspects of effort which are important and present in any agency relationship. Moreover, absenteeism can be involuntary due for instance to health problems. In this case, there is no link with effort.

Subjective measurements of effort are neither observed by the employer nor by someone else. The level of effort furnished by the employee is thus auto valued, because observable by the employee himself. These measurements can be captured by asking the employees to evaluate their level of effort on a Likert scale. The limit of an indicator with several levels is the heterogeneity of the evaluation, and employees can under evaluate or over evaluate their own level of effort. The subjective indicator used here results from the answer to the following question: *Do you think all your competences are devoted to this company? 1 = yes, 2 = no*. Among the 1809 employees interviewed, 372 declare shirking whereas 1437 state not to.

The key explanatory variable of this paper is the contractual status of the employee. As state by the Cameroonian labor Code, employees are classified according to two criteria: the written or verbal nature of the labor contract (UPC or SPC); and the affiliation of the employee to social security.

Given the principle of promotion, the contractual choices of employees result from the process illustrated by figure 1. This process is based on the idea that the employees hired under verbal contracts without SS, written contracts without SS and UPC with SS cannot be promoted. On the other hand, those hired under SPC with SS and verbal contracts with SS can benefit from a promotion. From this process we derive seven (7) possibilities of choice to the employees. Table 2 gives the denomination used in this context for each possibility. The first term of the fifth column indicates the contractual status at the time of recruitment and the second term the contractual status at the time of interview.

Table 3 shows that among the employees who cheat, 28.76% were recruited under UPC with SS whereas only 22.31% of the employees still under the most precarious status (verbal without SS) cheat. Employees engaged under SPC with SS and who are still there, account for only 3.76%. The chi square test gives chi2 = 43.2709 with p-value of 0.0000. These results confirm that the level of effort and the contractual forms are interdependent but there is no information about magnitude and direction of this relationship.

3.2. Modeling strategy

Our purpose is to test whether workers with temporary contracts provide more effort than those permanently employed. To ensure that the measured outcomes are not due to composition effects, the model introduces control variables describing the individual worker (age, sex, marital status, education, tenure, etc.), and job (tenure, firm size, industry, occupation). The effort variable has two options: the employee cheats or not. The binary logistic regression model is adapted for this analysis (Note 3).

Previous works on the relation between effort and labor contracts often treat the latter as an exogenous variable (Jimeno and the Cortes, 1996; Engellandt and Riphahn, 2005). However in reality, signing a particular contract during recruitment or when moving from a precarious to permanent situation depends on the characteristics of the employees, the economic conjuncture and the characteristics of the firm (D'Addio and Rosholm, 2005). To solve this insufficiency, it is essential to purge endogeneity from the employees' contractual trajectory. We use two stages

methodology. It consists in estimating the employees' contractual trajectory on its various determinants and to obtain the predicted probabilities which will be later used in the effort function.

The employees' contractual trajectory is summarized in figure 1. This figure shows that the employees have the choice between seven destinations. This can be captured by a nested logit model (Note 4). The probability of accepting contract j is given by the following expression:

$$j = \begin{cases} Verbal\text{-}SS = 0 \quad if \quad Y_{i0} = \max(Y_{ij}) \\ \text{Written-SS} = 1 \quad if \quad Y_{i1} = \max(Y_{ij}) \\ Verbal\_Verbal = 2 \quad if \quad Y_{i2} = \max(Y_{ij}) \\ Verbal\_UPC = 3 \quad if \quad Y_{i3} = \max(Y_{ij}) \\ SPC\_SPC = 4 \quad if \quad Y_{i4} = \max(Y_{ij}) \\ SPC\_UPC = 5 \quad if \quad Y_{i5} = \max(Y_{ij}) \\ UPC\_UPC = 6 \quad if \quad Y_{i6} = \max(Y_{ij}) \end{cases} \tag{1}$$

The choices are described by a "random utility model". Let us suppose that the utility drawn by the individual i from choice j is given by:

$$U_{ij} = Z_{ij}^{'}\beta + \varepsilon_{ij} \tag{2}$$

Where $Z_{ij}^{'}$, β and ε_{ij} are characteristics of workers and firms, parameters to be estimate and error term respectively. This choice is made only when he obtains the maximum utility among the other J utilities. Consequently, the statistical model is described by the probability that the J choice is made, which is:

$$P_{ij} = \Pr ob(U_{ij} > U_{ik};\ \forall k \neq j) = \Pr ob(Z^{'}\beta + \varepsilon > 0 \mid Z) \tag{3}$$

Running this model is only possible when the distribution of the random error term is known. For this study, we use the multinomial logit to perform the estimation.

$$\Pr ob(Y_i = j) = \frac{\exp(Z_{ij}^{'}\beta)}{\sum_{j=0}^{j=6} \exp(Z_{ij}^{'}\beta)} \tag{4}$$

Where $Y_i = j$ indicates that the dependent variable Y for individual i takes the values $j = 0,1,2,3,4,5,6$.

Description of variables is given in the annex. Table 4 gives the descriptive statistics of some variables. The executives are among employees who do not cheat. They are followed by the operators, that is, 11.56% and 18.55% respectively. Skilled workers and supervisors are represented almost in the same proportions among the employees who cheat, that is, 25.27% and 24.19% respectively. Among those who do not cheat, the supervisors and executives are less represented that is, 16.63% and 6.89% respectively. This result shows that employees of higher socio professional categories have a relative incentive to effort. This behavior can be explained by the fact that they are generally intended for supervision. In the same order of idea, the employees of the lower categories are strongly represented among those who do not cheat that is, 21.09%, 23.59% and 31.80% for workers, unskilled workers and skilled workers respectively. Men cheat more than women since 85% of shirkers are men. Human capital does not act uniformly on the level of effort. Employees having a secondary level of education cheat more than all others.

The food sector is where cheating is low (11%). These results can be due to the difficulty in setting standards to control the employees in the chemical sector and a relative facility to do the same in the food sector. In large companies, we note that employees are more inclined to shirk (more than 69% of workers) contrary to small companies where shirking accounts for only 6%.

4. Empirical results

Results are presented in tables 5 and 7. The former gives the marginal effects of the choice of contractual trajectory and the latter the determinants of the level of effort.

4.1. Contracts

In table 5 the reference variable is the trajectory *verbal – verbal* contract, which is supposed to be the most precarious. The model is overall significant as indicated by the p-value = 0.0000. The remaining results are presented in two sequences relating first to the characteristics of the employee and, second to the characteristics of the company.

The results obtained show that the probability of remaining under the written contract without affiliation to social security or following trajectory SPC - SPC decreases with age. Being aged 36 - 45 years increases by 14.11% the probability of following a verbal trajectory - UPC. Moreover, employees aged 26 - 35 years, 36 - 45 years and at least

46 years, have in terms of relative risk 5 times, 15 times and 6 times respectively more chances than employees of less than 25 years to follow the SPC - UPC trajectory. This analysis shows that insecure and precarious contracts are reserved to young people. To have been under an insecure contract before recruitment increases the probability of being hired under an insecure contract, and decreases the chances of having an UPC. Similarly, to have been under an UPC increases of almost 28% the probability to sign an UPC when hired in a new company.

Employers avoid holdup problems. This is why they prefer to pay for training of employees under a stable status, especially those recruited under UPC. Also, being a graduate of the general higher education increases by 14.15% the probability to be hired under UPC. This result shows that the graduates of general higher education having more information on the employment picture on the labor market improve their negotiation capacity and increase their chances to get stable jobs.

Regarding the characteristics of the company, it appears that to be employed in the mechanical sector decreases by 13.78% the chances to sign an UPC when recruited. However, moving from a verbal contract to an UPC increases them by 10.58%. Similarly, in the food sector, the probability of moving from a verbal contract to an UPC increases by 13.75%. As for the size of the company, we note that the chances of being hired under an UPC decrease in the average sized companies, that is, those with 50 - 100 workers.

As far as the economic environment is concerned, to be hired after 1995 reduces the chances to get a stable job, this shows that the return of economic growth in Cameroon is accompanied by the precariousness of the labor market.

4.2. Effort

In table 7, the first two columns represent the determinants of effort when the choice of the contractual trajectory is supposed to be exogenous whereas columns 3 and 4 represent the determinants of effort when the endogeneity of the choice of the contractual trajectory is controlled. Both models are globally significant, but the model including endogeneity behaves better.

The effects of the contractual status on the employees' level of effort have diversified results. Employees under UPC after a verbal contract provide more efforts than employees recruited under UPC. Following this trajectory increases by 56.41% the probability of not cheating when the endogeneity of the contractual status is taken into account. This result contrasts with Booth et al. (2002) which show that the absenteeism rate (respectively the number of not paid overtime) increases (respectively decreases) for the employees of Italian banks after their probationary period. In the case of Cameroun, we note that the signature of an UPC is not the finality of the employees under verbal contract. Thus if insecure contracts are regarded as a springboard towards the UPC, it is quite obvious that the signature of an UPC is an intermediate objective for the employees recruited under verbal contract.

The fact of not being affiliated to social security encourages the employees to shirk. To be under a verbal contract or written contract without affiliation to social security increases by 6.04% and 18.85% respectively the probability of cheating in model 1. This result shows that for these employees, the signature of an UPC is not a final aim but the wage is more important. As seen in table 6, the groups of employees who have the weakest wages are more willing to cheat.

In like manner, employees under UPC after a SPC or always under UPC value wages more than promotion for shirking. With wages weaker than those employees directly hired under UPC, they prefer to shirk.

The other results show that the probability of shirking increases with the size of the household and the exercise of an auxiliary activity. Adding a person in the household increases by 0.98% the probability of cheating whereas; the exercise of an auxiliary activity increases by 18.09% the probability of shirking. This result can be due to the fact that increasing the size of the household very often results in increasing family responsibilities (marriage, number of children in charge of, etc) which reduce the attachment of the worker to his main activity. Moreover, this increase in responsibility is accompanied by requirements in terms of income for family subsistence. The worker can thus be obliged to supplement the income from the main activity by the income from the auxiliary activity. In addition, the probability of cheating increases with the job located in Douala, the food and plastic sectors, the graduation from the technical higher education.

A contrario, the probability of not cheating increases with the age of worker and size of the company. Being at least 46 years old increases by 9.96% the probability of not cheating, which means that seniors are somehow attached to their main activity. In small or medium sized companies, supervision can be rather easy and justifies that their employees cannot cheat.

5. Conclusion

The main objective of this paper was to determine the effects of labor contracts on Cameroonian employee shirking behavior. Beyond the distinction permanent *versus* temporary, this paper has taken into consideration the peculiarities of the Cameroonian labor market: the verbal nature of some labor contracts and affiliation to social security. Moreover, this work integrates the transition or promotion from precarious position to the permanent contract. This made it possible by assembling the employees in seven groups. Shirking is measured by a subjective variable showing that labor contract is an agency relation. Our work was partly based on the fact that employees under temporary contracts are more likely not to cheat in order to get to the permanent status and on the other hand,

that employees under temporary contracts mostly find themselves on the secondary segment and under the hypotheses of efficiency wage theories are more likely to shirk compared to those under permanent contracts.

The results obtained show that employees under UPC after a verbal contract are more likely to make more efforts than those under UPC since their recruitment. Following this contractual trajectory increases about 56.41% the probability of not shirking. A contrario, the fact of being under a SPC since recruitment, increases by 60.86% the probability to shirk. In the same way, having no affiliation to social security increases the probability to shirk. These results show that the expected benefits from using temporary employees (wage costs) can be cancelled by shirking.

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Notes

Note1: Booth and al (2002) made it possible to show that temporary contracts lead to permanent contracts. In the case of Great Britain, they confirm that a great proportion of employees under temporary contracts move to permanent contracts with wage increase and advantages linked to the job.

Note 2: In this framework, job promotion is moving from a precarious contract to a permanent one.

Note 3: This study prefers the logistic model because of its flexibility in manipulations and the calculation of odds ratios; indicators which improve the interpretation of the results.

Note 4: Its estimation requires a particular treatment but, it allows deducing probabilities for each level and not probabilities for each choice. However from the decision tree of figure 1, only the probabilities of the last level alternatives can be given. Moreover, the implementation of such a model requires that the characteristics of the

various choices be known. In reality, these characteristics are non-existent and this is why this militates in favor of the simple multinomial logit model.

Annex: Description of variables

Variables	Definitions
Effort	(2) Two modalities Variable coded as follows: 0=cheats, 1=does not cheat.
Labor contrat	(4) Four modalities Variable coded as follows: 0=precarious contracts (informal and SPC); 1=UPC after an informal contract; 2=UPC after a SPC; 3=UPC since recruitment. Each of these modalities will sometimes be transformed into variable.
Age	The age in years in measured by four (4) qualitative variables age $\leq$25 ; age $\in$ [26, 35] ; age $\in$ [36, 45] ; age $\geq$46
Education	The type and level of education are measured by five (5) qualitative variables which are: at most primary level, general secondary, technical secondary, general higher et technical higher.
Training	Is measured by two qualitative variables which are : training and no training
Seniority	Number of years spent in the present firm, measured in months.
Socio professional Categories	Five categories are selected: workers, unskilled workers, skilled workers, supervisory staff, and manager staff.
Labor status before	It has four (4) qualitative variables: unemployed, verbal contract, SPC and UPC.
Means used for hiring	There were three qualitative variables: social network, demand and company.
Characteristics of the firm	
Location of the firm	The location of firm is measured by two qualitative variables: Douala and Yaoundé.
Size of the firm	The size in number of employees is measured by four (4) qualitative variables that is : size<25, size $\in$ [25, 50[, size $\in$ [50, 100[and size $\geq$100
Sector of activity	Qualitative variable represented by four (4) modalities transformed into dummy variables which are: chemical sector, food sector, plastic and paper sector, mechanic and wood sector.

N.B. Workers is the low level of socio professional categories.

Table 1. Characteristics of labor contracts.

Contracts	Duration	Renewal	Max duration	Written	Towards UPC	SS
UPC	Undetermined			Optional		Yes
Trial	Variable	1	Variable	Written	Yes	Yes
SPC	24 months	1	48 months	Written	Yes	Yes
Temporary C	3 months	1	6 months	Optional	Yes	Yes
Occasional C	15 days	1	1 month	Optional	Yes	Yes
Seasonal C	6 months	Several	-	Optional	Yes	Yes
Apprentice	48 months	-	48 months	Written	Yes	Yes
The term of a trial-basis contract varies with the socio-professional category of the employee. It is 15 days for categories 1 and 2, 1 month for categories 3 and 4,2 months for categories 5 and 6,3 months for categories 7,8 and 9 and 4 months for categories 10,11 and 12. It is sufficient to multiply these durations by 2 to obtain the maximum durations. As for the seasonal contracts, they last 6 months duration per annum with the same employer and can thus be repeated each year.						

Source: From: Labor Code of 1992, decree N° 93/577/PM of July 15, 1993 and the decree n° 091/DF/287 of July 30, 1969.

Table 2. Denomination of different contractual trajectories

Number	Hiring contract	Contract at interview	Promotion	Denomination	Workers
1	Verbal without SS	Verbal without SS	No	Verbal – SS	424
2	Written without SS	Written without SS	No	Written – SS	121
3	Verbal with SS	Verbal with SS	No	Verbal – Verbal	224
4	Verbal with SS	UPC with SS	Yes	Verbal – UPC	280
5	SPC with SS	SPC with SS	No	SPC – SPC	66
6	SPC with SS	UPC with SS	Yes	SPC – UPC	148
7	UPC with SS	UPC with SS	No	UPC – UPC	546

Source : Survey

Table 3. Interdependence between contractual choice and the level of effort.

Effort	**Contractual choice**							
Effort	Verbal – SS	Written - SS	Verbal –Verbal	Verbal –UPC	SPC - SPC	SPC - UPC	UPC – UPC	Total
Shirking	**83**	**45**	**49**	**31**	**14**	**43**	**107**	**372**
	22.31	*12.10*	*13.17*	*8.33*	*3.76*	*11.56*	*28.76*	*100.00*
	19.58	37.19	21.88	11.07	21.21	29.05	19.60	20.56
No shirking	**341**	**76**	**175**	**249**	**52**	**105**	**439**	**1437**
	23.73	*5.29*	*12.18*	*17.33*	*3.62*	*7.31*	*30.55*	*100.00*
	80.42	62.81	78.13	88.93	78.79	70.95	80.40	79.44
Total	**424**	**121**	**224**	**280**	**66**	**148**	**546**	**1809**
	23.44	*6.69*	*12.38*	*15.48*	*3.65*	*8.18*	*30.18*	*100.00*
	100	100,00	100.00	100.00	100.00	100.00	100.00	100.00
Pearson chi2 (6) = 43.2709 ; Pr = 0.000								

Source: Survey. The figures in italic are the proportions in column and the last line of each box is the proportion on line

Table 4. Selected sample characteristics by shirking status.

Variables	Shirking	No shirking
Effectifs	**20.56%**	**79.44%**
Age <=25	9.14 (0.0150)	8.70 (0.0074)
Age 26 – 35	52.69 (0.0259)	48.09 (0.0132)
Age 36 – 45	27.15 (0.0231)	28.67 (0.0119)
Age >46	11.02 (0.0163)	14.54 (0.0093)
Worker (operation)	18.55 (0.0202)	21.09 (0.0108)
Unskilled Worker	20.43 (0.0209)	23.59 (0.0112)
Skilled worker	25.27 (0.0226)	31.80 (0.0123)
Supervisory staff	24.19 (0.0222)	16.63 (0.0098)
Management staff	11.56 (0.0166)	6.89 (0.0067)
Single	48.39 (0.0259)	44.47 (0.0131)
Married	51.61 (0.0259)	55.53 (0.0131)
Male	83.60 (0.0192)	83.79 (0.0097)
Female	16.40 (0.0192)	16.21 (0.0097)
Primary	18.28 (0.0201)	25.05 (0.0114)
Second T	26.34 (0.0229)	27.35 (0.0118)
Second G	26.34 (0.0229)	31.18 (0.0122)
High tech	17.74 (0.0198)	8.07 (0.0072)
High. Gene.	11.29 (0.0164)	8.35 (0.0073)
Tenure	84.4328 (4.4632)	94.8149 (2.3816)
Experience	111.0806 (5.1197)	118.0619 (2.7260)
No training	73.38 (0.0229)	72.79 (0.0117)
Training	26.61 (0.0229)	27.21 (0.0117)
Demand and test	67.51 (0.0248)	61.33 (0.0130)
Social capital	31.37 (0.0245)	37.66 (0.0129)
Company (FNE)	11.20 (0.0056)	1.00 (0.0026)
Douala	95.95 (0.0102)	92.00 (0.0072)
Yaoundé	4.05 (0.0102)	8.00 (0.0072)
Chemical	40.32 (0.0255)	35.98 (0.0127)
Food	11.02 (0.0163)	21.16 (0.0108)
Plastic	25.54 (0.0226)	19.76 (0.0105)
Mechanic	23.12 (0.0219)	23.10 (0.0111)
Size <25	5.65 (0.0120)	6.12 (0.0063)
[25 – 50[	16.13 (0.0191)	19.00 (0.0104)
[50 – 100[	9.14 (0.0150)	14.34 (0.0092)
≥100	69.09 (0.0240)	60.54 (0.0129)

Source: Survey. The values in parentheses are standard deviations.

Table 5.Estimation results of contract status (marginal effects)

	Without SS	With SS				
	Written	**Verbal- Verbal**	**Verbal – UPC**	**SPC – SPC**	**SPC – UPC**	**UPC – UPC**
Age						
Age26-35	0.0557 (-2.35) **	-0.0497 (-1.25)	0.0845 (1.42)	-0.0179 (-1.10)	0.0822 (1.65) *	0.0494 (0.71)
Age36-45	-0.0942 (-4.76) ***	0.0240 (0.49)	0.1411 (1.79) *	-0.0345 (-2.54) **	0.1285 (1.56)	-0.0164 (-0.21)
Age-46	-0.0560 (-2.45) **	0.0480 (0.65)	0.1179 (1.18)	-0.0358 (-3.18) ***	0.0845 (0.91)	-0.0509 (-0.58)
Male	-0.0282 (-1.21)	0.0349 (1.22)	0.0214 (0.72)	0.0065 (0.58)	-0.0001 (-0.01)	-0.0108 (-0.28)
Married	0.0193 (1.19)	-0.0671 (-2.65) ***	0.0675 (2.86) ***	0.0006 (0.06)	0.0132 (1.01)	0.0408 (1.25)
Education						
Second T	0.0034 (0.15)	0.0039 (0.13)	-0.0235 (-0.80)	-0.0026 (-0.17)	0.0170 (0.78)	-0.0167 (-0.39)
Second G	0.0131 (0.57)	-0.0382 (-1.43)	-0.0120 (-0.41)	0.0025 (0.15)	0.0266 (1.15)	0.0040 (0.09)
High tech	0.0002 (0.01)	-0.0215 (-0.47)	-0.0286 (-0.68)	-0.0003 (-0.02)	0.0085 (0.28)	0.0954 (1.49)
High. Gene.	0.0059 (0.17)	-0.0422 (-0.95)	-0.0335 (-0.74)	-0.0141 (-0.88)	0.0216 (0.62)	0.1415 (2.08) **
Contract before						
Verbal - SS	0.0744 (2.26) **	0.0096 (0.29)	-0.0854 (-3.44) ***	-0.0045 (-0.35)	-0.0046 (-0.27)	-0.0446 (-1.02)
Verbal + SS	-0.0313 (-0.66)	0.0778 (1.02)	-0.0923 (-2.26) **	0.0171 (0.43)	0.0168 (0.42)	-0.0252 (-0.29)
Written – SS	0.1496 (2.82) ***	-0.0483 (-1.32)	-0.1004 (-3.66) ***	0.0259 (1.07)	-0.0211 (-1.23)	0.0221 (0.38)
SPC + SS	0.0640 (1.02)	-0.0671 (-1.63) *	-0.0974 (-3.06) ***	0.0243 (0.73)	-0.0332 (-1.83) *	0.0398 (0.51)
UPC + SS	0.0244 (0.55)	-0.0767 (-2.00) **	-0.0879 (-2.96) ***	-0.0040 (-0.21)	-0.0456 (-2.98) **	0.2796 (4.33) ***
Trainers	-0.0014 (-0.09)	-0.0477 (-2.05) **	0.0857 (3.28) ***	-0.0026 (-0.27)	0.0285 (1.96) **	0.0594 (1.88) *
Profession						
unskilled worker	-0.0441 (-2.78) ***	-0.0716 (-2.83) ***	0.0265 (0.67)	-0.0091 (-0.46)	0.1250 (2.07)	0.0958 (1.53)
skilled worker	-0.0663 (-3.92) ***	-0.1174 (-4.72) ***	0.0256 (0.69)	0.0508 (1.74) *	0.1340 (2.52)	0.1673 (2.81) ***
supervisory staff	-0.0730 (-5.09) ***	-0.1333 (-5.85) ***	-0.0157 (-0.40)	0.0361 (1.08)	0.0894 (1.56)	0.2938 (4.20) ***
management staff	-0.0643 (-4.59) ***	-0.1696 (-10.06) ***	-0.1045 (-3.01) ***	0.0608 (1.06)	0.0928 (1.18)	0.3394 (3.67) ***
Trade union	-0.0554 (-3.64) ***	0.0101 (0.47)	0.1080 (4.72) ***	-0.0285 (-2.91) ***	0.0187 (1.50)	0.1226 (4.15) ***
Company	0.0596 (1.27)	-0.0229 (-0.43)	-0.0369 (-0.78)	-0.0085 (-0.48)	0.0413 (1.19)	-0.1498 (-2.78) ***
Social capital	-0.0017 (-0.11)	0.0269 (1.15)	0.0019 (0.09)	-0.0063 (-0.60)	-0.0284 (-2.21)	-0.0379 (-1.22)
Douala	0.0284 (1.21)	-0.2121 (-3.31) ***	0.1746 (9.24) ***	-0.0023 (-0.12)	0.0599 (4.32)	-0.0027 (-0.04)
Sector of activity						
Food	-0.0367 (-2.11) **	-0.0378 (-1.28)	0.1375 (3.52) ***	-0.0096 (-0.76)	-0.0163 (-1.02)	-0.0087 (-0.21)
Plastic and paper	-0.0439 (-2.77) ***	0.0623 (1.87) *	0.0501 (1.41)	-0.0259 (-2.42) **	-0.0020 (-0.11)	-0.0298 (-0.75)
Mechanic	-0.0191 (-1.16)	-0.0028 (-0.09)	0.1058 (2.94) ***	0.0033 (0.27)	0.0189 (1.09)	-0.1378 (-3.88) ***
Firm size						
[25 – 50[	-0.0214 (-0.77)	0.1287 (1.37)	-0.0775 (-1.96) **	-0.0205 (-1.22)	0.0469 (0.68)	-0.0163 (-0.21)
[50 – 100[	-0.0179 (-0.62)	0.2530 (2.20) **	-0.0698 (-1.71) *	0.0132 (0.46)	0.0703 (0.83)	-0.2292 (-4.24) ***
$\geq$ 100	-0.0192 (-0.65)	0.1078 (1.94) *	-0.0493 (-1.09)	0.0031 (0.17)	0.0930 (2.39)	-0.0239 (-0.37)
Growth						
Before 1987	0.1379 (0.84)	0.0080 (0.11)	-0.1177 (-3.47) ***	-0.0242 (-1.79) *	-0.0255 (-1.07)	0.0209 (0.21)
After 1995	0.0819 (2.57)	0.0509 (1.17)	-0.0215 (-0.51)	-0.0404 (-1.31)	0.0104 (0.49)	-0.1423 (-2.23) **
Probability	0.0780	0.1592	0.1724	0.0362	0.0667	0.3426

Note: *** (**) * statistically significant at 1% (5%) and 10%.

Table 6. Distribution of wages (in thousands of CFA)

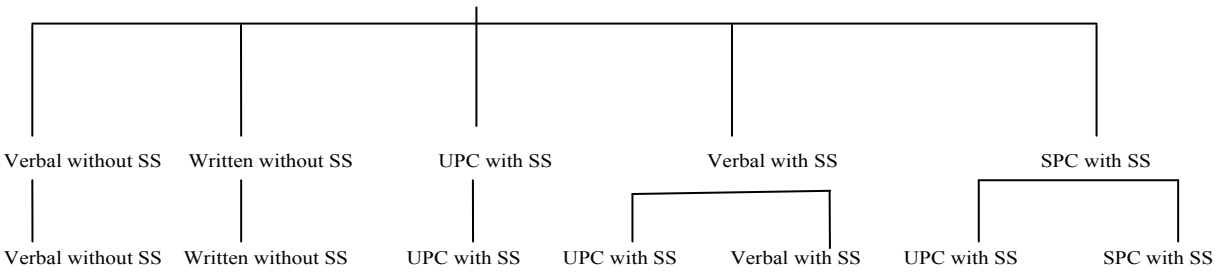
	Wage	Standard deviation	Workers	Rank	Shirking
Verbal – SS	77.730	60.618	424	1	YES
Written – SS	144.267	125.708	121	3	YES
Verbal-Verbal	121.51	77.535	224	2	YES
Verbal – UPC	179.623	116.726	280	4	NO
SPC – SPC	283.569	122.748	66	6	YES
SPC – UPC	223.380	162.192	148	5	YES
UPC – UPC	294.926	269..114	546	7	-
Total	184.859	190.664	1809		

Source: Survey

Table 7. Estimate results of the effort function.

	Coefficients	Marginal Effets	Coefficients	Marginal effect
Age				
Age26-35	0.0175 (0.08)	0.0025 (0.08)	-0.2846 (-1.07)	-0.0418 (-1.07)
Age36-45	0.3674 (1.37)	0.0510 (1.44)	-0.1990 (-0.56)	-0.0300 (-0.55)
Age-46	0.8310 (2.22) **	0.0996 (2.77) ***	0.4347 (1.01)	0.0575 (1.12)
Male	-0.2515 (-1.42)	-0.0348 (-1.50)	-0.2125 (-1.16)	-0.0297 (-1.22)
Household size	-0.0669 (-2.75) ***	-0.0097 (-2.75) ***	-0.0667 (-2.67) ***	-0.0098 (-2.68) ***
Secondary job	-0.8990 (-5.22) ***	-0.1608 (-4.49) ***	-0.9912 (-5.77) ***	-0.1809 (-4.94) ***
Education				
Second T	-0.0074 (-0.04)	0.0010 (-0.04)	-0.0419 (-0.21)	-0.0381 (-1.20)
Second G	-0.1959 (-1.01)	-0.0294 (-0.98)	-0.2503 (-1.24)	-0.0587 (-1.05)
High tech	-0.9231 (-3.47) ***	-0.1670 (-2.96) ***	-0.7616 (-2.77) ***	-0.1338 (-2.40) **
High. Gene.	-0.3931 (-1.34)	-0.0635 (-1.22)	-0.3643 (-1.14)	-0.0587 (-1.05)
Trainers	0.0687 (0.45)	0.0099 (0.46)	-0.1295 (-0.73)	-0.0193 (-0.72)
Tenure	0.0023 (0.17)	0.0003 (0.17)	0.0157 (1.06)	0.0023 (1.06)
Profession				
Unskilled Worker	-0.0515 (0.25)	-0.0075 (-0.25)	-0.1839 (-0.69)	-0.0278 (-0.67)
Skilled worker	-0.1050 (-0.48)	-0.0155 (-0.47)	0.0069 (0.02)	0.0010 (0.02)
Supervisory staff	-0.5297 (-2.10) **	-0.0860 (-1.91) *	-0.2252 (-0.49)	-0.0346 (-0.47)
Management staff	-0.6300 (-1.92) *	-0.1080 (-1.68) *	-0.0427 (-0.07)	-0.0063 (-0.07)
Trade union	0.2057 (1.41)	0.0297 (1.43)	-0.1657 (-0.74)	-0.0245 (-0.73)
Company	0.2394 (0.81)	0.0325 (0.87)	0.1333 (-0.74)	0.0188 (0.42)
Social capital	0.1917 (1.33)	0.0275 (1.36)	0.1715 (1.11)	0.0247 (1.13)
Douala	-0.8403 (-2.58) ***	-0.0966 (-3.44) ***	-1.4473 (-3.70) ***	-0.1408 (-6.21) ***
Sector of activity				
Food	0.5073 (2.37) **	0.0669 (2.66) ***	0.1150 (0.46)	0.0165 (0.47)
Plastic and paper	-0.3959 (-2.22) **	-0.0622 (-2.08) **	-0.6494 (-3.04) ***	-0.1070 (-2.76) ***
Mechanic	0.2217 (1.26)	0.0311 (1.31)	-0.0662 (-0.32)	-0.0098 (-0.32)
Firm size				
[25 – 50[	0.4642 (1.49)	0.0616 (1.65) *	0.5014 (1.53)	0.0664 (1.71) *
[50 – 100[	0.6196 (1.88) *	0.0779 (2.22) **	0.6913 (1.90) *	0.0858 (2.29) **
$\geq$ 100	-0.0699 (-0.25)	-0.0101 (-0.25)	-0.0640 (-0.20)	-0.0093 (-0.20)
Contractual status				
Verbal – SS	-0.3872 (-1.78) *	-0.0604 (1.68) *	0.5341 (0.54)	0.0784 (0.54)
Written – SS	-1.0087 (-4.13) ***	-0.1885 (-3.47) ***	-0.8144 (-0.52)	-0.1195 (-0.52)
Verbal – Verbal	-0.4457 (-2.02) **	-0.0723 (-1.84) *	-0.1238 (-0.09)	-0.0181 (-0.09)
Verbal – UPC	0.4485 (1.92) *	0.0592 (2.16) **	3.8423 (3.07) ***	0.5641 (3.10) ***
SPC – SPC	-0.0962 (-0.28)	-0.0144 (-0.27)	-4.1455 (-1.63)*	-0.6086 (-1.63) *
UPC – UPC	-0.4957 (-2.14) **	-0.0823 (-1.92) *	1.8586 (1.20)	0.2729 (1.20)
Constant	2.8524 (5.14) ***		3.6327 (5.63) ***	

Note: Number of observation = 1809. Log likelihood= -832.0893 (- 836.1936); LR chi2=174.20 (165.99). Prob> chi2=0.0000. The values in brackets are t of student. *** (**) * statistically significant at 1% (5%) and 10%.



Source: Survey

Figure 1. Decision tree for a contractual choice

The Empirical Evidence of Mean Diversion in the U.S. Labor Market 1970-2009

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Abstract

Policy makers love to speak about restoring the economy and the associated "good" jobs as voters imagine they were in the past. But is such economic nostalgia reasonable in a dynamic global economy? Our work here suggests that the labor market has been constantly evolving since 1970 and that there is no tendency to return to "normal" if such a normal were to be defined as it was in the good old days.

Since 1970 the mean and standard deviation of employment growth had actually been decreasing for each decade up until the 1990-99. For the most recent (2000-09) period, the standard deviation shows an uptick and a significant reduction in the mean. We find that the trend coefficient is statistically significant and has a negative sign. That implies the employment growth rate has a decreasing pattern over time.

Our results suggest, the level of the employment growth rates is mean-diverting and subject to a structural break. Second, in the presence of the ARCH effect, OLS standard errors can be misleading, with a spurious regression possibility. Finally, the ARCH effect and unit root problem have serious consequences for forecasting and the forecast band could be narrower than the actual.

Keywords: Employment, Structural Change, ARCH, Mean Diversion

JEL Classification: C10; J21; J30

Introduction

Policy makers love to speak about restoring the economy and the associated "good" jobs as voters imagine they were in the past. But is such economic nostalgia reasonable in a dynamic global economy? Moreover, has it actually been true that the economy, and particularly the labor market, were ever as stable as we imagine? This paper seeks to characterize the behavior of the U.S. employment growth rate over the economic cycle. We raise three fundamental questions which are; first, does the employment growth over time exhibit a mean-reverting behavior? That is, does the growth in employment exhibit a tendency to return to some average value? Second, how volatile are employment and does this volatility obscure the message of employment growth? Finally, do employment growth rates vary between decades/ sub-samples?

In this paper we divide the U.S. employment growth rate into decades since 1970. We test if all the data share the same statistical moments—average and standard deviation. We also estimate an instability ratio, the standard deviation as a percent of mean, where the higher value of the instability ratio is an indication of higher volatility. In addition, we test whether there is any change in the character (linear vs. non-linear) of the trend in employment growth over time. The next issue would be to test whether employment growth is mean-reverting or not. We employ unit root methodology on the series and test whether employment growth contains a unit root or not. If a series does not contain a unit root we call it stationary and, otherwise, non-stationary. Moreover, a stationary series fluctuates around a constant long-run mean that implies the series, employment growth in this case, has a finite variance which does not depend on time, hence mean reversion. On the other hand, if a series is non-stationary (contains a unit root) that implies the series has no tendency to return to the long run mean and the variance of the series is time dependent. Therefore, the best way to test whether the employment growth series is mean reverting would be to test whether employment growth contains a unit root (not mean reversion) or not (mean reversion).

Dickey and Fuller (1979, 1981) introduced the eminent and first standard process for unit root testing and their test is known as ADF (Augmented Dickey-Fuller) unit root test. However, there are some others unit root tests, other than the ADF test, available in the literature. For instance, Phillips and Perron (1988) proposed an alternative to the ADF test, called the PP test, and Kwiatkowski, Phillips, Schmidt, and Shin (1992) introduced KPSS test. Due to the serious issues related with the traditional unit root tests, which are the ADF, PP, and KPSS, recent literature proposed to employ the most efficient tests of unit root developed by Elliot, Rothenberg, and Stock (1996) (hence after ERS) as well as Ng and Perron (2001) (after here NP).

However, there is another potential issue which is very important and that is the presence of a structural break in the time series. Perron (1989) found that the standard ADF tests are biased towards the null hypothesis in the presence of a structural break in the time series. In other words, the ADF tests failed to reject the null of a unit root even though the time series is stationary and that happened because of a structural break in the time series. Perron (1989) suggested that it is not necessary that most macroeconomic time series are characterized by a unit root process—not mean reversion, but rather that persistence arises only from large and infrequent shocks and many macroeconomic time series return to their long run mean after small and frequent shocks. Banerjee et al. (1992), Christiano (1992) and Zivot and Andrews (1992) criticize Perron's idea of an exogenous structural break and they suggested that the structural break would be endogenous. Zivot and Andrews (1992) suggested a unit root test with endogenous break.

The above mentioned tests assumed that there is a break-point and determined the break date either exogenously or endogenously. But the important question is; if there is no break point and we enter a break point into the regression then what happened to the unit root tests results? Nunes et al. (1997) and Bai (1998) provided the answer to the question and the answer is "spurious break". More explicitly, when the disturbances of a regression model follow an $I(1)$ process, order of integration one, there is a tendency to estimate a break point in the middle of the sample, even though a break point does not actually exist. Therefore, unit root tests are not reliable in these cases; (1) when a break point exists and did not include in the test regression, (2) if a break point does not exist and did include in the test regression, and (3) the use of incorrect break date in the test regression.

Recently, Kim and Perron (2009) proposed a unit root test with structural break that address these issues and provide a more efficient testing procedure. Kim-Perron (2009) unit root test allows a break at unknown time under both the null and alternative hypotheses. The test also tackles the issue of "spurious break" and proposed a pre-test for a break that is valid whether the noise component is integrated or stationary (see Kim-Perron, 2009 for more detail).

We employ a comprehensive unit root methodology and use ADF, PP, KPSS, ERS, NP, Perron, Zivot-Andrews and Kim-Perron tests on the U.S. employment growth rate series and test whether the employment series is mean reverting.

Once we determine the econometric set-up for mean reversion then we would explore the volatility of the employment growth. We address the volatility issue in two different ways. First, we calculate the mean, standard deviation, and the instability ratio for each decade. This would provide a picture for each decade and, based on standard deviation and instability ratios, we can evaluate which decade has higher employment volatility, higher standard deviation and instability ratio. Second, we employ an Autoregressive Conditional Heteroscedasticity (ARCH) approach on the employment growth and the benefits of the ARCH are numerous. For instance, if we find the ARCH effect in a time series that indicates the series has volatility clustering—the deviation from the mean is not constant over time and that the deviation is smaller for some periods than others, and vice versa. Recently, Hamilton (2008) proposed the use of ARCH in macroeconomics and suggested that even if our primary interest is in the estimation of the conditional mean (mean reversion or not), correctly modeling the conditional variance (volatility of the series) can still be quite important for two reasons. First, due to the correction for outliers and high-variance episodes estimated parameters would be more accurate. Second, if we don't make the correction then the result would be a spurious regression (see Hamilton (2008) for more detail).

Our efforts suggest that since 1970 the mean and standard deviation of employment growth had actually been decreasing up until the 1990-99. For the most recent (2000-09) period, we see an uptick in the standard deviation and a significant reduction in the mean. Moreover, when we evaluate the entire period as a whole, 1970-2009, we find that the trend coefficient is statistically significant and has a negative sign. That implies the employment growth rate has a decreasing pattern over time. In addition, the standard deviation (1.79%) is higher than the mean (1.73%); this is evidence of high volatility in the employments series. Indeed, the growth of employment is volatile over time.

Summing up, our empirical analysis suggests that the level of the employment growth rates is mean-diverting and subject to a structural break. In addition, the ARCH effect in the employment growth series implies the employment series has a volatility cluster—the deviation from the mean is not constant over time and that the deviation is smaller for some periods than others, and vice versa. Finally, the ARCH effect and unit root problem have serious consequences for forecasting and the forecast band could be narrower than the actual.

The rest of the paper is organized as follows. In section 2 we discuss theory and data for the employment growth. Section 3 introduces the econometric set-up of the study and section 4 explains the results. The concluding remarks of the paper are discussing in section 5.

Dynamic Economy: Dynamic Labor Market

"They're closing down the textile mill across the railroad track

Foreman says these jobs are going boys and they ain't coming back to your hometown."

My Hometown, Bruce Springsteen from Born in the U.S.A., 1984

The old jobs are gone and are not coming back. Moreover, jobs seldom stay in the same place forever and are not likely to pay the same real wage and benefits over time. These are the cold hard facts that political rhetoric constantly attempts to shield from the public. As economists our job is very different today than it was thirty years ago and certainly is not in the same location many of us grew up. Moreover, the textile and shoe jobs of New England are gone and so was the relative standard of living associated with those jobs. In addition, many of the tobacco, textile, furniture and apparel jobs of the South are also gone. The hegemony of Detroit's auto industry is gone. Yet in their place are many health, education, information technology and business services jobs that did not exist at the end of World War II. Therefore, it seems that there is no mean reversion in the jobs data and there is no going back to the old economy.

Exhibit I provides dramatic visual evidence of the evolution of the American labor market since just 1970. Over that period job growth has been generally positive with the expected declines in employment during recessions. What is surprising to some extent is the decline in the pace of job growth over that same time period. Job growth since 1970 has steadily declined in the U.S.A of Bruce Springsteen.

It is true that the share of jobs going to manufacturing has declined while the share going into services has risen since 1970. (Note 1) Retail and wholesale service sector employment has risen but the largest percentage increase has been in government employment which has quadrupled over time. Some would describe this pattern as the arrival of the post-industrial state. In Exhibit II, the returns to education for workers are readily apparent. Just over the last six years we have witnessed the income disparity between workers of different education not only persist but actually increase over this period. With shift, on a percentage basis, from consumer demand for goods to services and the application of technology in the production of both goods and services there have been increased demands upon workers themselves to acquire new skills and work in new jobs that were unknown before the 1970s. Jobs for less-skilled workers have declined while workers in information-processing, communications and managerial areas have increased. (Note 2) Therefore, the employment growth may be mean-diverting and subject to a structural change.

It is worthwhile to mention that we are not the first who is going to apply unit root tests on the employment data. Several researchers have had employed unit root test on the employment series and there is mixed evidence whether employment is mean-reverting or not. Nelson and Plosser (1982) applied ADF test on the 14 U.S. macroeconomic series including employment. They used annual dataset for 1909-1970 time period and concluded that employment series is mean-diverting. Since then many researcher have used Nelson-Plosser dataset and have different conclusions for the employment. For instance, Perron (1989) include a structural break for the 1929 crash and concluded that employment is mean-reverting and subject to a structural break. Zivot and Andrews (1992) concluded that employment is mean-diverting. Lee and Strazicich (2003) included two breaks and based on the LM test concluded that employment is mean-diverting. (Note 3) But in this paper we are not going to use the Nelson-Plosser dataset for the following reasons; First, many researchers in the past, introduced or modified unit root test and compared their test's performance with the existing unit root tests and Nelson-Plosser dataset is good for comparison but objective of our study is not to introduce a new unit root test. In addition, we are interested to analyze the behavior of the employment growth and for that purpose latest employment data is more appropriate. Second, we are examining the employment behavior by decades since 1970. Third, we also concentrate on the volatility of the employment growth and apply ARCH approach. Finally, we apply a comprehensive unit root methodology on the employment growth.

We use the U.S. nonfarm payrolls, year-over-year percent change, and source of data series is Bureau of Labor Statistics (BLS). Our employment growth analysis begins with 1970:Q1 (quarterly data series). We do not extend back to the end of the World-War-II (WWII) because the U.S. economy could not function properly by mid or late 1960s. For instance, the U.S. economy slipped five times into recession between the end of the WWII and 1965. Therefore, the start date for our analysis is 1970:Q1. We divide the data series into four decades (1970-79, 1980-89, 1990-99 and 2000-09:Q3); the fourth is not a complete decade. Other possible choices could have been to divide the data into business cycles, from trough to peak, etc. Although, data division according to the business cycle is a good choice, it does not fit into our analysis. For instance, each business cycle does not equal in duration and the duration varies from 4 quarters to 30 quarters. Moreover, our analysis is based on regression analysis, i.e., estimation of the trend as well as application of the ARCH approach. For estimation purposes, more observations with bigger time span are always better than the fewer observations. Therefore, we divide the data into decades and each decade has at least one recession and that implies that each decade contains business cycle properties, e.g., peak and trough.

Econometrics of Mean Reversion

Unit Root Testing: Introduction

Dickey and Fuller (1979, 1981) introduced the idea of a unit root and proposed a standard unit root testing procedure which is known as ADF (Augmented Dickey-Fuller) test of unit root. But unit root testing became popular in economics, especially among macro-economists, after the publication of the seminal paper by Nelson and Plosser (1982). Nelson and Plosser employed unit root methodology on 14 U.S. macroeconomic time series and they could reject the null hypothesis of a unit root for only one time series, which was the unemployment rate. In addition, Nelson and Plosser concluded that many macroeconomic series are non-stationary. That implies many macroeconomic series exhibit trending behavior or a non-stationary mean—put simply, not mean-reverting. Therefore, unit root tests can be used to characterize a time series. There are many other unit root tests, other than ADF test, available in the literature. For instance; Phillips-Perron (1988) (PP), and Kwiatkowski-Phillips-Schmidt-Shin (1992) (KPSS) tests of unit root (also known as traditional unit root tests); tests introduced by Elliot-Rothenberg-Stock (1996) (ERS) and Ng-Perron (2001) (also known as efficient unit root tests). We employ all these tests on the U.S. employment series and test whether the employment series is mean reverting. (Note 4)

Unit root Tests and Structural Breaks

Perron (1989) challenged Nelson-Plosser's conclusion, that is, most macroeconomic time series contain a unit root. Perron argued that in the presence of a structural break, the standard ADF tests are biased towards the non-rejection of the null hypothesis. He concluded that most macroeconomic time series are not characterized by a unit root but rather that persistence arises only from large and infrequent shocks. In addition, Perron used the Nelson-Plosser dataset and incorporated an exogenous structural break for the 1929 Crash. He reversed the Nelson-Plosser's conclusion for 10 of the 13 macroeconomic time series.

However, Perron's assumption of 'known break date' (also known as exogenous break) was criticized, most notably by Christiano (1992) as "data mining". Christiano argued that the data based procedures are typically used to determine the most likely location of the break and this approach invalidates the distribution theory underlying conventional testing. Since then, there are two major views about the break date, which are (a) known or exogenous break date and (b) unknown or endogenous break date. Perron (1989) proposed an exogenous (known) structural break unit root test. Several other studies have developed using different methodologies for endogenously determining the break date, including Zivot and Andrews(1992), Banerjee et al. (1992), Perron and Vogelsand (1992), Lumsdaine and Papell(1997) and many others(see Byrne and Perman, 2006 for survey). (Note 5)

The above mentioned tests assumed that there is a break-point and determined the break date either exogenously or endogenously. But the important question is; if there is no break point and we enter a break point into the regression then what happened to the unit root tests results? Nunes et al. (1997) and Bai (1998) provided the answer to the question and the answer is "spurious break". More explicitly, when the disturbances of a regression model follow an $I(1)$ process, order of integration one, there is a tendency to estimate a break point in the middle of the sample, even though a break point does not actually exist. Therefore, unit root tests results are not reliable in these cases; (1) when a break point exists and did not include in the test regression, (2) if a break point does not exist and did include in the test regression, and (3) the use of incorrect break date in the test regression. The good thing of the Perron (1989) type's tests is that they are invariant to the break parameters and thus their performance does not depend on the magnitude of the break.

Recently, Kim-Perron (2009) proposed a unit root test with structural break that address these issues and provide a more efficient testing procedure. For instance, Perron (1989) test allows for a break under the null and alternative hypotheses but assume exogenous break and, on the other hand, Zivot-Andrews (1992) test assume endogenous break but did not allow break under the null hypothesis. In addition, both tests did not talk about the "spurious break". Kim-Perron (2009) unit root test allows a break at unknown time under both the null and alternative hypotheses. The test also tackles the issue of "spurious break" and proposed a pre-test for a break that is valid whether the noise component is integrated or stationary (see Kim-Perron; 2009).

Unit Root tests with Exogenous Break: Perron tests

Perron (1989) introduced the first standard unit root tests with structural break and all others tests are extension or modification of the Perron's test and thereby we start with the Perron test. Perron suggested three models. The models take into account the existence of three kinds of structural breaks: a 'crash' model (Model A), which allows for a break in the level (or intercept) of the series; a 'changing growth' model (Model B), which permits for a break in the slope (or rate of growth); and lastly one that includes both effects to occur simultaneously (Model C), i.e. one time change in both the level and the slope of the series.

$$\text{Model (A)} \quad \Delta y_t = \gamma + \gamma_1 DU_t + d(DTB)_t + \alpha y_{t-1} + \beta time + \sum_{j=1}^{p} \phi_j \Delta y_{t-j} + \varepsilon_t \tag{1}$$

Model (B) $$\Delta y_t = \gamma + \gamma_1 DT_t^* + \alpha y_{t-1} + \beta time + \sum_{j=1}^{p} \phi_j \Delta y_{t-j} + \varepsilon_t \quad (2)$$

Model (C) $$\Delta y_t = \gamma + \gamma_1 DU_t + d(DTB)_t + \gamma_2 DT_t + \alpha y_{t-1} + \beta time + \sum_{j=1}^{p} \phi_j \Delta y_{t-j} + \varepsilon_t \quad (3)$$

Where y_t is dependent variable and employment growth in our case. *Time* is a time variable or time dummy. The intercept dummy DU_t represents a change in the level;

$$DU_t = \begin{cases} 1 & if \quad t > TB \\ 0 & otherwise \end{cases} \quad (4)$$

The slope dummy DT_t (also DT_t^*) represents a change in the slope of the trend function;

$$D^*T_t = \begin{cases} t & if \quad t > TB \\ 0 & otherwise \end{cases} \quad (5)$$

The crash dummy model;

$$DTB = \begin{cases} 1 & if \quad t = TB + 1 \\ 0 & otherwise \end{cases} \quad (6)$$

TB is the break date. It is worth mentioning that each of the three models has a unit root with a break under the null hypothesis, as the dummy variables are incorporated in the regression under the null. The alternative hypothesis is a broken trend stationary process.

Unit Root tests with Endogenous Break: Zivot-Andrews Tests

The endogenous structural break test of Zivot and Andrews (1992) is a sequential test which utilizes the full sample and uses a different dummy variable for each possible break date. The selection criterion for the break date is based on the t-statistic from an ADF test and a minimum (i.e. most negative) value of t-statistic will be the indication of the break date. Consequently, a break date will be chosen where evidence is least favorable for the unit root null hypothesis. The Zivot-Andrews minimum t-statistic test has its own asymptotic theory and critical values. The latter are more negative than those provided by the Perron (1989) and may be suggest greater difficulty in rejecting the unit root null hypothesis. Zivot-Andrews test evaluates the joint null hypothesis of a unit root with no break in the series. As a consequence, accepting the null hypothesis in the context of Zivot-Andrews test does not imply unit root but rather unit root without a break. The critical values for Zivot-Andrews tests are derived under the assumption of no structural breaks under the null hypothesis.

Efficient Unit Root tests with Break: Kim-Perron Tests

Kim and Perron (2009) test allows break under both the null and alternative hypotheses and , when a break is present, the limit distribution of the test is the same as in the case of a known break date, thereby allowing increased power while maintaining the correct size. If there is no break in the trend then we can apply the standard ADF or any unit root test with no break dummies. Hence, we need a pre-test to assess whether a break is present or not. Kim and Perron (2009) proposed the procedure that has the correct size and powerful whether the noise is stationary or integrated. (Note 6) The testing procedure is based on a quasi-GLS approach using an autoregression of order one for the noise component, which a truncation to 1 when α is in some neighborhood of 1, and a bias correct. For a given break date, one constructs the F-test for the null hypothesis of no structural change in the deterministic components. Kim and Perron (2009) labeled the test as Exp-W_{FS}. The test has the same asymptotic size whether the noise is stationary or integrated (see Kim-Perron; 2009 for more detail). We apply Perron (1989), Zivot-Andrews (1992) and Kim-Perron (2009) tests on the employment growth and test whether the employment series is mean-reverting as well as subject to a structural change.

Macroeconomics and ARCH: Hamilton (2008)

Once we settled the issue of the mean-reversion then the natural question would be does employment series has a volatility cluster? Moreover, we would like to know the behavior of the variance of the employment series. To answer all these questions we employ the Autoregressive Conditional Heteroscedasticity (ARCH) approach on the employment and the benefits of the ARCH are numerous. For instance, if we find the ARCH effect in a time series, employment growth in this case, then that indicates the series has volatility clustering, i.e., some periods are more volatile than others. In other words, the deviation from the mean is smaller for some periods than others, and vice versa.

Recently, Hamilton (2008) proposed use of the ARCH in macroeconomics and suggested that even if our primary objective is the estimation of the conditional mean (mean reversion or not) having a correct description of the conditional variance (volatility of the series) can still be quite important for two reasons. First, OLS standard errors can be misleading, with a spurious regression possibility in which a true null hypothesis is asymptotically rejected

with probability one. Second, the inference about the conditional mean can be inappropriately influenced by outliers and high-variance episodes. Consequently, if we incorporate the conditional variance directly into the estimation of the mean then the estimates of the mean would be more efficient (see Hamilton (2008) for more detail). Therefore, we utilize the ARCH approach.

Results

Simple Statistics: The Mean, Standard deviation, Instability Ratio, and Trend

We broke up the employment growth data since 1970 into decades which roughly approximates four distinct periods of economic performance and political policy orientations. We estimate a mean, standard deviation and instability ratio for each decade. The instability ratio, standard deviation as percent of mean, represents the volatility of the employment series in each decade where the higher value of the instability ratio is an indication of higher volatility. One vital benefit of the instability ratio is that it identifies the magnitude of the volatility of employment growth by decade. Without an instability ratio, it is hard to specify employment volatility by decades for researchers. For instance, if we set the standard deviation as the volatility criterion, then the 1970s has highest standard deviation. If we stick with this criterion, then the 1970s is most volatile. But the problem with this criterion is that the 1970s also has the highest mean. Therefore, standard deviation alone is not the best measure of volatility especially when we compare different decades. Indeed, we need to consider both mean and standard deviation to determine volatility in the employment growth by decades. The instability ratio includes both mean and standard deviation and gives us information about which decade has a higher standard deviation relative to the mean for employment growth. Based on the instability ratio we conclude that 2000-09 is most volatile and 1990s is most stable decade for employment growth.

For the 1970s period, see Table 1 for results, employment growth contains a trend, in that, the coefficients of the time variable (time dummy) are statistically significant and that the trend is linear and upward, since coefficient of the time variable is positive. In addition, 1970s contain highest mean (2.49%) and standard deviation (2.15%) and we estimate an instability ratio 86.35 (standard deviation is 86.35 percent of the mean). There are several reasons behind the high standard deviation of the 1970s. For instance, oil prices quadrupled following the Arab Oil Embargo in late 1973; there was a financial crisis/stock market collapse and a substantial slowdown in the global economy. These factors may account for the volatility of the employment growth during the 1970s. As we continue testing over subsequent decades we find that the results of the 1970s are not repeated during the 1980s—a decade of apparent prosperity and stock market gains relative to the 1970s. During the 1980s, the standard deviation of employment growth appears large relative to its average value; standard deviation (1.91%) is higher than the mean (1.87%). We find a non-linear trend for the 1980s, a U-shaped trend. In addition, the instability ratio (102.14) is higher than during 1970s. The 1980s also had an oil shock and global economic activity turned down. There was a financial crisis/stock market crash and nonfarm employment tumbled 3.1 percent during the 1981-82 recession.

The 1990s also follows a non-linear trend, U-shaped trend, and a decline in the mean (1.8%) as well as in standard deviation (1.26%). But the decline in the standard deviation is much more than the decline in the mean. Consequently, the instability ratio (70) is smallest in the 1990s thereby this decade is most stable for the employment growth. The major factors behind this instability are that the "great moderation" and the Information Technology (IT) boom. During the 1990s U.S. economy experienced a boost in the productivity and that is known as the great moderation and during that period output per-worker increased. (Note 7) The IT boom bring in many new jobs, however, the out-sourcing job process also got more attention. Overall, the 1990s is most stable decade for the employment growth. For the most recent period (2000-09), employment growth does not follow the decreasing pattern of the last three decades and that is reduction in the mean and standard deviation. Instead, the current period shows a significant decline in the mean and an uptick in the standard deviation. The instability ratio (191.2) is highest in all decades and thereby most volatile decade for employment growth. In addition, there is no evidence of a trend that is the coefficient of the time variable is statistically insignificant. There are some major reasons for this high volatility as well as the reduction in the mean, (1) bust of the IT bubble, (2) more job out-source during 1st half of 2000s , (3) 2001 recession had a job-less recovery and (4) 2007-09 recession has the highest job loss since post WW-II. (Note 8)

Our efforts suggest that since 1970 the mean and standard deviation of employment growth had actually been decreasing up until the most recent (2000-09) period. The most recent period shows a significant decline in the mean and an uptick in the standard deviation. When we evaluate the entire period as a whole, 1970-2009, we find that the trend coefficient is statistically significant and has a negative sign. That implies the employment growth rate has a decreasing pattern over time. In addition, the standard deviation (1.79%) is higher than the mean (1.73%), this is evidence of high volatility in the employment series. Indeed, the growth of employment is volatile over time as pictured by Exhibit I. Overall; this pattern suggests that the character of employment growth changes over time due to changing underlying economic forces and/or policy changes.

Unit Root Tests without Structural Break

Table 2 shows results based on unit root tests and these tests do not consider a structural break in the test regression as well as in the null and the alternative hypotheses. We start with the ADF test's results. First case we consider

within the ADF test is the zero-mean case (no intercept and trend in the test regression). (Note 9) We reject the null hypothesis that the employment series has a unit root (not mean-reversion) in favor of the alternative hypothesis that the employment series is stationary (mean-reversion). In second case, we incorporated a constant (also known as drift parameter) in the test regression but results did not show any change and the employment series is still mean-reverting (stationary). The third case which includes a constant and a linear trend in the test regression and the result is as rejection of the null hypothesis of a unit root. Therefore, based on the ADF test results, the employment growth series is mean reverting.

The next unit root test we applied on the employment growth series is the PP test. The PP test has the null hypothesis of a unit root and the alternative is stationary (mean-reversion). We ran three different regression equations which are (i) equation with no intercept and trend, (ii) regression equation with constant and (iii) test equation with a constant and a linear trend. The results based on the PP test indicate strong evidence of mean-reversion. In other words, in all three cases we reject the null hypothesis of a unit root and conclude that the employments series is mean-reverting. We also applied the KPSS test on the employment growth series. The null hypothesis of the KPSS test is that the underline series is stationary (in our case, the employment series is stationary) and the alternative hypothesis is non-stationary. The KPSS test only considers two cases, which are (a) test regression with a constant and (b) regression equation with a constant and a linear trend. We failed to reject the Ho: the employments series is stationary in both cases thereby the KPSS test results indicate that the U.S. employment growth series is mean-reverting.

Interesting, all three unit root tests have the same conclusion, that is, the level of the employment growth series is mean-reverting. However, as we mentioned earlier, the ADF, PP and the KPSS tests have some limitations and may lead to a misleading conclusion. Therefore, we employ more efficient and reliable unit root tests which are ERS (DF-GLS and Point-optimal) and Ng-Perron tests. The results based on ERS and Ng-Perron tests are also available in Table 2. The DF-GLS test has the null hypothesis of a unit root and the alternative is stationary. We failed to reject the null hypothesis of a unit root in both cases; (i) a constant in the test regression and (ii) a constant and a linear trend in the regression. Therefore, the DF-GLS test results contradict the ADF, PP and KPSS tests' results. Moreover, the DF-GLS test indicates that the level of the employment growth series is not mean-reverting. However, the first difference of the employment growth series is stationary. (Note 10)

The next unit root test we applied on the employment series is the ERS Point-optimal unit root test which has the null hypothesis of a unit root and the alternative hypothesis is stationary (mean-reversion). When we include a constant in the test regression then we reject the null hypothesis that the employment series has a unit root at 10% level of significance. That implies the employment growth series is mean reverting. However, when we include a constant and a linear trend in the test regression then the result rejects the idea of the mean-reversion, the level of the employment series has a unit root. But the first difference of the employment growth series is stationary. Although the ERS point-optimal unit root test has a confusing conclusion, if we set the level of significance as 5% then we fail to reject the null hypothesis of a unit root. Now we proceed to the most efficient test of unit root and that is Ng-Perron tests. The results based on the Ng-Perron tests indicate that the employment growth series contains a unit root. In other words, the employments series is not mean reverting.

In sum, based on the unit root tests without structural break, we conclude that the level of the U.S. employment growth rates is not mean-reverting. Although, the ADF, PP, and the KPSS tests' results are in favor of the mean-reversion, these tests have lower power than the ERS and Ng-Perron tests. Therefore, we give more importance to those results which are based on the ERS and Ng-Perron tests. (Note 11)

Unit Root Tests with Structural Break

In this section of the study we discuss the results based on the unit root tests which incorporate a structural break (see Table 3 for results). We utilized the Perron (1989) test and consider 1973:Q4 as a break date. (Note 12) We failed to reject the null hypothesis of a unit root with a structural break. That implies, the employments series is not only mean diverting but also has a structural break and the break date is 1973:Q4. The next test we applied on the employment growth series is the Zivot-Andrews test. We test different options for a break date. For instance, 1973:Q4-1975:Q1 (time duration of the 1973-75 recession) and 1981:Q3-1982:Q4 (time duration of the 1981-82 recession). We try one by one each quarter of the above mentioned time period. We end up 1975:Q1 as a break date. The null hypothesis of the Zivot-Andrews test is a unit root with no structural break. The results based on the Zivot-Andrews test fail to reject the null hypothesis and conclude that the employment growth series is mean diverting. The Zivot-Andrews test's results are not in favor of a structural break but the Perron test supports the idea of a structural break in the employment growth series. The Zivot-Andrews test does not assume a structural break under the null hypothesis but the Perron test allows for a break under the null and alternative hypotheses. Nunes et al. (1997) suggested that there may be some size distortion for Zivot-Andrews test.

The first step of the Kim-Perron procedure is a pre-test for the break date. We apply the EXP-W_{FS} test and found that employment growth series has a structural break and that is 1973:Q4. Next step would be to follow the Kim-Perron unit root test and determine whether employment growth contains a unit root. Based on the Kim-Perron test results, we fail to reject the null hypothesis that employment growth contains a unit root as well as subject to a

structural break for all three models. The Kim-Perron unit root test is the most efficient test and thereby, based on the Kim-Peron test, we conclude that employment growth series contains a unit root and subject to a structural break in our sample period.

ARCH Results

We have found that the level of the employment growth series is non-stationary, mean-diverting, that implies that the mean and/or variance of the employments series are not constant over time and may be time dependent. But it is still important to analyze the behavior of the employments series' variance and test whether the variance is volatile over time; it is also known as the ARCH effect. The ARCH effect has very serious consequences for modeling and forecasting. For instance, in the presence of the ARCH effect OLS standard errors can be misleading, with a spurious regression possibility (see Hamilton (2008) for more detail). Another issue could be that the forecast band could be narrower than the actual. Therefore, we employ the ARCH approach which overcomes the constant variance problem. We divided the sample period into decades and applied an ARCH Approach on each decade's data as well as the complete sample that is 1970:Q1-2009:Q3, see Table 1 for results. We found an ARCH effect for each decade as well as for the complete sample period. (Note 13) The implication of the ARCH effects is that the employment growth series has a volatility cluster—some periods are more volatile than others. In other words, the variance of the employment growth is not constant over time and has episodes of high variance for some periods than others. That also implies, the forecast band, upper and lower band of the forecast, will not be constant and may be smaller for some time period than others, and vice versa.

If we sum-up our empirical analysis, then the level of the employment series is mean diverting and subject to a structural break. The ARCH effect tells us the employment growth series has a volatility cluster—some periods are more volatile than others.

Conclusion: Key findings of the Study

Policy makers love to speak about restoring the economy and the associated "good" jobs as voters imagine they were in the past. But is such economic nostalgia reasonable in a dynamic global economy? Moreover, has it actually been true that the economy, and particularly the labor market, were ever as stable as we imagine? Our work here suggests that the labor market has been constantly evolving since 1970 and that there is no tendency to return to "normal" if such a normal were to be defined as it was in the good old days. Moreover, labor market policies built on such nostalgia in an attempt to return to the past are misplaced at best and likely to hurt workers more by providing false hopes and also lead to a misallocation of economic resources than if forward looking policies were adopted to adapt workers for the future of the labor market.

Our efforts suggest that since 1970 the mean and standard deviation of employment growth had actually been decreasing up until the most recent (2000-09) period. The most recent period (2000-09) shows a significant decline in the mean and an uptick in the standard deviation. When we evaluate the entire period as a whole, 1970-2009, we find that the trend coefficient is statistically significant and has a negative sign. That implies the employment growth rate has a decreasing pattern over time. In addition, the standard deviation (1.79%) is higher than the mean (1.73%); this is evidence of high volatility in the employments series.

Summing-up, our empirical analysis suggests that the level of the employment growth rates is mean-diverting and subject to a structural break. Therefore, the level of the employment series is not appropriate for the modeling and forecasting purpose because of a unit root problem. Second, due to the presence of a structural break in the employment series it would be better to employ only those techniques which are assuming a structural break in the data e.g., cointegration tests with a structural break. Third, in the presence of the ARCH effect, OLS standard errors can be misleading, with a spurious regression possibility. Finally, the ARCH effect and unit root problem have serious consequences for forecasting and the forecast band could be narrower than the actual.

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Notes

Note 1. For some microeconomic fundamentals behind these patterns please see Silvia (2006).

Note 2. U.S. Bureau of the Census, Statistical Abstract of the United States (Washington, D.C., U.S. Government Printing Office, various issues.

Note 3. See Byrne and Perman (2006) for a survey

Note 4. Here we are not explaining these tests in detail because of space limit. See Silvia and Iqbal (2009) for more detail.

Note 5. It is worth mentioning that many researchers are considering multiple structural breaks. The argument for incorporating more than one break is that only considering one break is insufficient and leads to a loss of information when actually more than one break exits. Lumsdaine and Papell (1997), Clemente et al. (1998), and Pappel and Prodan (2003) considered multiple breaks. But we are not using multiple breaks test in this study because our analysis starts, sample start date, from 1970 and it is relatively a short history. Therefore, we only employ single break tests, both exogenous and endogenous breaks test.

Note 6. It is worthwhile to mention that this procedure originally introduced by Perron and Yabu (2009).

Note 7. During the great moderation U.S. productivity increased and the volatility associated with the productivity reduced. However, the causes and the consequences of the great moderation are debatable, see Gordon (2005) for more detail.

Note 8. The 2007-09 recession is not officially ended at the timing of this writing.

Note 9. Ng and Perron (2001) suggested that the Modified Akaike Information Criterion (MAIC) is a better choice for the lag order selection thereby we select lag length based on MAIC, see Ng and Perron (2001) for more detail.

Note 10. We only report the results for the level of the employment growth series because we are interested in the mean reverting properties of the employment growth series. However, we also estimate the results for the first difference. All results and data are available upon request from authors.

Note 11. Although, ERS point-optimal test is rejecting Ho: the employment series has a unit root, at 10% level of significance but the standard level of significance is 5% and at 5% ERS failed to reject the null hypothesis of a unit root.

Note 12. We are considering 1973:Q4 as break date because this date is the beginning of the 1973-75 recession. This recession is famous for the initial Post World-War-II oil shock and, due to the oil shock, energy input prices rose sharply, production technologies were rendered obsolete and hence the employment growth rates become volatile.

Note 13. It is worth mentioning that we used the level and 1st difference of the employment growth series and found ARCH effect in both cases.

Table 1. Employment Growth, Nonfarm Payrolls, Year-to-Year percent Change

Period	Mean	S.D*	Instability Ratio**	Skewness	Kurtosis	Trend	ARCH
1970-79	2.49	2.15	86.35	-0.76	-0.37	Linear(positive)	ARCH effect
1980-89	1.87	1.91	102.14	-0.67	-0.06	Non-linear(U-shape)	ARCH effect
1990-99	1.8	1.26	70	-1.21	0.62	Non-linear(U-shape)	ARCH effect
2000-09	0.68	1.3	191.2	-0.46	-0.83	No Trend	ARCH effect
1970-2009	1.73	1.79	103.47	-0.32	-0.39	Linear(negative sign)	ARCH effect

*S.D. = Standard Deviation

** Instability Ratio = (S.D./Mean)*100

Table 2. Unit Root Tests; Without Structural Break

	Test Option		
Test Name	**Constant**	**Constant & Trend**	**None**
ADF	No	No	No
PP	No	No	No
KPSS	No	No	N/A
DF-GLS	Yes	Yes	N/A
ERS	No	Yes	N/A
Ng-Perron	Yes	Yes	N/A

Table 3. Unit Root Tests; With Structural Break

	Test Option		
Test Name	**Model A**	**Model B**	**Model C**
Perron*	Yes	Yes	Yes
Zivot-Andrews**	Yes	Yes	Yes
Kim-Perron***	Yes	Yes	Yes

No = No unit root --- Mean-reversion; Yes = Unit root ---- Not Mean-reversion; * Break Date= 1973:4Q; ** Break Date= 1975:Q1

*** Break Date= 1973:Q4

Exhibit I

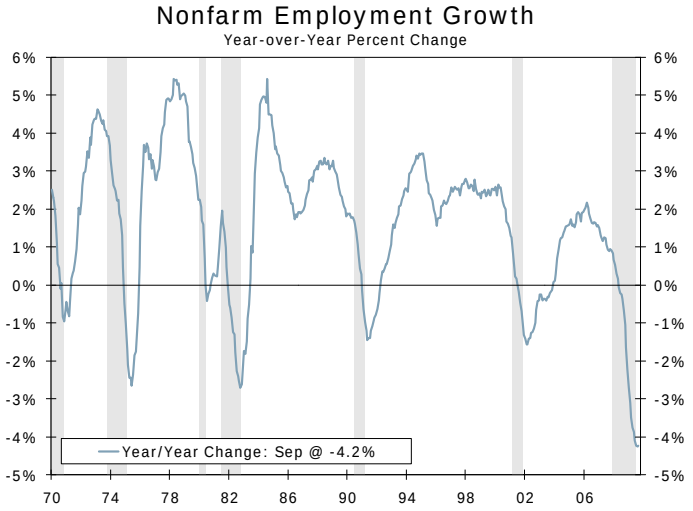
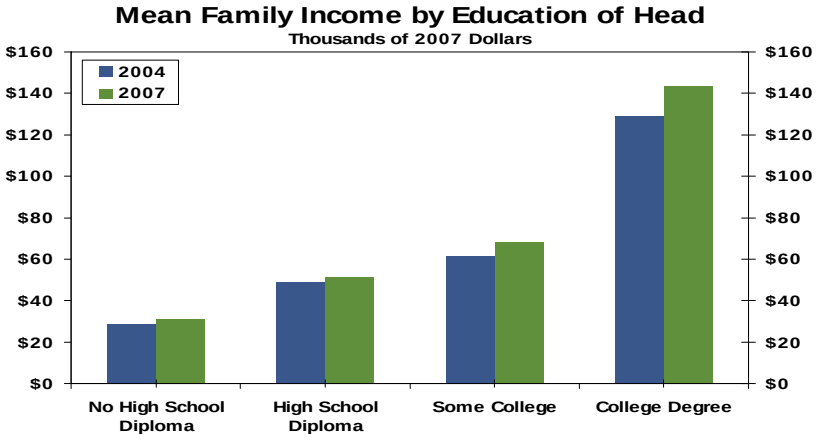


Exhibit II



Dynamic Multibeta Macroeconomic Asset Pricing Model at NAFTA Stock Markets

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Abstract

Applying a multifactor beta model, this papers examines the case of the NAFTA countries, Mexico, Canada and United States. Its objectives are, first, identifying the relationship between local macroeconomic factors and asset pricing at each market; and, second, examine the integration of each market to global market macroeconomic variables. Results show that local factors weight more than international factors at each market, revealing mild segmentation among these markets. The level of integration of local markets with global variables is greater for United States, while for Mexico is the lowest.

Keywords: Systematic risk, Macroeconomic variables, Asset pricing, Capital markets, NAFTA

1. Introduction

Financial globalization has increased correlations and cointegration among the world stock markets, making international portfolio diversification less attractive. However, financial research continues to confirm the presence of market segmentations among the international markets particularly for the case of emerging and developed markets. Since intrinsic risk can be diversified away, determining the sources and impact of systematic risk at emerging markets and their patterns of integration with the world markets has become a key issue and has led to wide research in the financial literature. Built on the foundations laid down by Markowitz (1952; 1959) and Tobin (1958), the Capital Asset Pricing Model, CAPM, advanced by Sharpe (1963; 1964), Lintner (1965) and Mossin (1966) asserts that the only source of systematic risk is the comovement of financial assets with the market. However, an ample body of empirical evidence suggests that one or more additional factors may be required to explain asset returns.

Arbitrage Pricing Theory (APT) put forth by Ross (1976) and the Multi-Beta Capital Asset Pricing Model (MBCAPM) developed by Merton (1973) are the main theoretical approaches dealing with the existence of several systematic risk factors. Based on general equilibrium arguments, the Merton MBCAPM shows that whenever the risk free rate is stochastic, then other sources of risk, including macroeconomic variables, affect the investment opportunities set and market risk is only one of the relevant risk sources. APT was introduced as an alternative to CAPM, but not requiring the identification of the theoretical market portfolio, as CAPM does. Based on the absence of arbitrage opportunities in large, well informed markets, it asserts that asset value fluctuations is influenced not only by the market factor, but by other factors as well, including macroeconomic factors. Macroeconomic and financial variables, suggested by economic theory, have been used to capture systematic risk. Chen, Roll and Ross (1986) propound a five-factor model. Other studies have favored corporate financial variables.

Extending systematic risk analysis to an international investment environment raises some concerns. The level of integration between markets bears important implications both for asset pricing theory and for portfolio selection. Cho, Eun and Senbet (1986) sustain that assets from different, but integrated, markets are priced jointly. On the contrary, for the case of segmented markets, assets from different markets although might show the same level of risk have different expected returns when expressed in a common currency, creating arbitrage opportunities assuming that there are no cross-border barriers to investments. Currently, financial globalization should be leading towards integration of capital markets. Thus, in domestic capital markets fully integrated to the world capital market, local trading and valuation should be based only on international risk factors; only systematic world risk factors become relevant. On the contrary, at segmented domestic capital markets, assets are valued exclusively based on impacts from domestic systematic risk sources. Cho, Eun and Senbet (1986) find these results with an international APT specification. Applying cointegration analysis Cham and Lai (1993), Pérez de Gracia and Cuñado (2000), and

Da Costa and Cereta (2001) obtain similar results. Nonetheless, various cross-country studies find, with some caveats, that the importance of local risk factors is receding among developed markets. Nikkinen and Sahlström (2004) find that U.S. macroeconomic news announcements are valuable information on European stock markets, while domestic news releases seem to be unimportant. Finally, a study by Vajhekoshi and Nummelin (2005) evidence that international segmentation changes overtime. In the case of emerging markets the evidence on the importance of local macroeconomic factors on asset pricing is limited; moreover, numerous studies conclude that emerging markets returns are weakly correlated to international variables. Contributing to the debate on this issue, this paper tests: a) the extend of capital markets integration among Mexico, Canada and United States, members of the North American Free Trade Agreement (NAFTA); and b) integration of each of those markets with the world capital market.

2. Literature review

The literature on systematic risk analysis for the case of United States is ample. In a pioneer work, Chen, Roll and Ross (1986), based both in economic intuition and empirical research propound two classes of systematic sources: forces that change the discount rate used to discount future expected cash flows, and forces which influence the expected cash flows levels. Testing an empirical multifactor systematic risk model they determine as priced risk factors the yield spread between long and short interest rates for U.S. government bonds, expected inflation, unexpected inflation, industrial production growth and default premium (measured as the spread between corporate high and low-grade bonds). Van den Goorbergh, De Roon and Werker (2003) confirm that interest rates continue being an important variable to explain U.S. assets' returns. Carmichael and Samson (2001) also find evidence on the significance of interest rates to explain the returns of assets listed at the Toronto Stock Exchange.

Evidence on the relationship between stock market returns and interest rate behavior has been also found relevant for the case of other stock markets. Alam and Uddim (2009) present evidence for both developed and developing countries, Dropsy and Nazarin (1995), and Drehman and Manning (2004) have detected such relationship for several developed stock markets, including the U.S. and Canadian markets; Clare and Thomas (1994) show evidence for the United Kingdom stock market; Groenewold and Fraser (1997) and Kazi (2009) for the Australian market. Evidence has also been found by Schor, Bonomo and Pereira Valls (1998) for the Brazilian stock market, and Ratner and Leal (2001) for the emerging markets from Argentina, Brazil and Chile. Navarro and Santillán (2001), Márquez, Islas and Venegas (2003), and Al-Shanfari (2003) and Bucio Pacheco (2009) have found evidence that interest rate behavior is a relevant Mexican stock market risk factor.

Financial theory also points out that equities could serve as a hedge against inflation; hence a positive sign relationship should be expected. However, several studies suggest that inflation and equities returns are negatively related; e.g. Fama (1981), Spyrou (2001) and Ionnidis *et al* (2005). De la Calle (1991), Nava (1996), Doshi, Johnson, Ortiz and Soenen (2001), Ratner and Leal (2001), Navarro and Santillán (2001) and Cabello, de Jesús and Ortiz (2006) have found evidence suggesting that Mexican assets' returns are positively related with inflation. Choudry (2001) also confirms a positive relationship between stock returns and inflation for the cases of Argentine, Chile, Mexico and Venezuela and López Herrera and Vázquez (2002) and Bucio Pacheco (2009) show that changes in price levels contribute to explain returns in a sample of Mexican stocks. Gargopadhyay (1994), Qi and Maddala (1999) and Van den Goorbergh, de Roon and Werker (2003) have found also evidence on the relationship between stock returns and inflation at US stock market, and Carmichael and Samson (2001) at Canadian stock market. Several studies confirm industrial production growth as a significant risk factor for stock returns. Gargopadhyay (1994) and Qi and Maddala (1999) present evidence for the U.S. stock market. Koutoulas and Kryzanowsky (1996) and Kryzanowsky, Lalancette and To (1997) reach similar results for the Canadian stock market. Nonetheless, it is important to note that the evidence presented by Islas and Levy Mangin (2002) underlies the fact that market returns are the only variable that explains share returns for the Spanish capital market; macroeconomic variables, including industrial production do not have any explanatory power. Research for the Mexican stock market has generally failed to find a significant relationship between stock returns and industrial production growth. However, recently, Ortiz, de Jesus and Cabello (2007) found a bilateral Granger causality between the stock market and industrial production. The relationship between stock returns and industrial production has been found significant for the stock exchanges from Brazil (Schor, Bonomo and Pereira Valls, 1998), Greece (Hondroyiannis and Papapetrou, 2001), and United Kingdom (Al-Shanfari, 2003; Darsinos and Satchell, 2003).

Empirical research also identifies other variables as sources of equities risk and returns. Money supply seems to contribute to explain Mexican stock returns, as suggested by the results reached by De la Calle (1991), Nava (1996), Navarro and Santillán (2001), Al-Shanfari (2003) and Bucio Pacheco (2009). Similar results have been reported by Qi and Maddala (1999) and Rapach (2001) for the U.S. stock market case. Navarro and Santillán (2001) have found that exports behavior is a significant variable to explain Mexican stock market returns. Koutoulas and Kryzanowsky (1996) and Kryzanowsky, Lalancette and To (1997) have found evidence of the importance of exports growth to explain Canadian assets and portfolio returns. Bailey and Chung (1986), Nava (1996), Navarro and Santillán (2001) and, Cabello, de Jesús and Ortiz (2006) report evidence of exchange risk relevance for the Mexican stock market; Koutoulas and Kryzanowsky (1996) and Kryzanowsky, Lalancette and To (1997) obtained similar results examining risk-return behavior of Canadian assets and portfolios.

A myriad of studies have been devoted to analyze the relationship between national markets. During the 1970's research reported low correlations among them, and provided evidence concerning the importance of local factors in the risk-return generating process (Eun and Shim, 1993). This has apparently changed over time.due to globalization processes. Nikkinen and Sahlström (2004) find that U.S. macroeconomic news announcements are valuable information on European stock markets, while domestic news releases seem to be unimportant. For the Canadian and U.S. markets, Perez Caldwell (1997) using an APT framework finds that neither Canadian factors influence U.S. returns, nor U.S. factors affect Canadian returns; these markets are therefore not integrated. However, Xinga and Howe (2002) document a significant positive relationshjp between world stock returns and the variance of returns in the United Kingdom. Similar evidence is reported by Leong and Felmingham (2003) who examine the interdependence of five developed Asian markets. Their evidence reveals that correlation has strengthened following the Asian crises; moreover, half bivariate pairings of stock indexes from those countries indicates nonbreaking bivariate cointegration, while four are cointegrated subject to a structural break. More recently, Southall (2009) using weekly data for a ten year study shows that macroeconomic variables have had increasing importance in the European capital markets; the importance of international macroeconomic variables has also increased for the new member countries from the Europeand Union, while at the same time local macroeconomic factors decrease in importance.

For the case of emerging markets the evidence is limited and contradictory. Wongbangpoa and Sharma (2002) find that in the case of five ASEAN countries long and short term relationships can be observed between stock prices and selected macroeconomic variables. Moreover, changes on the macroeconomic variables in these countries cause and are caused by stock prices in the Granger sense. Bilson, and Hooperb (2005) find only moderate evidence to support the contention that local macroeconomic variables have explanatory power over stock returns in emerging markets. However, Ewing *et al* (1999) examine the NAFTA countries stock markets for the period 1987:11-1997:03. They find no cointegration present in these markets even when the passage of NAFTA is taken into account; segmentation of these three markets remains and long-run diversification across them is possible. However, using daily, weekly and monthly data for the period June 1, 1989 to April 2002 Darrat and Zhong (2005) using cross-correlations, multivariate price cointegrating systems, speed of convergence, and generalized variance decomposition found intensified market linkages among the NAFTA capital markets since the agreement was enforced. Finally, Verma and Ozuma (2005) find little evidence that Latin American stock markets are responsive to movements in cross-country Latin American macroeconomic variables. However, their results show that Mexico's stock market affects other Latin American stock markets but not vice-versa; this could be a side effect of Mexico's close ties with the United States.

3. Data and methodology

Monthly data from market returns and selected local and international variables are used for the period January1984 to December 2004, which can be identified as a "first generation" integration period among the NAFTA members. Rather than constructing portfolios for each market, a dynamic Merton like multibeta capital asset pricing model is estimated on market returns of each country. This approach allows to evidence directly the existence of different asset pricing processes at each country, as well as evidence on their integration to international economic activity. Mexican, Canadian, and U.S. share price indexes and all domestic and international macroeconomic series, all expressed in U.S. dollars, were gathered for the period December 1983 to December 2004 from IMF's *Financial Statistics* CD; US exchange rate from FREDII Databank; WTI oil prices from Financial Forecast Center website, and the the proxy for the world capital market portfolio is the Morgan Stanley Capital International (MSCI) index.

Succinctly, the multi-beta CAPM asserts that the return on any security to the security's sensitivity, i.e. systematic risk, to a set of influences:

$$r_i - r_f = \beta_{im}(r_m - r_f) + \beta_{iI1}(r_{I1} - r_f) + \beta_{iI2}(r_{I2} - r_f) + \beta_{iI3}(r_{I3} - r_f) + \ldots \quad (1)$$

Here, r_i = return on asset *i*; r_f = risk free rate; β_{im} = sensitivity to the market risk premium; and β_{ilj} = sensitivity to other I factors risk premium, j = 1 …n.

For the empirical analysis carried out in this work, the linear multibeta model extended into a dynamic regression analysis and can be stated as follows:

$$r_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i r_{t-1} + \sum_{i=1}^{k} \sum_{j=0}^{l} \beta_{i,j} X_{i,t-j} + \psi' \delta + \varepsilon_t \quad , \quad t = 1,2,\ldots,T \quad (2)$$

where r_t is the market return in excess of the risk free rate, i.e., the market risk premium. X_t are observations of explicative variables values, i.e., systematic risk factors in excess of the risk free rate; hence these factors can be regarded as premiums for the risk factors. δ is a matrix with *m dummy* variables which capture the effects of events whose nature can alter the probabilistic distribution of the market risk premium. The α_i's, β_i's and the vector ψ' are parameters to be estimated, and show the relationship between risk factors and market risk premium; these parameters therefore show the reward for systematic risk bearing; ε_t is a contemporary disturbance term.

Lagged variables are included because the set of information available to investors for decision making includes past events. In addition the impact of macroeconomic variables are felt during and after several periods ahead. Thus, the dynamic model represented by equation (2) acknowledges the influence of past and current economic variables on investors expectations about securities values. Chosen risk factors are those determined by López Herrera and Ortiz (2005) as proxies for systematic risk sources for the Mexican, Canadian and U.S. capital markets. Applying principal component analysis (Tabachnick and Fidell, 1989), factors identified derive from a set of 13 macroeconomic variables found as relevant in the financial literature, such as those identified in the previous section. Principal components were obtained from the correlation matrix of rates of growth and changes in domestic and global financial and macroeconomic variables. Thus, risk factors used in this study are built as linear combinations of such rates of growth and changes. The set of domestic variables for each country includes: money market interest rate, short-term treasury bill rate, money supply, prices level, industrial production, international reserves, exports, imports and exchange rate. Additionally, to capture global systematic risk, four international variables are included: World Capital Market portfolio returns, world exports rate of growth, one-month LIBOR rate, and changes on the WTI oil prices. Following conventional criteria for the selection of factors, López Herrera and Ortiz (2005) find that only three risk factors are relevant to Mexican and Canadian cases, and for U.S. three to four factors are relevant.

4. Empirical analysis

Table 1 presents the basic descriptive statistics of log returns for the stock market index series from Canada, United States and Mexico. As shown there, the Mexican stock market mean return is the highest for the full period under consideration. Indeed, mean return for the Mexican stock market is five times greater than mean returns reported by the Canadian stock market, and almost twice as big as average monthly return from the U.S. market; Mexico's average return for the 1984-2002 period was also two and a half times higher than the world capital market monthly return. However, Mexico´s stock exchange volatility is the highest among the three countries, which is consistent with recent trends of higher returns and high volatility at emerging markets as compared with mature markets (Chukwuogor-Ndu, 2007). Hence, it is worth noting that using the mean/standard deviation ratio as an over all measure of risk taken to be rewarded, the U.S. market provided higher returns per unit of risk taken (0.175), while the Canadian market offered the lowest reward to units of risk taken (0.073); the risk premium from the Mexican market (0.12) was lower than that offered by both the U.S. market and the world market (0.14). Finally, it is worth noting that all four markets are skewed left and that their distribution is leptokurtic; corroborating these characteristics the Jarque-Bera statistic indicates non normality. Risk premiums corresponding both to each local stock market and the various risk factors were estimated from the local stock market return, or else the principal component proxy for the risk factor, minus the domestic risk free rate. To represent the risk free rate for each market, the domestic short-term government bills rate was chosen (Canadian Bills, Treasury Bill and Certificados de Tesoreria from Mexico).

The variables finally selected for the model are:

MXSMRP = Mexican capital market risk premium

MXCP1RP = Domestic Mexican stock market risk factor 1 risk premium

MXCP2RP = Domestic Mexican stock market risk factor 2 risk premium

MXCP3RP = Domestic Mexican stock market risk factor 3 risk premium

CNSMRP = Canadian capital market risk premium

CNCP1RP = Domestic Canadian stock market risk factor 1 risk premium

CNCP2RP = Domestic Canadian stock market risk factor 2 risk premium

CNCP3RP = Domestic Canadian stock market risk factor 3 risk premium

USSMRP = US capital market risk premium

USCP1RP = Domestic US stock market risk factor 1 risk premium

USCP2RP = Domestic US stock market risk factor 2 risk premium

USCP3RP = Domestic US stock market risk factor 3 risk premium

USCP4RP = Domestic US stock market risk factor 4 risk premium

Principal components for each market, derived by Lopez-Herrera and Ortiz (2005) include innovations in the following variables (signs shown in parenthesis): Mexico: risk factor 1: (-) peso/US dollar depreciation; (+) industrial production, (+) inflation, (+) money supply: risk factor 2: (+) domestic exports, (+) domestic imports; (+) world exports; risk factor 3: (+) domestic interest rates, (+) Mexican Treasury Bills. Canada: risk factor 1: (+) Canadian dollar/US dollar depreciation; (+) industrial production, (+) inflation, (+) money supply; risk factor 2: (+) Canadian bills, (+) Libor rate; risk factor 3: (+) Canadian exports, (-) world capital market. United States: risk factor 1: (+) US exports, (+) US imports, (+) world exports, (+) interest rates, (+) Libor rate; risk factor 2: (-) US exports, (-) world exports), (+) interest rates, (+) dollar relative price; risk factor 3: (-) dollar relative price, (+) World capital market, (+) TBills, (+) Libor rate; Risk factor 4: (+) price index, (-) exchange rate depreciation.

Previous to estimating the model, unit root tests are in order for all variables involved, to determine whether or not they presented a long-run equilibrium relationship. That is, making sure that the variables are stationary involved in the regressions and avoiding spurious relationships. Table 2 shows the results for the Dickey-Fuller and Phillips-Perron unit root tests. The evidence provided by the unit root tests, confirm stationarity for almost all variables at one percent level of significance. Only two cases could cast some doubt about their stationarity. Under any alternative specification, the Dickey-Fuller test does not reject the hypothesis of the existence of an unit root for the risk premium corresponding to the third domestic Canadian stock market risk factor (CNCP3RP). However, the Phillips-Perron tests points out in the opposite sense, that is, it rejects the existence of a unit root for that series at one percent of significance. This conflictive result can be viewed as the lack of power of the Dickey-Fuller test to reject the null hypothesis, or else, alternatively, derived from other characteristics of the series' behavior such as structural breaks. To avoid any Type II error, it seems adequate in this case to accept the evidence provided by Phillips-Perron test. In the case of the risk premium related to the second domestic U.S. stock market risk factor (USCP2RP), the Dickey-Fuller test including an intercept and a linear trend also fails to reject the null hypothesis, while the Phillips-Perron test again suggests the opposite. But the non-rejection is only marginal (the marginal significance level is of 0.0528); similarly, the linear trend coefficient is very small and not significant at any level.

To capture the impacts that certain events can exert on the stock markets risk premium, *dummy* variables were added into the model equations. These dummy variables intend to pick the effects of market cracks: CRACK87, TEQUILA, DRAGON, VODKA and BRASIL were included to represent, respectively, the effect of the 1987 October market crash, and the Mexican, Asian, Russian and Brazilian crises, each represented by a value of one for the month occurring the crisis and zero for any other month. Finally, the variable NAFTA was added to the equations with a value of 1 since January of 1994 and cero for the previous months, to asses any impact of this agreement on the stock exchanges of these three countries; similarly the *dummy* variable FTAUSCAN was included in the equations corresponding to the risk premium of Canadian and US stock markets to capture the effects of the commercial agreement signed between Canada and US; its assigned values are 1 since January 1989, and cero for all previous months. Another variable named STABILIZATION is also included to depict the efforts to control inflation in Mexico; enforced since December 1987. Financial economic literature sustains that a reduction on market and asset risk premiums must be observed after a liberalization date. Mexico's financial liberalization process is captured with the dummy variable ADR. Although economic and financial liberalization started before the first issuing of ADR's, the liberalization process between 1983 and 1988 was a response to financial restrictions faced by Mexico in the aftermath of the 1982 foreign debt problem (Cabello, 1999). Following the nationalization of the banking system both government authorities and private entrepreneurs saw in this market an appropriate mechanism to promote savings and channeling them to productive investments. The adequacy of first ADR issuing date to capture the effects of liberalization can be explained by the fact that it is on this date that foreign investors have effective access to the assets before restricted to them; and it is the date when local domestic firms have effective access to foreign financing. Errunza, Hogan and Hung (1999), and Bekaert, Harvey and Lumsdaine (2002), have found evidence that the date in which a country issues its first ADR has a significant effect on the local market of the issuing firm; The importance of ADR's in integration processes has also been confirmed by Evans and Hanatkovska)(2005), and Chen, Choi and Kini (2008). Hence, the dummy variable ADR has a value of 1 beginning September 1989, the month when the first Mexican ADR was listed at NYSE, and cero in any other previous month. Applying a sequential reduction procedure, final estimation models were obtained. Equation (2) is transformed in the following operational model:

$$r_t = \alpha_0 + \sum_{i=1}^{12} \alpha_i r_{t-1} + \sum_{i=1}^{3} \sum_{j=0}^{12} \beta_{i,j} X_{i,t-j} + \psi' \delta + \varepsilon_t \qquad t = 1,2,\ldots,T \tag{3}$$

,

Here, the multibeta model is extended to include twelve lags of both dependent and independent variables and for the case of three principal components, which are the cases of Canada and Mexico. A similar model can be extended for the case of United States which includes four principal components.

Including the dummy type variables, the empirical model is further extended to:

$$r_t = \alpha_0 + \sum_{i=1}^{12} \alpha_i r_{t-1} + \sum_{i=1}^{3} \sum_{j=0}^{12} \beta_{i,j} X_{i,t-j} + \psi_1 CRACK\,87 + \psi_2 STABILIZATION$$
$$+ \psi_3 ADR + \psi_4 NAFTA + \psi_5 VODKA + \gamma WCMPRP + \varepsilon_t \qquad t = 1,2,\ldots,T \tag{4}$$

A similar approach is followed in this study for the cases of Canada and United States. Tables 3, 4 and 5 show, respectively, the OLS estimations for Mexican, Canadian and U.S. stock market risk premium.

As shown in Table 3, almost all the estimated coefficients are highly significant, the only exception is the coefficient of the tenth lag of *potrmanteu* MXCP3RP which is only significant at a marginal level superior to 5%. The R^2 confirms that the variables in the model jointly explain a bit more than 60% of the variations of the risk premium in the Mexican stock market. The Jarque-Bera statistic fails to reject the residual normality hypothesis. There is no evidence of heteroscedasticity and the Ramsey Reset test does not show evidence of problems in specification. The

Breusch-Godfrey LM test rejects autocorrelations up to twelve lags. Nevertheless, is worth noting that Ljung-Box test shows positive autcorrelations at second and fifth lags, but they are only significant at a10% level. The ARCH LM test and *pormanteu* test of squared residuals exhibit the presence of a significant ARCH effect.

Only MXCP1RP, both contemporaneous and lagged, and lagged values of MXCP3RP are significant to explain Mexican stock market risk premium. Neither present period nor lagged values of MXCP2RP are significant. Following López Herrera and Ortiz (2005), MXCP1RP, MXCP2RP and MXCP3RP could be identified, respectively, as risk premiums to exposition to economic activity conditions, foreign trade activity behavior, and money market conditions. Consequently, results underlie the importance of real economic and monetary conditions on stock market performance. Evidence of significant lagged variables is similar to Hondroyiannis and Papapetrou (2001) and Dritsaki-Bargiota and Dritsaki (2004), who find that in the Athens stock market past inflation rate and past changes on interest rate cause Granger stock market returns. Finally, it is important to stress that World capital market risk premium is also significant to explain the Mexican stock market risk premium.

The empirical evidence also suggests that official efforts to stabilize the Mexican economy had some effects on stock market risk premium. Similarly, underscoring the importance of economic integration, NAFTA has induced a significant reduction in the level of risk premium (almost 3.1%). The first issue of corporate Mexican ADRs also led to a decrease of six percent in risk premium, almost twice as much as the NAFTA impact. It is also worth noting that the official announcement date about Mexico´s securities market liberalization was not significant; seemingly to investors is more important the effective access date than the official liberalization announcement. Concerning market crashes, only the October crack of 1987, and the Russian crisis of 1998 are significant, but neither the Asian nor the Brazilian crises affected market returns in Mexico.. Surprisingly, the Mexican tequila crisis apparently did not exerted effects on the Mexican equities market. Considering the magnitude of the impacts caused by that crisis on the entire economy, its negative impacts most likely are fully reflected in other economic variables, which are captured in the model.

In the case of the Canadian stock market risk premium, as Table 4 shows, the estimated model performs even better. R^2 is higher and the conventional measures used for statistical evaluation show no evidence of problems in estimation. It is worth noting that all contemporaneous values of the three risk factors premia are statistically significant, as well as some of their lagged values, albeit some at only at a five percent level of significance. Consistent with previous findings by López Herrera and Ortiz (2005), risk factors associated to the Canadian case are very similar to the Mexican case, almost identical in composition; the high level of significance of the risk rewards evidence the relevance of macroeconomic risk factors to explain risk premium at the Canadian stock market. Commercial agreements signed with U.S., and with United States and Mexico (NAFTA), have impacted risk premium at the Canadian stock market. Concerning crises, findings reveal that only the October 1987 world market crash and the Russian crisis have had some effect on risk premium at the Canadian stock market.

The U.S. stock market risk premium estimated model does not present any problem of specification; as shown in Table 5; however, its R^2 is lower than those obtained for the adjusted models for Mexico and Canada. Nevertheless, the model is satisfactory in statistical terms. It is worth noting that OLS estimates reported, derived from sequential analysis, include only three principal components as significant regressors. Only contemporaneous values of the first and third factors risk premiums are significant, at one percent level of significance; yet lagged values of the first second and third factors risk premiums are also significant, although in some cases only at 10% significance level. As previously reported, Lopez and Ortiz (2005) using principal components analysis identify four relevant risk factors for the U.S. Their findings suggest that the first risk factor captures effects sprung from the degree of openness of the U.S. economy, both from a commercial and financial perspective; the second risk factor captures the effects of U.S. trade balance deficit; the third risk factor represent local financial relationships; surprisingly, the fourth risk factor, eliminated by sequential analysis, depicts the influence of economic uncertainty derived from inflation and exchange rate changes. Significant coefficients results suggest that only the level of openness and domestic financial conditions are important to explain U.S. stock market risk premium. That explains why U.S. commercial agreements with Canada and Mexico have had no effects on risk premium. However, the market crack of October1987, coupled with the 1997 Asian crisis and Russian 1998 crisis seemingly affected U.S. stock market risk premium.

Finally, segmentation of the stock markets from the NAFTA countries is confirmed by the different levels of integration of each market to international macroeconomic variables. Principal component analysis suggests for the total world exports is the only international variable relevant for the Mexican case. The importance of this variable included in the regression analysis indicates that at least to some degree the Mexican stock market is sensitive to international systematic risk sources. At any rate, in the Mexican case it also stands out the fact that principal component analysis suggested not to include in the model returns from the world portfolio market because it does not contribute with relevant information to explain variability of the entire set of economic variables analyzed. In other words, considering the Mexican case, world market returns is a variable totally independent from the set of variables relevant for this market. However, including the world market risk premium (world returns minus LIBOR rate) in the OLS regression, as shown in Table 3, the corresponding coefficient is highly significant. All these results

imply a partial segmentation of the Mexican market with respect to the world market, since local macroeconomic risk factors remain important, while only some international risk factors seem to weight in its variability of returns.

In the case of Canada, results show that returns from the world market and the LIBOR interest rate contribute to explain variability of the set of economic series included in the analysis; however, total world exports are excluded as a relevant variable for the Canadian case. At any rate, in the regression analysis performed for this country, the relevant risk factors are comprised of local and international sources of systematic risk; hence the Canadian stock market is case is a clear case of mild segmentation.

Of the three countries participating at the NAFTA, the U.S. capital market shows a greater exposition to international risk factors, which is confirmed by principal components analysis, albeit domestic macroeconomic variables remain important. Regression results confirm that three international variables are important to determine systematic risk at the U.S. market. Table 5 incorporates therefore in the regression analysis the over all impact from local and international in the variability of returns in this market.

5. Conclusions

Mexican, Canadian and U.S. stock markets sources of risk premiums have been analyzed in this paper on the basis of multifactor systematic risk models, one for each stock market. Risk factors were chosen from principal components analysis previously applied for these markets by Lopez Herrera and Ortiz (2005). Results show that linear combinations of variables studied, i.e., the principal components, are relevant to explain the corresponding risk premium at the markets under study. The set of series used includes both domestic and international economic variables; the high significance of the estimated risk factors' coefficients built with these variables implies that domestic and foreign sources of systematic risk coexist driving returns in NAFTA area stock markets. Domestic and international sources of systematic risk explain at a high degree of significance risk premiums of Mexican, Canadian and U.S. stock markets. It can therefore be concluded that each one of these markets is partially segmented from the world capital market. Local risk factors matter for each country, and different international risk factors are relevant for each market. This is confirmed by the multibeta regression analysis carried out for each market, extending the model with sequential analysis to include dynamic impacts from the risk factors on the returns of each market. The evidence confirms the fact that the markets from Canada, Mexico and United States respond differently to international risks factors. The empirical evidence provided in this paper offers some empirical support to the hypothesis of partial segmentation among Mexican, Canadian and US stock markets. The greater number of significant coefficients in the Canadian and US stock markets estimated equations in comparison with the number of significant coefficients in the Mexico's stock market equation, suggests that more economic information is used by investors in the former two markets. The significant coefficients of lagged variables in the three markets show that past economic information is valuable for investors. To enhance economic development of these nations, further development and integration of their capital markets is in order, particularly considering that integration between Mexico and its neighboring partners has taken place in asymmetrical terms, a developing economy vis a vis two developed countries.

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Table 1. Stock maket indexes descriptive statistics. January 1984 - December 2002

Variable	*Mean* %	*Standard Deviation %*	*Skewness*	*Kurtosis*	*Normality*[1] χ^2	*p-value*[2]
MXSMR	1.56	12.98	-1.46	8.38	355.64	< 0.01
CNSMR	0.31	5.28	-1.19	7.81	273.44	< 0.01
USSMR	0.83	4.74	-1.19	7.73	266.40	< 0.01
WCMPR	0.64	4.43	-0.71	4.65	44.95	< 0.01

MXSMR = Mexican stock market return; CNSMR = Canadian stock market return

USSMR = US stock market return; WCMPR = World capital market portfolio return

[1] Jarque-Bera Normality Test; [2] Corresponding to Jarque-Bera Normality Test

Table 2. Unit-root tests. January 1984 - December 2002

Variable	*Dickey-Fuller*			*Phillips-Perron*		
	$\hat{\tau}_\beta$	$\hat{\tau}_\mu$	$\hat{\tau}$	$\tilde{t}_\beta$	$\tilde{t}_\mu$	$\tilde{t}$
MXSMRP	-11.8859 (< 0.01)	-11.90629 (< 0.01)	-11.88975 (< 0.01)	-11.58902 (< 0.01)	-11.62544 (< 0.01)	-11.62727 (< 0.01)
MXCP1RP	-4.715812 (< 0.01)	-4.004314 (< 0.01)	-3.983363 (< 0.01)	-12.16695 (< 0.01)	-9.984977 (< 0.01)	-9.623234 (< 0.01)
MXCP2RP	-4.105369 (< 0.01)	-4.989822 (< 0.01)	-5. 19312 (< 0.01)	-17.17264 (< 0.01)	-16.67433 (< 0.01)	-16.01074 (< 0.01)
MXCP3RP	-6.332118 (< 0.01)	-3.777054 (< 0.01)	-4.039627 (< 0.01)	-9.002729 (< 0.01)	-7.009106 (< 0.01)	-6.60967 (< 0.01)
CNSMRP	-13.68538 (< 0.01)	-13.71624 (< 0.01)	-13.72409 (< 0.01)	-13.64112 (< 0.01)	-13.67688 (< 0.01)	-13.68573 (< 0.01)
CNCP1RP	-15.69266 (< 0.01)	-15.11491 (< 0.01)	-8.59651 (< 0.01)	-15.76772 (< 0.01)	-15.12122 (< 0.01)	-8.59651 (< 0.01)
CNCP2RP	-13.32813 (< 0.01)	-6.020712 (< 0.01)	-4.966256 (< 0.01)	-13.765 (< 0.01)	-13.40314 (< 0.01)	-12.34138 (< 0.01)
CNCP3RP	-2.349826 (0.4049)	-2.091389 (0.2484)	-1.281338 (0.1842)	-17.16467 (< 0.01)	-16.7641 (< 0.01)	-14.47754 (< 0.01)
USSMRP	-15.25422 (< 0.01)	-15.25979 (< 0.01)	-15.18532 (< 0.01)	-15.48099 (< 0.01)	-15.45182 (< 0.01)	-15.27842 (< 0.01)
USCP1RP	-3.90788 (0.0136)	-3.954336 (< 0.01)	-3.30804 (< 0.01)	-13.20581 (< 0.01)	-13.23523 (< 0.01)	-12.65507 (< 0.01)
USCP2RP	-3.409153 (0.0528)	-3.224223 (0.0199)	-2.56797 (0.0102)	-13.75375 (< 0.01)	-13.54463 (< 0.01)	-12.59578 (< 0.01)
USCP3RP	-14.86461 (< 0.01)	-14.90263 (< 0.01)	-13.15324 (< 0.01)	-14.86437 (< 0.01)	-14.90057 (< 0.01)	-14.00308 (< 0.01)
USCP4RP	-12.68851 (< 0.01)	-11.55161 (< 0.01)	-5.128514 (< 0.01)	-12.79716 (< 0.01)	-12.03036 (< 0.01)	-11.44356 (< 0.01)

Lags choice in Dickey-Fuller test (ADF) is performed with Schwarz Information Criterion and with the Newey-West band in Phillips-Perron test.

$\hat{\tau}_\beta$ and $\tilde{t}_\beta$ corresponding to the test with intercept and a linear trend: $\Delta x_t = \mu + \gamma x_{t-1} + \beta_t + \eta_t$

$$H_0 : x_t = x_{t-1} + \eta_t \; ; H_a : x_t = \mu + \Phi x_{t-1} + \beta_t + \eta_t \;\; ; \Phi < 1, \Phi - 1 = \gamma$$

$\hat{\tau}_\mu$ and $\tilde{t}_\mu$ corresponding to the test with intercept and no linear trend: $\Delta x_t = \mu + \gamma x_{t-1} + \eta_t$

$$H_0 : x_t = x_{t-1} + \eta_t \; ; H_a : x_t = \mu + \Phi x_{t-1} + \eta_t \;\; ; \Phi < 1, \Phi - 1 = \gamma$$

$\hat{\tau}$ and $\tilde{t}$ corresponding to the test with no intercept neither linear trend: $\Delta x_t = \gamma x_{t-1} + \eta_t$

$$H_0 : x_t = x_{t-1} + \eta_t \; ; H_a : x_t = \Phi x_{t-1} + \beta_t + \eta_t \;\; ; \Phi < 1, \Phi - 1 = \gamma$$

Numbers between parenthesis are MacKinnon *p values*, denoting the test marginal significance level.

Table 3. Mexican stock market risk premiums January 1984 - December 2002

$$r_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i r_{t-1} + \sum_{i=1}^{k} \sum_{j=0}^{l} \beta_{i,l} X_{i,t-j} + \psi'\delta + \varepsilon_t$$

Variable	*Coefficient*	*Standard error*	*t*	*p-value*
Intercept	29.79453	3.467057	8.593608	< 0.01
MXCP1RP	3.333101	0.339130	9.828400	< 0.01
$MXCP1RP_{t-7}$	0.699068	0.347269	2.013043	0.0454
$MXCP3RP_{t-5}$	1.386047	0.483189	2.868537	< 0.01
$MXCP3RP_{t-7}$	1.583049	0.489634	3.233125	< 0.01
$MXCP3RP_{t-10}$	0.851159	0.436956	1.947926	**0.0528**
CRACK87	-73.56751	6.506447	-11.30686	< 0.01
STABILIZATION	-22.37618	3.407775	-6.566213	< 0.01
ADR	-6.170827	2.288154	-2.696858	< 0.01
NAFTA	-3.097350	1.420947	-2.179778	0.0304
VODKA	-22.96762	8.701067	-2.639632	< 0.01
WCMPRP	0.688886	0.138953	4.957704	< 0.01
R squared	0.604155			
Adjusted R squared	0.583018			
χ^2 normality (Jarque-Bera)	1.313496			0.518135
F autocorrelation (12 lags)	1.072840			0.385041
χ^2 autocorrelation (LM Breusch-Godfrey), 12 lags	13.56646			0.329245
$F_{\text{heteroskedasticity}}$	1.175003			0.287627
χ^2 heteroskedasticity	19.79570			0.284812
Arch-12	25.70875			0.011799
F RESET	0.174280			0.676773

Table 4. Canadian stock market risk premiums. January 1984 - December 2002

$$r_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i r_{t-1} + \sum_{i=1}^{k} \sum_{j=0}^{l} \beta_{i,l} X_{i,t-j} + \psi'\delta + \varepsilon_t$$

Variable	*Coefficient*	*Standard error*	*T*	*P-value*
$CNSMRP_{t-1}$	-0.113360	0.057105	-1.985140	0.0485
$CNSMRP_{t-2}$	-0.075743	0.042365	-1.787880	**0.0753**
$CNSMRP_{t-9}$	0.125749	0.052150	2.411306	0.0168
$CNSMRP_{t-12}$	-0.119731	0.040537	-2.953644	< 0.01
CNCP1RP	-1.806084	0.117337	-15.39224	< 0.01
$CNCP1RP_{t-1}$	-0.507908	0.150298	-3.379353	< 0.01
$CNCP1RP_{t-6}$	-0.267669	0.118317	-2.262306	0.0248
$CNCP1RP_{t-7}$	-0.290540	0.117664	-2.469239	0.0144
$CNCP1RP_{t-9}$	0.372095	0.149571	2.487743	0.0137
CNCP2RP	-0.942160	0.189872	-4.962068	< 0.01
$CNCP2RP_{t-4}$	0.488078	0.184870	2.640113	< 0.01
CNCP3RP	1.662172	0.213798	7.774499	< 0.01
$CNCP3RP_{t-1}$	1.657927	0.252172	6.574582	< 0.01
$CNCP3RP_{t-2}$	0.626961	0.232273	2.699242	< 0.01
$CNCP3RP_{t-3}$	0.805694	0.202664	3.975519	< 0.01
$CNCP3RP_{t-11}$	0.692567	0.201046	3.444811	< 0.01
CRACK87	-16.28601	3.339931	-4.876151	< 0.01
FTAUSCN	2.376313	0.611934	3.883283	< 0.01
NAFTA	-1.197348	0.567335	-2.110478	0.0361
VODKA	-16.36974	3.283867	-4.984897	< 0.01
R squared	0.707868			
Adjusted R squared	0.679549			
$\chi^2_{\text{normality}}$ (Jarque-Bera)	1.747899			0.417300
$F_{\text{autocorrelation}}$ (12 lags)	0.696172			0.753977
$\chi^2_{\text{autocorrelation}}$ (L-M Breusch-Godfrey), 12 lags	9.370266			0.671022
$F_{\text{heteroskedasticity}}$	1.034620			0.424959
$\chi^2_{\text{heteroskedasticity}}$	37.20390			0.413409
Arch-12	9.123443			0.692352
F_{RESET}	1.543741			0.215554

Table 5. U.S. stock market risk premiums. January 1984 – December 2002

$$r_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i r_{t-1} + \sum_{i=1}^{k} \sum_{j=0}^{l} \beta_{i,l} X_{i,t-j} + \psi'\delta + \varepsilon_t$$

Variable	*Coefficient*	*Standard error*	*T*	*p-value*
Intercept	1.161529	0.340119	3.415071	< 0.01
$USSMRP_{t-7}$	0.099762	0.052735	1.891776	**0.0600**
$USSMRP_{t-9}$	0.145816	0.064304	2.267584	0.0244
$USSMRP_{t-11}$	0.150638	0.062429	2.412953	0.0167
USCP1RP	-0.489019	0.174393	-2.804126	< 0.01
$USCP1RP_{t-2}$	-0.327338	0.166958	-1.960602	**0.0513**
$USCP1RP_{t-6}$	-0.285797	0.168206	-1.699088	**0.0909**
$USCP1RP_{t-8}$	0.315647	0.184085	1.714681	**0.0880**
$USCP1RP_{t-9}$	0.315247	0.176527	1.785834	**0.0757**
$USCP1RP_{t-12}$	0.406553	0.172078	2.362604	0.0191
$USCP2RP_{t-9}$	0.558397	0.201689	2.768599	< 0.01
$USCP2RP_{t-10}$	-0.503209	0.209159	-2.405865	0.0171
USCP3RP	2.196201	0.257078	8.542934	< 0.01
$USCP3RP_{t-5}$	0.713167	0.230922	3.088344	< 0.01
$USCP3RP_{t-9}$	-0.543719	0.274368	-1.981710	0.0489
$USCP3RP_{t-11}$	-0.517751	0.274362	-1.887110	**0.0606**
CRACK87	-19.65779	3.674967	-5.349108	< 0.01
DRAGON	-6.580707	3.510101	-1.874791	**0.0623**
VODKA	-12.11189	3.533418	-3.427812	< 0.01
R squared	0.536858			
Adjusted R squared	0.494540			
$\chi^2_{\text{normality}}$ (Jarque-Bera)	1.243182			0.537089
$F_{\text{autocorrelation}}$ (12 lags)	0.593937			0.845449
$\chi^2_{\text{autocorrelation}}$ (L-M Breusch-Godfrey), 12 lags	8.012839			0.784126
$F_{\text{heteroskedasticity}}$	0.770117			0.811112
$\chi^2_{\text{heteroskedasticity}}$	26.46589			0.782567
Arch-12	7.657551			0.811287
F_{RESET}	1.016584			0.314574

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Foreign Exchange Reserves and Inflation in Pakistan: Evidence from ARDL Modelling Approach

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Abstract

Interest in detection of factors considered responsible for uneven fluctuations in steady state growth of world economies is long standing. There has been an explosion of theoretical literature and empirical evidences which think about compassionate to resolve the issue. Hike in prices of goods and services and foreign exchange are two important aspects which are blamed for such bumpy vacillation in economic growth of the world economies like all other political, social and economic factors. It is true that both factors have special significance for economic growth, but inquiry about internal relationships of the above mentioned both variables still has research thirst. The novelty of this research paper is that it provides the empirical evidence regarding the relationships between foreign exchange reserves and inflation, focusing on Pakistan's experience since 1960. We used the Auto Regressive Distributive Lag Model (ARDL) proposed by Pesaran et al. (2001) in order to investigate the order of co-integration between inflation and foreign exchange reserves through bound testing approach, and also use the OLS estimation to determine the long run relationship. Through this econometric technique, we traced out the nature of relationship and speed of adjustment in the concerned variable due to fluctuations in the level of foreign exchange reserves. Empirical results indicate that the rise in foreign exchange reserves leads to lower the rate of inflation in Pakistan during the study period.

Keywords: Inflation, Foreign Exchange, ARDL Estimation, GDP Deflator, Error correction, Pakistan

Introduction

In the empirical literature many studies claim that inflation is a key economic variable for policy makers, researchers and investors. Around the world no one could refute its matchless position especially in monetary policy determination. So due to worldwide dramatic changes in the inflation and its exceptional position, in recent years research is concerned more with the aspects of inflation. Changes in price levels are caused by national factors like supply shock such as bad harvests, the monopoly of producers, and increase in factors cost, scarcity of raw material, and depreciation/devaluation of domestic currency etc. The change in general price levels may also be caused by excessive or disproportional demand for example increase in population, decline in real income and so forth. But in the current world's economic scenario it is observed that the national factors are not exclusively responsible for inflation, international factors like hike in oil products prices, financial assistance from abroad, and changes in volume and rate of foreign exchange etc. may be to blame for such hike in domestic price level.

In this respect, the study regarding the nature and intensity of relationship between foreign exchange reserves and inflation rate is also a hot issue for researchers especially in those economies where above said variables have uneven and rapid fluctuations. In the modern era the factors like foreign exchange rate and foreign exchange reserves play critical role in economic stability, especially in case of small open economy like Pakistan. The reason is that the bumpy and rapid variations in foreign exchange rate and in its level affect the profitability of entrepreneurs and multinational corporations directly and indirectly. And as a result change in supply of goods and services play a significant role for inflation variations. In case of Pakistan, experience of last few decades of currency devaluation or depreciation has affected our foreign exchange reserves significantly. And such variations in foreign exchange reserves also have an effect on the prices of goods and services. It means that foreign exchange reserves or its level adjusts quickly to the inflation rate in Pakistan. So in this background we have endeavored to investigate the nature and intensity of such connection between foreign exchange reserves and inflation rate. The novelty of this research paper is that it analyzes the relationships between changes in level of foreign exchange reserves and rate of inflation in Pakistan. To asses the direction of relationship between foreign exchange reserves and rate of inflation in Pakistan, we

directly regressed the reduced form relationship equation through most reliable and recent econometric technique known as ARDL approach and OLS method.

Khan and Qayyum (2007) find that exchange rate is co-integrated with (WPI) price level in Pakistan. Nieh and Chung (2005) and Rahman and Hossain (2003) conclude that the stable exchange rate help the enterprises in investment. Parikh and Williams (1998) bring to a close that fluctuations in exchange rate may have significant impact on prices, unemployment and quantity output. Eatzaz and Ali (1999) probe that relationships between inflation and exchange rate are not unidirectional and simple. In the short run, the effect of inflation on devaluation is greater than the devaluation on inflation and movement in exchange rate generally driven by price inflation in Pakistan. Research undertaken in Pakistan by Ahmed and Ram (1991); Bilquees (1988); Hassan and Khan (1994) and Khan and Qasim (1996) provides reliable evidence that the domestic price level reacts significantly but gradually to devaluation. Meiselman (1975) looks into the connection between international reserves and inflation and find the direct association between changes in international reserves and inflation. Heller (1976) investigates the association between international reserves and world wide inflation and shows that change in international reserves positively affect the world wide inflation through change in monetary base and money supply. Genberg and Swoboda (1977) and Parkin (1977) also probe the nature of correlation between above discussed variables and get the consistent results with Meiselman (1975) and Heller (1976) finale. They conclude that the increase in national money supplies prompted by the international reserves enlargement ultimately have positive impact on national inflation. Khan (1979) finds that it was the growth in international reserves that augment or enlarge the level of inflation. In other words we can say that Mr. Khan Results were consistent with the quantity theory of money approach extended to the international economy.

Haastrecht and Pelsser (2008) studied the relationship between the Generic Pricing of foreign exchange, inflation and stock options. Utami and Inanga (2009) tested Fisher effect theory considering yearly and quarterly data on inflation, rate of interest and exchange rate of four countries for the period 2003-2008. They found that interest rate differential and changes in exchange rate are positively and significantly related. Prasertnukul et. al (2010) examined that inflation targeting caused a fall in exchange rate volatility in Asian countries.

The main rationale of this study is empirical scrutiny of the nature of relationship between targeted variables in Pakistan, through ARDL a recent estimation technique, as well as the examination that either it is a short run phenomenon or change in the foreign exchange reserves also affect the inflation rate in long span of time. The second objective of this paper is to probe whether in Pakistan there is typical positive association between foreign exchange reserves and inflation rate (as discussed in literature) or in accordance with our hypothesis (negative correlation between focused variables) in Pakistan. The Third purpose of this study is provision of empirical evidences for those countries that have identical foreign exchange reserves conditions and other economic circumstances and also want to get rid from the problems associated with inflation rate. The paper is organized as follows. After a brief theoretical introduction, section 1 outlines the basic hypothesis which we develop regarding the relationship between focused variables in Pakistan. Section 2 presents Data, Model and the Econometric Methodology, Section 3 is based on empirical examination and analysis of results. And section 4 gives us conclusion and policy recommendations.

1. The Basic Hypothesis

It is our primary hypothesis that there is a negative connection between foreign exchange reserves and rate of inflation in Pakistan. Changes in foreign exchange reserves in Pakistan indirectly and inversely affect the rate of inflation. We know that an increase in foreign exchange reserves enhance the monetary base, and presence of stable money multiplier ultimately will have a direct increase in national money supply. Then increase in the national money supplies in turn has an impact on national inflation rate channels via supply changes. Usually increase in monetary base through increase in foreign reserves tends to boost up the aggregate demand of economy. But the case of developing country like Pakistan (importer of less elastic goods and services) is a little bit different than typical behavior. The reason is that Pakistan is an agrarian and less developed country. Its imports are based on approximately inelastic items (oil products, pesticides, fertilizers, medicine, machinery, and food products etc.). It means more or less these imports are compulsory for the survival of the economy. Increase in foreign exchange reserves leads to the enhancement of the monetary base which in turn leads to bigger import of oil, machinery and other raw material. As a result needless increase in productive capacity decreases profits of entrepreneurs and prices of products. Consequently there is reduction in national inflation rate, and vice versa. Another important transmission mechanism links with the agricultural production. Because Pakistan is an agricultural country, through reduction in foreign exchange reserves agriculture products are affected at all levels resulting is decline in agricultural raw material and oil products imports, which in turn is observed in the form of supply shock and higher level of food and core inflation, and vice versa.

2. Data, Model and Econometric Methodology

2.1 Data

This study analyzes the impact of foreign exchange reserves on inflation rate in Pakistan by using the annual time series statistics from 1960 to 2007, so the total number of observations is 48. All the statistics are taken from International Financial Statistics. Foreign Exchange reserves is measured in Million US $, and GDPD (Gross Domestic Product Deflator) is used here as proxy of inflation. We used logarithm transformation of both variables for econometric estimation.

2.2 The Model

To examine the Foreign Exchange Reserves - Inflation rate long run relationships in Pakistan we develop the following econometric model for estimation,

$$(GDPD)_t = \beta_0 + \beta_1 (FE)_t + \varepsilon_t \text{ ----------(1)}$$

Here (GDPD) is Gross Domestic Product Deflator (a proxy of inflation rate), and (FE) is stands for Foreign Exchange reserves, at a certain period of time t; β0 is the constant; and εt is the stochastic disturbance term. The Foreign Exchange reserves and Inflation rate correlation is determined by the size of beta. To examine the relationships between focused variables study employs the autoregressive distributed lag model (ARDL) suggested by Pesaran et al, (2001), for co-integration investigation (time series data) and error correction (short run) analysis. We use variables in natural logarithm form to asses the significance of Foreign Exchange reserves on inflation rate in Pakistan. So the log transformation of model is as follow:

$$\ln(GDPD)_t = \beta_0 + \beta_1 \ln(FE)_t + \varepsilon_t \text{ ----------(2)}$$

In case of more than unity value of concerned beta or slop coefficient (elasticity) rate of inflation will be more sensitive and elastic with the change in foreign exchange.

2.3 Econometric Methodology

2.3.1 Unit Root Estimation

In order to investigate the level of integration this study makes use of standard tests like ADF (Augmented Dicky Fuller) and DF-GLS (Dicky Fuller Generalized Least Square). Due to less reliability of ADF for small size data (Dejong et al. 1992, Sollice and Harris 2003, Shahbaz et al. 2008) we also use the DF-GLS for scrutiny of co-integration between above mentioned variables. Dejong et al. 1992 and Harris 2003 summarized that some time ADF committing type 1 and type 2 error when samples size are small. Then for more reliability we use DF-GLS as well as ADF test.

The Dicky-Fuller Generalized Least Square de trending test developed by Elliot et al. (1996) and followed by Ng-Perron (2001). On of the assumption that there is need to test the order of integration of variable Xt, Elliot et al. (1996) enhance the power of ADF test by de trending criteria and DF-GLS test is based on null hypothesis *H0: δ=0* in the regression:

$$\Delta X_t^d = \delta^* X_{t-1}^d + \delta_1^* \Delta X_{t-1}^d + \ldots\ldots\ldots + \delta_{p-1}^* \Delta X_{t-p+1}^d + \eta_t \text{ ------(3)}$$

Where $X^d{}_t$ is the de trended series and null hypotheses of this test is that X_t has a random walk trend, possibly with drift as follows.

$$X_t^d = X_t - \hat{\varphi}_0 - \hat{\varphi}_1 t \text{ ----------(4)}$$

Actually, two hypotheses are proposed.

(1) X_t is stationary about a linear time trend and

(2) It is stationary with a non zero mean, but with no linear time trend.

Considering the alternative hypotheses, the DF-GLS test is performed by first estimating the intercept and trend utilizing the generalized least square technique. This estimation is investigated by generating the following variables:

$$\overline{X} = \left[X_t, (1-\overline{\beta}L)X_2, \ldots\ldots\ldots\ldots, (1-\overline{\beta}L)X_t\right] \text{------(5)}$$

$$\overline{Y} = \left[X_t, (1-\overline{\beta}L)Y_2, \ldots\ldots\ldots\ldots, (1-\overline{\beta}L)Y_t.\right] \text{------(6)}$$

And

$$Y_t = (1,t)\overline{\beta} = 1 + \frac{\overline{\alpha}}{T} \text{ ----------(7)}$$

Where "T" stands for number of observation of X variable and α is fixed. (Note 1)

While OLS estimation is followed by this equation:

$$\overline{X} = \varphi_0 \overline{Y} + \varphi_1 Y_t + \varepsilon_t \text{ ----------(8)}$$

And OLS estimator's φ_0 and φ_1 are utilized for the removal of trend from as X_t above. ADF test is employed on the transformed variables by fitting the OLS regression. (Note 2)

$$\Delta X_t^d = \lambda_0 + \rho X_{t-1}^d + \sum_{j=1}^{k} \gamma_j \Delta X_{t-j}^d + u_t \quad \text{----------(9)}$$

In alternative hypothesis, ά= -7 in the required equation of β, above, then they calculate $X_t^d = X_t - \varphi_0$, fit the ADF regression on new transformed variable and employ the test of the null hypothesis that is ρ=0.

In recent times, Ng-Perron (2001) developed four test statistics utilizing GLS de- trended data D_t^d. the calculates values of theses tests based on forms of Philip –Perron (1988) Z_α and Z_t statistics., the Bhargava (1986) R_1 statistics , and the Elliot, Rotherberg and Stock (1996) created optimal best statistics. The terms are defining as follows:

$$k = \sum_{t=2}^{T} \left(D_{t-1}^d\right)^2 / T^2 \quad \text{----------(10)}$$

While de-trend GLS tailored statistics are as given below:

$$MZ_a^d = \left(T^{-1}\left(D_T^d\right)^2 - f_0\right)/(2k) \qquad MZ_t^d = MZ_a \times MSB$$

$$MSB = (k / f_0)^{1/2} \quad \text{and}$$

$$MP_t^d = \{c^{-2}k - c^{-}T^{-1}(D_t^d)^2 / f_0 = \{c^{-2}k + (1-c^{-})T^{-1}(D_t^d)^2 / f_0$$

If $x_t = \{1\}$ in first case and $x_t = \{1, t\}$ in second. (Note 3)

2.3.2 ARDL approach to Co-integration

To examine the long run relationships between foreign exchange reserves and inflation rate in Pakistan, this study uses recent co-integration analysis approach, known as autoregressive-distributed lag (ARDL) model {Pesaran *et al*. (2001)}. Pesaran *et al.* co-integration approach, is also known as Bounds testing technique. To begins with; we test for the null hypothesis of no co-integration against the existence of a long run relationship. Unlike other co integration techniques (e.g., Johansen's 1991) which require certain pre-testing for unit roots, that either our focused variables are integrated at the same order / level or not. All other techniques require the same level of Stationarity of variables for further process. But the ARDL model provides an substitute test for examining a long run relationship regardless of whether the underlying variables are I(0),I(1), or fractionally integrated. This approach has the following econometric advantages in comparison to other Co-integration procedures.

1) The long and short-run parameters of the model in question are estimated simultaneously;

2) The ARDL approach to testing for the existence of a long-run relationship between the variables in levels is applicable irrespective of whether the underlying regressors are purely *I*(0), purely *I*(1), or fractionally integrated;

3) The small sample properties of the bounds testing approach are far superior to that of multivariate co-integration. The bounds testing approach of Pesaran *et al.* (2001) is employed to test the existence of a co-integration relationship among the variables.

4) Modified ARDL method is free from any problem faced by traditional techniques in the literature.

The Pesaran *et al.* procedure involves investigating the existence of a long-run relationship in the form of the unrestricted error correction model for each variable. According to ARDL procedure the unrestricted model of our concerned function will be as follow:

$$\Delta \ln(GDPD)_t = \lambda_0 + \sum_{i=1}^{n} \lambda_i \Delta \ln(GDPD)_{t-i} + \sum_{i=0}^{n} \lambda_i \Delta \ln(FE)_{t-i} +$$
$$\alpha_1 \ln(GDPD)_{t-1} + \alpha_2 \ln(FE)_{t-1} + \nu_{1t} \quad \text{----------(11)}$$

Where ln(GDPD) is the natural logarithms of Gross domestic product deflator , ln(FE) is the natural logarithms of foreign exchange reserves , Δ is the difference operator and vi is the stochastic error term. To analyze the long run relationship existence we restrict the coefficients α_1 and α_2. The modified ARDL approach estimate '(n+1)' number of regression in order to obtain optimal lag length for each variable, where 'n' is the number of lags to be used in the equation#11. The null hypothesis which we develop for investigation of long run is as follow:

$$H_0 = \alpha_1 = \alpha_2 = 0$$

The F-test is used to test the existence of long-run relationships. Thus; the Pesaran *et al*. approach compute two sets of critical values for a given significance level. One set assumes that all variables are *I*(0) and the other set assumes they are all *I*(1). If the computed F-statistic exceeds the upper critical bounds value, then the H_0 (null hypothesis) is rejected. If the F-statistic falls into the bounds, then the test becomes inconclusive. Lastly, if the F-statistic is below the lower critical bounds value, it implies no co-integration. When long-run relationship exists, the F-test indicates which variable should be normalized.

Moreover, when the order of integration of the variables is known and if all the variables are *I(1)*,then the decision is based on the upper bound value. Similarly, if all the variables are *I(0)*,then the decision is based on the lower bound. After estimation of long run relationship by employing the selected ARDL model, there is variety of diagnostic and stability tests, and utilization of these tests in turn enhance the credibility of regressed model. These diagnostic tests examine the serial correlation, functional form, normality and heteroscedasticity associated with model.

3. Empirical Examination and Analysis.

3.1Unit Root Problem and Co-integration analysis

To investigate the order of integration we relied on the ADF (Augmented Dicky Fuller) and more reliable test especially for small size data is DF-GLS (Dicky Fuller Generalized Least Square) tests. The statistics of DF-GLS usually considered more power full than other test like ADF etc. But here we find that both tests give us the same results. Statistics of both tests are given in the tables # 1 & 2 arranged in the end of paper. According to both unit root process (which investigate the order where our focused variables are stationary) results reveals that the both our given variables are stationary at first difference and at 1 % level of significance. After this clarity that our variables are stationary at first difference we used the ARDL (Autoregressive Distributive Lag Model) by Pesaran (2001) to inquire the existence of co-integration either in long run or in short span of time. The results of ARDL co-integration test are presented in table #3 given in the end of paper. Here our assumed null hypothesis is "Existence of no co-integration between inflation rate (ln GDPD) and foreign exchange reserves (ln FE)" but our trace/calculated t value of foreign exchange reserves variable is -4.0037, has zero probability of acceptance of our proposed null hypothesis of no co-integration. Hence we reject our null hypothesis in the favor of alternative hypothesis and conclude that there is existence of co-integration between our focused variables. Results reveals like other economies that foreign exchange reserves also affect the rate of inflations in Pakistan. We used the Measure of goodness of fit, Adjusted R square, Durbin Watson and all other results of F and LM diagnostic tests to enhance the credibility of our empirical results of co-integration. LM &F tests results clearly indicate the correct functional form, no presence of autocorrelation and heteroscedasticity, in our regressed line. So we strongly conclude that long run relationship exist between inflation and foreign exchange level in Pakistan during study period.

3.2 long Run and Short Run Dynamics Behaviors

As we observed that our targeted variables foreign exchange reserves and inflation rate exhibit the long run connection between one and other. To investigate the intensity of such relationships we regressed the equation. Table 4 given in the end of paper shows the results of long run coefficient. This table describes the long run elasticity because all variables are in logarithm form. Estimation shows that Foreign Exchange reserves (FE) has negative and significant affect on rate of inflation in Pakistan in long span of time. No doubt elasticity of inflation with respect to change in levels of foreign exchange reserves in Pakistan is very low, but impacts of change in foreign exchange reserves on inflation rate are not ignorable. Because t ratio of foreign exchange reserves coefficient not only statistically significant but also has zero probability of acceptance of null hypothesis of no long run relationship between foreign exchange reserves and inflation rate in Pakistan. Lagged values of GDP deflator with difference 1 and 2 also have positive and significant impact on inflation in Pakistan. The reliability of our long run regressed function improved by the sound and stable diagnostic tests like, measure of goodness of fit, Adjusted R square, Durbin Watson d statistics, LM and F tests of autocorrelation, heteroscedasticity, and correct functional form of our regressed line . LM &F tests results clearly indicate the no presence of autocorrelation, and heteroscedasticity. Coefficient of determination is close to unity with significant F ratio. It is true that D.W. statistics is meaning less in the presence of lagged values of dependent variable as explanatory variable but it will be compensated by diagnostic test of serial correlation. This is indicating the no auto/serial correlation in data. Tests of correct functional form and heteroscedasticity are also satisfactory. So we may rely on our finding that foreign exchange reserves inversely and significantly affects the rate of inflation in Pakistan in long span of time.

Finally we employed the ECM version of modified ARDL to investigate the short run dynamic relationships. An important attribute of ARDL approach of estimation is, it provides the speed of correction if the dependent variable deviates from its steady state path due to uneven fluctuation of explanatory variables. All this will be done through the ECM (Error Correction Mechanism). We regressed the lagged value of inflation rate deputy on lagged value of our explanatory variable FE (foreign exchange reserves) with error correction variable at first difference as follow.

$$\Delta \ln(GDPD)_t = \lambda_0 + \sum_{i=1}^{n} \lambda_i \Delta \ln(GDPD)_{t-i} + \sum_{i=0}^{n} \lambda_i \Delta \ln(FE)_{t-i} + (ECM)_{t-1} \text{ ------(12)}$$

Table # 5 reports the results of ECM formulation of above given equation. According to Engle Granger (1987), co-integrated must have in ECM representation. As we state above here the ECM strategy will provides the answer of trouble if we found the spurious correlation in the short run dynamic relationship between Gross Domestic Product Deflator (proxy of inflation) and Foreign Exchange reserves. More technically, ECM measures the speed of adjustment back to co-integrated relationships. Here in estimation the signs of the short run dynamic impacts are maintained to the long span of time. The equilibrium correction coefficients estimated value is -0.133 (reported -0.13), which is significant and has correct sign also imply a fairly 13.3 % per annum speed of correction if economy suffered with unexpected inflation due to uneven variations in foreign exchange reserves. In other words 13.3 % disequilibrium (in inflation) from the previous year shock (in foreign exchange reserves) converges back to the long run equilibrium in the current year. Short run coefficient of determination and Durbin Watson statistics are also quite satisfactory

4. Conclusion

In this paper we have concluded the negative and significant relationship between foreign exchange reserves and inflation rate in Pakistan. This study has examined the empirical evidence through most reliable "ARDL" econometric technique. Our results are consistent with our hypothesis; our core explanatory variable "foreign exchange reserves" has negative and significant relationship with rate of inflation in Pakistan. The results differ from the earlier studies (most studies show the positive relationship between foreign exchange and inflation) on the following grounds.

1) Usually we expect the increase in reserves enhance the money supply which in turn raises the prices of commodities in general. But Pakistan's case is different than other developed, higher income developing countries and countries having more elastic imports. Pakistan's imports are based on food, crude oil, agriculture raw material, machinery and medicine etc. and all imports more or less rely on the foreign exchange reserves. Decline in the volume of foreign exchange reserves in turn reduces the imports of industrial and agricultural raw material ingredients immediately, and as a results supply shock enhances the price levels.

2) Less developed capital/ financial markets can not absorb even a slight change in reserves and ultimately there is a change in price levels, unless the national monetary authorities take appropriate actions to neutralize these foreign exchange changes.

3) Decline in foreign exchange reserves generates economic instability. Accordingly multinational companies reduce their business and as a result there is also a supply shock.

In broad terms our results here tend to defy the quantity theory of money, because here reductions in money supply via decline in foreign reserves augment the price level in general. So the finale of this story is; any short fall in foreign exchange reserves in Pakistan undoubtedly has some adverse effects on prices of goods and services, even though it may not be as strong as expected.

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Notes

Note 1. The power of envelop curve is one half at ά=-13.7 when the model has contestant and trend term, and at ά=- 7 when it has only constant term (see Elliot et al., 1996 for comprehensive study)

Note 2. For the critical values (see Elliot et al., 1996) of null hypothesis which is ρ=0.

Note 3. See Shahbaz et al.(2008) "Rural –Urban inequality under Finance and Trade Nexus: An Econometric Evidence" Paper in PSDE 23RD Annual General Meeting and Conference.

Times Series Data Unit Root Test Statistics

Table 1. ADF Unit Root Test Statistics

Variable	Level			1st difference		
	Inter.	Trend & Inter.	None	Intercept	Trend & Inter.	None
GDPD*	0.04	-3.35	2.55	-4.03**	-3.98**	-1.85
FE*	-0.41	-2.71	1.03	-6.98**	-7.02**	6.83
Critical Values			L.O.S —›	1%	5%	10%
			Intercept	-3.59	-2.93	-2.60
			Tr.&Inter.	-4.17	-3.51	-3.18
			None	-2.62	-1.95	-1.61

*Stands for natural log, **Stands for ratio is significant at 1%

Table 2. DF-GLS(Dicky Filler Generalized Least Square) Unit Root Test Statistics

Variable	Level		1st difference		
	Intercept.	Trend & Inter	Intercept	Trend & Inter.	
GDPD*	0.46	-2.84	-3.87**	-4.06**	
FE*	-0.27	-2.47	-6.37**	-7.09**	
Critical Values	L.O.S —›		1%	5%	10%
	Intercept		-2.62	-1.94	-1.61
	Tr. & Inter.		-3.77	-3.19	-2.89

*Stands for natural log, **Stands for ratio is significant at 1%

Table 3. Autoregressive Distributed Lag Estimates

ARDL Co-integration Testing (1, 1) selected based on Schwarz Bayesian Criterion

Dependent variable is GDPD, n=47 (1961-07)				
Regressors	Coefficient	Standard Error	F-Ratio	Prob.
GDPD(-1)	1.13	0.02	65.45	0.00
FE	0.01	0.00	-4.00	0.00
FE(-1)	0.002	0.00	1.94	0.06
C	-0.18	0.46	-0.38	0.71
R-Squared 0.99		R-Bar-Squared 0.99		
F-stat. F(3,43) 6117.4		DW-statistic 2.13		

Diagnostic Tests

#	Nature of Test	LM Test			F Test		
		Lags	Cal. Value	Prob.	df	Cal. Value	Prob.
1	Serial Correlation	CHSQ(1)	2.27	0.13	F(1,42)	2.13	0.15
2	Functional Form	CHSQ(1)	0.32	0.57	F(1,42)	0.29	0.59
3	Heteroscedasticity	CHSQ(1)	2.31	0.13	F(1,45)	2.33	0.13

Table 4. Estimated Long Run Coefficients

Dependent variable is GDPD n= 46 (1962 -07)				
Regressor	Coefficient	Standard Error	T-Ratio	Prob.
FE	- 0.001	0.00	-4.77	0.00
GDPD(-1)	0.85	0.14	6.01	0.00
GDPD(-2)	0.33	0.16	2.04	0.05
C	-0.29	0.48	-0.59	0.55
R-Squared 0.99		R-Bar-Squared 0.99		
F-stat. F(3,43) 5937		DW-statistic 2.10		

Diagnostic Tests

#	Nature of Test	LM Test			F Test		
		Lags	Cal. Value	Prob.	df	Cal. Value	Prob.
1	Serial Correlation	CHSQ(1)	1.37	0.24	F(1,41)	1.26	0.27
2	Functional Form	CHSQ(1)	0.05	0.82	F(1,41)	0.04	0.84
3	Heteroscedasticity	CHSQ(1)	4.62	0.03	F(1,44)	4.92	0.13

Table 5. Short Run Estimates

Dependent variable is ΔGDPD, n=47 (1961-07)				
Regressor	Coefficient	Standard Error	T-Ratio	Prob.
Δ(FE)	-0.01	0.00	-4.00	0.00
C	-0.18	0.46	-0.38	0.71
ECM(-1)	-0.13	0.02	-7.70	0.00
R-Squared 0.68		R-Bar-Squared 0.65		
F-stat. F(3,43) 29.46		DW-statistic 2.10		

Uncovered Interest Parity and Monetary Policy Freedom in Countries with the Highest Degree of Financial Openness

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Abstract

This study reviews the uncovered interest parity hypothesis in perfectly open economies. To meet the assumption of perfect capital mobility, we only include countries and periods with the highest degree of capital account openness in the sample. Using several specifications from the restricted to the less restricted models, we estimate the relationship among exchange rate, domestic and benchmark interest rates. Regardless of the exchange rate regime, we find evidence that domestic interest rate is highly sensitive to international interest rate. Therefore, monetary policy independence would be affected.

Keywords: Uncovered interest parity, Monetary policy, Exchange rate, Capital account openness

Introduction

Uncovered interest parity (UIP) is an important building block of many theoretical models, but a vast number of empirical tests fail to find supporting evidence (Alper et al., 2009). In addition to the existence of arbitrage, commonly UIP is tested jointly with three more assumptions, i.e. free capital mobility, rational (unbiased) expectation and risk neutrality. The failure of these assumptions may contribute to the failure of UIP test (Montiel, 1994).

First, capital account may not always be as open as assumed. When capital is not freely mobile, exchange rate and interest rate may not adjust to the return differentials. Secondly, UIP may also fail because of the failure of the rational expectation. Because of the data availability, the expected exchange rate is usually set to the *ex-post* exchange rate. If exchange rate is determined by other factors, the use of *ex-post* exchange rate could cause the deviations from UIP. Finally, the different risk perceptions between domestic and foreign interest rates may also influence the evidence.

This study uses several empirical methods to review the UIP concept. The capital account openness assumption could not be tested independently because it is inherent in the UIP concept. Therefore, we limit the sample only for countries and periods with the highest degree of capital account openness to maintain the free capital mobility assumption. Risk neutrality is another component of the UIP. By restricting the sample to ensure capital account openness, we may test the risk neutrality part of the UIP together with the rational expectation.

The rest of the paper is organized as follows. Section 2 presents the methodology. The result and discussion are presented in Section 3. Finally, section 4 concludes.

Methodology and Data

If capital is freely mobile, the existence of arbitrage equates domestic and foreign return. UIP hypothesis can be expressed as the relationship among domestic interest rate (id_t), foreign interest rate (if_t) and expected depreciation (s_{t+1}/s_t):

$$(1+id_t)=(1+if_t)\cdot\frac{s_{t+1}}{s_t} \tag{1}$$

or in logarithmic terms

$$lrd_t = lrf_t + lfx_t \tag{2}$$

where lrd denotes domestic return, lrf is foreign return and lfx is expected depreciation.
We test this relationship using several econometric models as follow:

$$lfx_t = \alpha + \beta\cdot(lrd_t - lrf_t) + \varepsilon \tag{3}$$

$$lrd_t - lfx_t = \alpha + \beta\cdot lrf_t + \varepsilon \tag{4}$$

$$lfx_t = \alpha + \beta_1\cdot lrd_t + \beta_2\cdot lrf_t + \varepsilon \tag{5}$$

$$lrd_t = \alpha + \beta_1\cdot lrf_t + \beta_2\cdot lfx_t + \varepsilon \tag{6}$$

Flood and Rose (2002) and Chinn (2006) estimate Eq. (3) as the test for UIP with the null hypothesis of $\beta = 1$. Foreign exchange market efficiency is the focus of attention. Without reliable estimates of the expected exchange rate, empirical literatures usually use *ex-post* exchange rate. Therefore, this model is testing the joint hypotheses of

UIP and rational expectation. The rejection of the null hypothesis might be caused by several factors. Besides the openness of the capital account, the exchange market inefficiency or other factors may affect the exchange rate movement. Next, there might be different risk perception for the increase of domestic and foreign interest rate. Moreover, if the exchange rate regime is hard peg or credibly managed, the expected depreciation would be zero, constant or exogenously determined by the central bank. In this case, putting the expected depreciation as dependent variable would be inappropriate. Therefore, the cause of the deviation in this specification may vary.

Frankel and Okongwu (1995) employ Eq. (4) to measure the perfect substitutability between domestic and foreign assets with the null hypothesis of $\beta = 1$. In this specification, the focus is on the expected local assets returns. In this specification, expected depreciation is combined into domestic return. In this case, the estimation on the hard peg or managed regime would be possible. However, the problem with rational expectation may still affect the dependent variable.

The last two equations are less restricted than the previous two in the sense that each parameter is allowed to be different. Eq. (5) corresponds to Eq. (3) if we put restriction $\beta_2 = -\beta_1$. The difference is that Eq. (5) allows different impacts of domestic and foreign interest rate. We may obtain evidence of the foreign exchange market efficiency or the rational expectation hypothesis if this specification could establish significant relationship. If the parameters of domestic and foreign interest are different, it may imply the difference in the perceived risk between domestic and foreign interest rates.

Eq. (6) distinguishes the impacts of foreign interest rate and expected depreciation. Eq. (4) corresponds to restriction $\beta_2 = 1$ in Eq. (6). In this sense, we could get the relationship between domestic and benchmark interest rate separately from the expected depreciation. We focus our attention on β_1 and β_2. If domestic interest rates follow the movement of the benchmark rates, β_1 should equal to unity.

In addition, we also apply dynamic specification to estimate short-run and long-run relationships:

$$\Delta lrd_t = \alpha + \beta_1 \cdot \Delta lrf_t + \beta_2 \cdot \Delta lfx_t + \theta \cdot (lrd_{t-1} - \gamma_1 \cdot lrf_{t-1} - \gamma_2 \cdot lfx_{t-1}) + \varepsilon_t \quad (7)$$

In this specification, β indicates the short-run relationship and γ signifies long-run or level relationship. The parameter θ measures speed of adjustment of domestic interest rate towards the long-run equilibrium. If domestic interest rate responds to minimize deviations from the long-run equilibrium, θ should be negative.

This paper employs data from International Financial Statistics of the International Monetary Fund. Additional interest rate data are also obtained from the Central Bank of Denmark and Bank Indonesia. We use monthly money market rates for domestic rates (60B..ZF...) because they reflect the market forces better than other rates. For the benchmark rate, we use U.S. Treasury Bill rate (Note 1). Ex-post exchange rates are used because the appropriate ex-ante expectations of future exchange rates are unobservable. Exchange rates are expressed in terms of domestic currency per U.S. dollars.

As the sample, we choose countries and periods with the highest degree of the openness of the capital account according to KAOPEN index of Chinn and Ito (2008). The sample coverage is dictated by the availability of the data. We include countries with more than nine years of data. The final sample consists of 18 countries. Based on the actual exchange rate following Levy-Yeyati and Sturzenegger (2005) and Frankel et al. (2004), we classify Bahrain, Hong Kong, Indonesia and Lithuania under the managed regime and other fourteen countries under the floating regime.

Result and Discussion

First, we plot domestic interest rates with benchmark interest rates for each country (Figure 1). The periods and scale for each country is different. We only include the periods with the highest degree of capital account openness in each country. From the figure, we may see that the movements of the domestic interest rates are quite similar with the benchmark interest rate in some countries.

The result is presented in Table 1-3. The dataset is the same. Therefore, we only put the information on the period and number of observation in the first table. The standard errors are robust to both heteroskedasticity and autocorrelation. The upper part shows the estimation on a country-by-country basis. The lower part pools the data across countries.

Table 1 presents the results from Eq. (3) and Eq. (4). We start with the Eq. (3) which is commonly used in UIP test. The result is similar with the previous literatures. The coefficients of interest differentials are not significant in almost all countries. Only one has positive and significant value of β. In the pooled analysis, managed regime has positive value of β, while floating regime has marginally significant negative value of β.

Foreign interest rates do not have significant relationships with the domestic returns adjusted for expected depreciation in the next model (Eq. (4)), except in three countries. Two countries are under managed regime, Bahrain with hard peg and Hong Kong with Currency Board System. Another one is Canada with floating regime.

Eq. (5) also fails to provide the expected results (Table 2). Two countries have only weakly significant coefficient of domestic interest, one of them has the incorrect sign. All significant coefficients of the benchmark rate have the incorrect sign. Pooled analysis produces significant parameters, but the sign is also incorrect.

The results of the Eq. (3) and Eq. (5) indicate that foreign exchange market is not efficient or at least does not respond to changes in domestic and benchmark interest rates as expected. The movement of the exchange rate is determined by factors other than interest rates.

The fourth model (Eq. (6)) reveals interesting results. Except for two countries, the coefficient of foreign interest rate is positive and highly significant in all countries. In the pooled estimates, we find that the slopes are not statistically different from unity. The hypotheses of $\beta = 1$ could not be rejected with 5% confidence level. However, the coefficients of exchange rate are not significantly different from zero in all individual countries and pooled estimates.

Table 3 presents the results of dynamic specification (Eq. (7)). All coefficient of the foreign interest rate is positive with 13 out of 18 are significant. Pooled data estimates are also significant and not statistically different from unity in both managed and floating regimes. However, the managed regimes seem to adjust more rapidly with half-life of 1 month compared to the floating regimes with half-life of five months. Moreover, floating regimes have smaller R^2 value than managed regimes. This implies that factors other than the international interest rate have more influence on floating regimes than managed regimes.

Although the objectives and variables are not exactly the same, our results are in line with Frankel et al. (2004) and Shambaugh (2004). They find that interest rates are converging in the long-run, regardless of the foreign exchange regime. The differences between fixed and floating regime are on the adjustment speed and R^2 value.

The results indicate that domestic interest rates follow the movement of benchmark interest rates, but exchange rates do not adjust to this movement. In this case, monetary policy freedom would be affected. However, this should not be interpreted that the expected depreciations do not matter at all. Domestic interest rates may adjust according to the *ex ante* expected depreciation, but may not reflect the *ex post* depreciation. On the contrary, exchange rate may be determined by other factors. Therefore, deviations from the interest rates' predicted value may happen.

Conclusions

This study uses several empirical methods to test the UIP hypothesis. To emulate the perfect capital mobility, we include only countries and periods with the highest degree of capital account openness in the sample. We find that exchange rates do not reflect domestic and international returns. However, we find close long-run relationships between domestic and international interest rates. UIP hypothesis holds in the sense that domestic interest rates adjust to the benchmark interest rate. It applies regardless of the currency regime. Therefore, a complete monetary policy freedom might not be attainable.

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Notes

Note 1. Other benchmark rates, such as U.S. LIBOR dollar rate and Fed Rate, are highly correlated with the U.S. Treasury Bill rate. We also experimented with these rates and the results were similar.

Table 1. Expected depreciation and domestic return adjusted for expected depreciation estimation

				$lfx_t = \alpha + \beta (lrd_t - lrf_t)$					$lrd_t - lfx_t = \alpha + \beta lrf_t$				
No	**Country**	**Period**	**T**	**α**		**β**		**R^2**	**α**		**β**		**R^2**
1	Australia	1988:01 - 1998:12	132	2.95		-0.54		0.002	-3.93		2.14		0.011
				(4.20)		(1.01)			(10.42)		(2.01)		
2	Bahrain	1985:07 - 2006:12	258	0.00		0.00		0.001	0.14	***	1.14	***	0.984
				(.00)		(.00)			(.06)		(.01)		
3	Canada	1975:01 - 2008:06	402	1.03		-0.62		0.004	2.94		0.75	**	0.013
				(1.30)		(.45)			(2.52)		(.33)		
4	Denmark	1992:01 - 2008:06	198	-1.27		-0.38		0.001	13.83	**	-1.98		0.009
				(2.44)		(.98)			(5.97)		(1.49)		
5	Euro	1999:01 - 2008:06	114	-3.73		-4.54	**	0.042	16.01	**	-2.90		0.025
				(2.95)		(2.00)			(6.69)		(1.86)		
6	Germany	1970:01 - 1998:11	347	-3.07		-0.53		0.002	14.28	**	-0.81		0.003
				(2.29)		(.84)			(5.93)		(.85)		
7	Hong Kong	1994:01 - 2008:06	174	0.07		-0.02		0.000	-0.57		1.16	***	0.501
				(.09)		(.05)			(.43)		(.11)		
8	Indonesia	1983:01 - 1995:12	156	5.91		0.49		0.002	6.66		-0.46		0.000
				(3.83)		(.63)			(8.13)		(1.37)		
9	Japan	1983:01 - 1994:12	144	-10.66	***	-2.76		0.019	21.94	**	-1.50		0.007
				(4.08)		(1.80)			(8.95)		(1.40)		
10	Kuwait	1979:01 - 1990:06	138	0.19		-0.44		0.004	7.04		0.09		0.000
				(1.27)		(.56)			(4.66)		(.46)		
11	Lithuania	1998:01 - 2008:06	126	-5.63	***	-0.11		0.000	14.11	**	-1.49		0.012
				(2.13)		(.78)			(5.87)		(1.24)		
12	Malaysia	1982:01 - 1992:12	132	0.93		-0.31		0.005	10.38	*	-0.78		0.014
				(1.71)		(.49)			(5.84)		(.70)		
13	Netherlands	1981:01 - 1998:11	215	-1.86		-1.40		0.009	11.18		-0.58		0.002
				(3.10)		(1.18)			(7.67)		(1.09)		
14	New Zealand	1988:01 - 2008:06	246	0.19		-0.18		0.000	16.24	***	-1.80		0.010
				(4.39)		(1.00)			(5.60)		(1.15)		
15	Peru	1997:01 - 2008:06	138	-1.88		0.55	**	0.031	4.05		0.94		0.009
				(1.73)		(.24)			(2.81)		(.63)		
16	Singapore	1982:01 - 2008:06	318	-3.91	**	-1.60	*	0.011	3.52	*	0.35		0.002
				(1.91)		(.88)			(1.82)		(.32)		
17	UK	1983:01 - 2008:06	306	2.70		-1.44		0.008	6.66		0.38		0.001
				(2.81)		(1.22)			(5.22)		(1.11)		
18	Vanuatu	1986:05 - 1998:12	152	1.35		0.14		0.000	3.74		0.25		0.000
				(3.12)		(1.45)			(8.73)		(1.72)		
Pooled													
	Managed Regime		714	0.38	*	0.37	***	0.041	3.76	*	0.34		0.007
	(4 countries)			(.21)		(.12)			(2.26)		(.49)		
	Floating Regime		2982	-0.62	***	-0.52	*	0.006	8.35	***	-0.16		0.003
	(14 countries)			(.23)		(.27)			(1.58)		(.28)		
	All Countries		3696	-0.25		-0.40	*	0.011	7.56	***	-0.10		0.005
	(18 countries)			(.25)		(.24)			(1.37)		(.25)		

Notes: *, ** and *** represent 10%, 5% and 1% levels of significance, respectively. Standard errors reported in parentheses are robust to heteroskedasticity and autocorrelation.

Table 2. Less restricted specification for expected depreciation and domestic return estimation

		$lfx_t = \alpha + \beta_1 lrd_t + \beta_2 lrf_t$						$lrd_t = \alpha + \beta_1 lrf_t + \beta_2 lfx_t$								
No	**Country**	**α**		**β_1**		**β_2**	**R^2**	**α**		**β_1**		**β_2**		**R^2**		
1	Australia	-4.47		-1.32		3.20	0.006	-3.62	***	2.30	***	-0.01		0.789		
		(12.15)		(1.37)		(3.97)		(1.11)		(.20)		(.01)				
2	Bahrain	0.00		0.00		0.00	0.003	0.15	***	1.14	***	-0.67		0.984		
		(.00)		(.00)		(.00)		(.06)		(.01)		(1.69)				
3	Canada	-1.72		-0.79	*	1.31	** 0.010	0.67	*	1.15	***	-0.01		0.766		
		(2.53)		(.45)		(.59)		(.36)		(.06)		(.01)				
4	Denmark	-10.47		0.14		2.17	0.011	3.89	***	0.22		0.00		0.017		
		(6.85)		(1.04)		(1.52)		(.96)		(.18)		(.01)				
5	Euro	-4.21		-4.39		4.54	** 0.042	2.15	***	0.31	***	0.00		0.319		
		(11.44)		(3.94)		(1.99)		(.26)		(.07)		(.00)				
6	Germany	-11.50	*	0.18		1.14	0.007	3.41	***	0.40	***	0.00		0.176		
		(6.56)		(.97)		(.95)		(.79)		(.10)		(.00)				
7	Hong Kong	-0.10		-0.04		0.08	0.003	-0.66	**	1.21	***	-0.03		0.710		
		(.27)		(.06)		(.10)		(.28)		(.07)		(.05)				
8	Indonesia	-3.14		0.55		0.84	0.005	7.74	***	0.84	***	0.00		0.159		
		(12.30)		(.73)		(.94)		(1.69)		(.29)		(.00)				
9	Japan	-14.96		-2.23		3.01	* 0.020	2.09	***	0.47	***	0.00		0.310		
		(9.70)		(2.31)		(1.76)		(.63)		(.08)		(.00)				
10	Kuwait	-3.78		0.07		0.41	0.009	3.50	***	0.54	***	0.00		0.565		
		(5.18)		(.62)		(.53)		(.67)		(.08)		(.01)				
11	Lithuania	-13.87	**	0.80		1.61	0.026	1.27	***	0.62	***	0.00		0.324		
		(6.57)		(.94)		(1.10)		(.34)		(.12)		(.00)				
12	Malaysia	-4.53		0.08		0.74	0.013	6.36	***	-0.04		0.00		0.002		
		(5.93)		(.57)		(.70)		(1.19)		(.14)		(.02)				
13	Netherlands	-2.39		-1.35		1.43	0.009	3.71	***	0.37	***	0.00		0.194		
		(8.41)		(1.51)		(1.24)		(.98)		(.12)		(.00)				
14	New Zealand	-11.81	**	-0.50		3.49	* 0.028	2.93	***	1.13	***	0.00		0.521		
		(5.55)		(.99)		(1.82)		(.53)		(.13)		(.00)				
15	Peru	-4.16		0.46	*	0.30	0.035	-0.03		2.24	***	0.04		0.384		
		(2.79)		(.27)		(.83)		(.64)		(.30)		(.03)				
16	Singapore	-3.86	**	-1.61		1.60	* 0.011	-0.15		0.75	***	-0.01		0.774		
		(1.79)		(1.21)		(.91)		(.19)		(.04)		(.00)				
17	UK	-1.13		-1.50		2.30	0.011	2.18	***	1.08	***	-0.01		0.540		
		(4.89)		(1.24)		(1.71)		(.55)		(.13)		(.01)				
18	Vanuatu	0.65		0.22		-0.11	0.000	5.63	***	0.19	***	0.00		0.073		
		(10.04)		(1.26)		(1.78)		(.40)		(.05)		(.00)				
Pooled																
	Managed Regime	-2.63		0.37	***	0.29	0.043	1.80	***	1.00	***	0.00	***	0.796		
	(4 countries)	(2.13)		(.14)		(.38)		(.44)		(.10)		(.00)				
	Floating Regime	-5.54	***	-0.35		1.21	*** 0.011	2.06	***	0.78	***	0.00	*	0.493		
	(14 countries)	(1.30)		(.25)		(.22)		(.73)		(.13)		(.00)				
	All Countries	-4.98	***	-0.25		1.10	*** 0.015	2.06	***	0.81	***	0.00		0.581		
	(18 countries)	(1.15)		(.22)		(.20)		(.62)		(.12)		(.00)				

Notes: *, ** and *** represent 10%, 5% and 1% levels of significance, respectively. Standard errors reported in parentheses are robust to heteroskedasticity and autocorrelation.

Table 3. Dynamic specification

		$\Delta lrd_t = \alpha + \beta_1 \Delta lrf_t + \beta_2 \Delta lfx_t + \theta (lrd_{t-1} - \gamma_1 lrf_{t-1} - \gamma_2 lfx_{t-1})$												
No	**Country**	**α**		**β_1**		**β_2**		**θ**		**γ_1**		**γ_2**		**R^2**
1	Australia	-0.37	***	0.78	***	0.00		-0.04	**	3.12	***	-0.05		0.315
		(.13)		(.15)		(.00)		(.02)		(.92)		(.03)		
2	Bahrain	0.06	**	1.05	***	-0.25		-0.42	***	1.13	***	12.82	***	0.481
		(.03)		(.09)		(.88)		(.06)		(.02)		(4.79)		
3	Canada	-0.06		0.03		-0.01	*	-0.27	***	1.29	***	-0.02	**	0.226
		(.11)		(.13)		(.00)		(.07)		(.07)		(.01)		
4	Denmark	0.01		0.03		0.00		-0.03		0.99		-0.04		0.042
		(.08)		(.12)		(.00)		(.04)		(.60)		(.04)		
5	Euro	-0.07	*	0.26	***	0.00		-0.01		5.51		-0.07		0.359
		(.04)		(.08)		(.00)		(.02)		(14.09)		(.22)		
6	Germany	0.28		0.06		0.00		-0.12	***	0.55	***	0.02		0.072
		(.19)		(.10)		(.00)		(.04)		(.13)		(.01)		
7	Hong Kong	-0.48	**	0.66	***	-0.05		-0.61	***	1.24	***	-0.25	**	0.338
		(.19)		(.24)		(.04)		(.14)		(.08)		(.10)		
8	Indonesia	3.69	**	1.11		0.00		-0.48	***	0.84	**	0.01		0.249
		(1.55)		(1.17)		(.00)		(.16)		(.37)		(.01)		
9	Japan	-0.16	**	0.12	*	0.00		-0.04	*	1.41	**	0.01		0.105
		(.07)		(.07)		(.00)		(.02)		(.62)		(.03)		
10	Kuwait	0.52	*	0.41	***	0.00		-0.17	***	0.60	***	0.05	*	0.294
		(.28)		(.10)		(.00)		(.05)		(.18)		(.03)		
11	Lithuania	0.30	*	-0.71		0.00		-0.31	***	0.67	***	0.00		0.187
		(.16)		(.46)		(.00)		(.08)		(.16)		(.01)		
12	Malaysia	0.97		-0.31		0.00		-0.20	***	0.15		0.05		0.112
		(.60)		(.28)		(.01)		(.07)		(.25)		(.05)		
13	Netherlands	-0.07		0.16	***	0.00		-0.02		1.21		-0.04		0.067
		(.13)		(.05)		(.00)		(.02)		(1.05)		(.04)		
14	New Zealand	0.14		0.29	*	0.00	*	-0.05	**	1.02	***	-0.05		0.058
		(.09)		(.15)		(.00)		(.02)		(.29)		(.03)		
15	Peru	-0.15		0.21		-0.01		-0.22	***	2.32	***	0.11		0.143
		(.23)		(.86)		(.01)		(.08)		(.47)		(.08)		
16	Singapore	-0.02		0.23		0.00		-0.14	***	0.75	***	0.04		0.125
		(.06)		(.16)		(.00)		(.04)		(.07)		(.05)		
17	UK	0.07		0.09		0.00		-0.08	***	1.29	***	0.01		0.059
		(.08)		(.18)		(.00)		(.02)		(.23)		(.02)		
18	Vanuatu	0.63	**	-0.26		0.00		-0.11	**	0.17		-0.01		0.052
		(.27)		(.18)		(.00)		(.05)		(.16)		(.02)		
Pooled														
	Managed Regime	0.80	***	0.66	**	0.00	***	-0.46	***	1.01	***	0.00		0.238
	(4 countries)	(.19)		(.32)		(.00)		(.03)		(.10)		(.00)		
	Floating Regime	0.08		0.18	***	0.00		-0.10	***	0.99	***	0.00		0.069
	(14 countries)	(.08)		(.06)		(.00)		(.02)		(.15)		(.01)		
	All Countries	0.20		0.20	***	0.00		-0.15	***	0.93	***	0.00		0.090
	(18 countries)	(.13)		(.07)		(.00)		(.04)		(.13)		(.00)		

Notes: *, ** and *** represent 10%, 5% and 1% levels of significance, respectively. Standard errors reported in parentheses are robust to heteroskedasticity and autocorrelation.

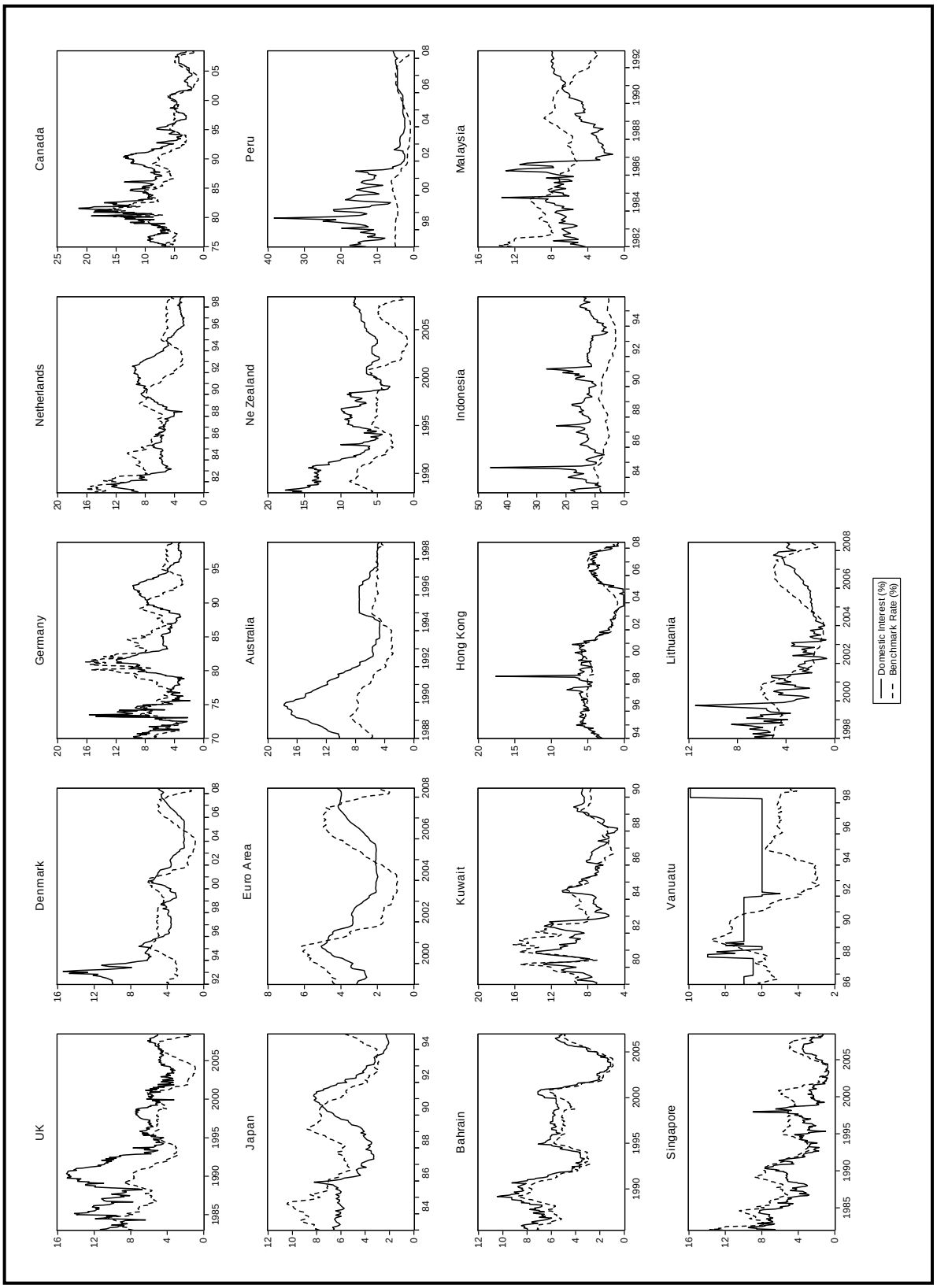

Figure 1. Domestic and Benchmark Interest Rates

Notes: The period and scale for each country are different.

Total Factor Productivity in Food Industries of Iran

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Abstract

Considering to Importance of Food Industries (Priority of the Non-oil Exports in Foreign Trade, respond to Nutrition of population and Prevention of Wastage) This paper examines the levels of labor, total productivity and technical changes in food industries and compare with total industries of Iran over the period of 1971-2006. The results show that labor productivity and total factor productivity in food industries were lower than the average total industries over the period. Also, the estimation of technical changes has shown that the measure of technical change in food industries was 0.09 percent while for total industries was 0.16 percent over the period.

Keywords: Labor Productivity, Total Factor Productivity (TFP), Technical Changes

1. Introduction

The term productivity has been a key concept for national development strategy due to its impact on economic and social development. Today, the concept is not only known by economists and managers, but has all been involved in economic activity. Productivity is a notion that has profound importance in our lives. It can have major effects at the national, industrial and individual levels. At the national level, productive growth accounts for large proportions of growth in the nation's gross national product (GNP) and can help reduce inflation (Kendrick, 1984). At the firm and industry level, an increase in productivity can create competition that can lead to industry and firm growth (Pritchard, 1992). At the individual level, productivity can lead to improvements in the quality of life, increased leisure time and advancement within an organization (Kendrick, 1984; Pritchard, 1992). McGinn (2002) reflected on the impact productivity can have on a person's standard of living. Considering the importance of food industries of Iran, this paper examines productivity in food industries as being compared to total industry of Iran.

1.1Food Industry in Iran

Food industry is recognized as a 'sunrise industry' in Iran, with huge potential for the enlistment of the agricultural economy, creation of large scale processed food, manufacturing, food chain facilities and the generation of employment and export earnings. As a result, this industry is one of the largest industries in Iran. Based on the recent reports (2006) by the Statistical Centre of Iran (SCI), the sector is ranked first in terms of employment (18 percent). Moreover, in terms of value-added, it is ranked third (16 percent).

Furthermore, the development of these industries would increase the demand for agricultural products in food processing and reduce the level of waste**.** The importance equally lies in identifying the strength and the weakness of the food industry in presenting scientific solutions to researchers. It will also assist economic policymakers to reach their program goals quickly. The brief importance of food industries is due to the three important factors; 1) Priority of the Non-oil Exports in Foreign Trade. 2) Respond to Nutrition of population. 3) Prevention of Wastage.

Now the main question is whether all the capacity of this industry has been used. In other words, how is the situation of total productivity in food industry; or what is the state of productivity growth of the food industry in the past 30 years as compared to the present?

2. Literature review

The word "productivity" appeared for the first time in an article by Quesnay (Note 1) in 1766. More than a century later in 1883, Littre defined productivity as the "faculty to produce" and this definition continued to appear in the Larouss dictionary.

In business or industrial context, it is the ratio of output production in relation to input efforts. While there is no disagreement with this notion, a look at productivity literatures and its various applications reveals that there is neither a unique purpose for, nor a single measure of productivity(OECD, 2001).

The economic theory of productivity measurement goes back to the work of Jan Tinbergen (1942;) and independently, to Robert Solow(1957) . These studies formulated productivity measures in a production function context and linked them to the analysis of economic growth:

$Y(t) = (t).\ F[K(t), L(t)]$

Where Y (t) stands for aggregate production (or aggregate income), K (t) is the stock of physical capital used in production, L (t) is the amount of labor inputs, and A (t) is the total factor productivity.

International organizations of productivity (APO & OECD) (Note 2) have attempted to present a practical guide for the measurement of productivity. Their attempt has been used to compare economies in terms of productivity. In recent years, there has been an increasing interest in the examination of productivity from different parts of the economy such as industry, agriculture, and services. Numerous studies have attempted to explain productivity in the economic sector, for example, productivity growth in Swedish manufacturing (Carlsson, 1981), the impact of regional investment incentives on employment and productivity in Canada (Daly, Gorman, Lenjosek, MacNevin, & Phiriyapreunt, 1993), productivity and imperfect competition in Italian firms (Contini, Revelli, & Cuneo, 1992), explaining total factor productivity differentials in urban manufacturing of U.S (Mullen & Williams, 1990).

Total factor productivity growth in manufacturing has been examined by applied parametric and non-parametric approaches. In most of the studies have used non-parametric approach, wherein total factor productivity growth has decomposed into efficiency change and technological change. Efficiency change measures ‘‘catching-up’’ to the isoquant while technological change measures shifts in the isoquant. For example,see Weber and Domazlicky (1999) ;Nemoto and Goto (2005); Yu(2007); (Maniadakis and Thanassoulis (2004) and Radam (2007).

Several researchers used econometric approaches to estimate the level of TFP and growth rate of TFP in manufacturing. In this approach, the growth rate of TFP is measured as the residual growth in value added in manufacturing, after accounting for the contribution of input growth to value added. Lach (1995), Windle and Dresner (1992), Rushdi (2000), Eslava et al (2004), Lam and Lam (2005)and Mollick and Cabral (2009). In these researches, Translog production function and Cobb-Douglas production function form have been applied to estimate TFP growth and estimate the share of production inputs that utilized in index method.

In recent years, several attempts have been made to investigate productivity in different sectors of Iran economics. Most studies in productivity have only been carried out in a sectoral or regional areas of economy, for example; Salimifar (2005) utilized translog production function for computing total factor production growth in Khorasan province industry of Iran. The scholar applied Kendrik index for accounting total factor production level.

Askari et al. (2007) utilized the primer index, Solow index, Kendrik index, Divisia index and Tornvist index to investigate productivity in rural industries of Iran. The intellectuals compared all the production function (Cob-Douglass, Debertin, Translog and CES) and found that the Cob-Douglass production function was suitable for the industry. Bakhshali and Mojtahed (2005) carried out a comparative investigation of technology change on productivity of inputs in the industrial and agricultural sectors. The scholars utilized Cobb-Douglas production function to obtain technology change on productivity and found that the effects of technology change in industrial sector was more than the agricultural sector, technology change for industry and agricultural were 0.04 and 0.03 respectively.

However, given the volume of works done in other countries on the concept of productivity, much work still needs to be done within the Iranian context. So far these studies have only been applied to investigate productivity in total industries. On the other hand, lack of research related to productivity in food industry of Iran has existed as a problem for many years. To fill the existing gap discovered within the Iranian context, the current study will examine productivity in food industry of Iran.

3. Methodology

The objective of this paper is identifying place of food industries in term of productivity compared to total industry, Therefore, at first index method will be applied to measure total productivity levels and then will utilize econometrics method for estimation of TFP growth.

As said, production function expresses output as a function of the stock capital, employment, and a shift factor (t), time, where the latter proxies the effects of productivity and technical progress. The subscript t also represents time.

$$Q_t = F(K_t, L_t, t) \tag{1}$$

Assume that the argument “t” is separable from K and L;

$$Q_t = A_t F(K_t, L_t) \tag{2}$$

This way, A_t is referred to as exogenous, disembodied, and Hicks-neutral technical progress, and was measured by how output changes and time elapses with the input bundle held constant. Therefore, the notion of overall productivity can be reinterpreted as an index of all those factors other than labor and capital not explicitly accounted for but contributed to the generation of output.

$$A_t = \frac{Q_t}{F(K_t, L_t)} \tag{3}$$

3.1 Kendrick Index

Kendrick's index of total factor productivity for the case of value added as output, and two inputs can be written as:

$$A_t = \frac{V_t}{F(rK_t, wL_t)} \tag{4}$$

Where;

A_t is the value of index in a given year,

T_V is the added value; *w* and *r* denote the factor rewards of labor and capital respectively in the base year.

3.2 Parametric Approach

Parametric approach consists in econometric estimation of production functions to infer contributions of different factors and of an autonomous increase in production over time, independent of inputs. This later increase which is a shift over time in the production function, can be more properly identified as technological progress. It is one of the factors underlying productivity growth. Below commonly used specifications of production functions are given.

Cobb-Douglas Specification:

$$Q = A_0 e^{\lambda t} K^{\alpha} L^{\beta} \tag{5}$$

Where, Q, L, K and **t** refer to output, labor, capital and time. α, and β give factor shares respectively for labor and capital. A_0 describes initial conditions. Technological change takes place at a constant rate λ. It is assumed to be disembodied and Hicks-neutral, so that when there is a shift in the production function, K/L ratio remains unchanged at constant prices. Log-linear form this function can be written as:

$$\ln Q = \ln A_0 + \lambda t + \alpha \ln K + \beta \ln L \tag{6}$$

4. Data sources

Annual data on output, value added, capital and labor for the food industries and total industries in two-digit were compiled for the period 1971–2006 from the *Annual Survey of Manufacturing Industries* published by the Statistical Centre of Iran. The variables were deflated by using price index of each group on the base year 1997 that published by Central Bank of Iran.

5. Empirical results

The levels of productivity between food industries and total industries are obtained by using Kendrick Index as exhibited on the equations below:

$$TFP_t^{food} = \frac{V_t^{food}}{INPUT_t^{food}} \tag{7}$$

$$TFP_t^{tootal} = \frac{V_t^{tootal}}{INPUT_t^{tootal}} \tag{8}$$

Where, Q_t^{food} is added value of food industries and Q_t^{total} is added value of total industries in term of fix price (1997). $INPUT_t^{food}$ and $INPUT_t^{total}$ are value all used input in the food industry. The levels of productivity between food industries and total industries are summarized in Table (1). Also trend of total productivity and labor productivity illustrated in figures (1&2).

The results of this study indicate that total factor productivity in food industries has been much lower than total industries (see figure 1), while labor productivity in food and total industries has been very close together, except that in recent years, total industries have been higher food industries (see figure 2).

To estimate of technological changes although panel data existed for food industries but due to lack of panel data for total industries, we have to use time series data for our estimations.

The Cob-Douglass production function form is applied for food industries as:

$$\ln Q_t^{food} = \alpha_0 + \alpha_1 \ln K_t^{food} + \alpha_2 \ln L_t^{food} + \gamma^{food} t \tag{9}$$

And for total industries as:

$$\ln Q_t^{total} = \alpha_0 + \alpha_1 \ln K_t^{total} + \alpha_2 \ln L_t^{total} + \gamma^{total} t \tag{10}$$

Where, Q_t^{food} is output of food industries and Q_t^{total} is output of total industries in the period 1971–2006.

The estimation of value of λ^{food} and λ^{total} are 0.09 percent and 0.16 percent for food and total industries respectively;

Ln Q^{food}=-186+0.52K^{food}+0.91L^{food}+***0.09t***

R-squared=0.99 t: (5.2) (3.5) (3)

Ln Q^{total}=-333+0.24K^{total}+1.2L^{total}+***0.16t***

R-squared=0.99 (1.8) (3.3) (4)

The results of the estimation show that Technological changes in food industries have been lower than total industries over the 1971-2006 periods.

In general all results show that the productivity and Technological changes in food industries of Iran are not satisfactory and acceptable. This study was aimed to find out the reasons for this egregious difference between food and total industry of Iran in terms of labor productivity, total productivity and Technological changes.

Several reasons have been found for this problem; one of the findings was that the capital per worker in food industry was lower than the total industry in 1995-2005 periods (see Table and Figure 3). The capital per worker has a positive relationship with labor and total productivity. The low capital per worker causes a decrease in productivity. Another reason for having low productivity in food industry was that the ratio of women workers to men workers in food industry was higher than total industry (See Table 3 and Figure 4). According to empirical evidences female employees' productivity is generally less than male employees' productivity (Verner, 2000), (Crepon, Deniau, & Perez-Duarte, 2002), (Kawaguchi, 2003) and (Liqin & Xiao, 2006).

Finally, the differences between the educated workers in food industry and total industry can be one of the reasons for differential productivity in food and total industry (see Table 3 and Figure 5). Table 3 and Figure 4 show that the educated workers in food industries are less than in total industries in the overall period of 1995-2006. According to human capital theory, a higher education yields a higher productivity (Schultz, 1960). Empirical evidences related to human capital have proven this theory (Ballot, Fakhfakh, & Taymaz, 2001), (Stephan & Szalai, 2003), (Takii, 2003), (Lorraine, Reed, & Reenen, 2006) and (Biesebroeck, 2007).

6. Conclusion

In conclusion, the importance of food industries, i.e. Priority of the Non-oil Exports in Foreign Trade, Respond to Nutrition of Population and Prevention of Wastage, and lack of research related to productivity in food industry of Iran have led to this study on the productivity in food industry of Iran over the 1971-2006 periods. The examination of the levels of labor productivity, total productivity and technical changes in food industries and compared with the total industries of Iran showed that labor productivity and total factor productivity in food industries were lower than the average total industries over the period. Also the estimation of technical changes show that the measurement of technical change in food industries was 0.09 percent while for total industries was 0.16 percent over the period. There have been several reasons for this egregious difference between the food and total industry of Iran in terms of labor productivity, total productivity and Technological changes. The reasons were due to lower capital per worker, lower educated workers and higher women workers in food industry in respect to total industry.

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Notes

Note 1. Larouse Etvmological Dictionary, 1946-49 Edition.

Note 2. Asian Productivity Organization (APO). Organization for Economic Co-Operation and Development(OECD)

Table 1. labor productivity and TFP in food and total industries (fixed price)

Year	Labor productivity		Total productivity	
	Food Industry	Total Industry	Food Industry	Total Industry
1971	0.419074	0.418037	0.143398	0.829021
1972	0.547322	0.386809	0.136641	0.543355
1973	0.592461	0.389315	0.160119	0.595152
1974	0.452931	0.377472	0.100047	0.53501
1975	0.451063	0.407327	0.104893	0.548073
1976	0.596606	0.481387	0.135962	0.65074
1979	0.360781	0.363538	0.118259	0.758586
1980	0.353418	0.393839	0.154295	1.053975
1981	0.405762	0.43764	0.153766	1.071234
1982	0.363855	0.343862	0.14741	0.883038
1983	0.341752	0.359971	0.130723	0.88424
1984	0.307335	0.355228	0.115829	0.901605
1985	0.337856	0.333989	0.138331	0.930905
1986	0.271882	0.260908	0.091822	0.554662
1987	0.212396	0.231035	0.091146	0.628634
1988	0.307694	0.260323	0.098914	0.579632
1989	0.250194	0.244317	0.095668	0.630191
1990	0.61794	0.590208	0.153284	1.023927
1991	0.386334	0.372798	0.128583	0.884586
1992	0.338733	0.366721	0.102741	0.795847
1993	0.43567	0.387642	0.126332	0.772406
1994	0.430933	0.400857	0.105558	0.727541
1995	0.326485	0.334088	0.095639	0.659666
1996	0.315638	0.370592	0.091565	0.719743
1997	0.352647	0.428602	0.090005	0.758803
1998	0.368705	0.414514	0.095418	0.730456
1999	0.379319	0.455628	0.09742	0.774861
2000	0.353902	0.49906	0.078792	0.737476
2001	0.350024	0.543125	0.071333	0.7382
2002	0.405686	0.546085	0.07258	0.678622
2003	0.389732	0.622189	0.058277	0.625237
2004	0.378778	0.695975	0.048675	0.593204
2005	0.440355	0.740551	0.055071	0.593145
2006	0.466378	0.891648	0.050571	0.60538

Table 2. the estimated coefficients model(9 and 10)

TYPE	Total Industries		Food Industries	
Variables	Coefficient	Prob	Coefficient	Prob
YEAR	0.165844	0.0004	0.091940	0.0068
LNCAPITAL	0.244035	0.0807	0.522019	0.0000
LNLABOR	1.213964	0.0022	0.914750	0.0015
C	-333.8040	0.0003	-185.9852	0.0047
R-squared	0.994893	F-statistic=1363.675	0.997627	F-statistic=2942.976

Table 3. Comparison the effective factors on productivity in food and total industries of Iran

FACTORS	WOMEN/MEN WORKERS		EDUCATED/TOTAL WORKERS		CAPITAL/WORKER	
YEAR	TOTAL	FOOD	TOTAL	FOOD	TOTAL	FOOD
1995	0.071814	0.092859	0.265471	0.214457	96.54142	92.64408
1996	0.070085	0.09036	0.277107	0.226396	84.77112	78.5319
1997	0.070125	0.087929	0.292787	0.235041	80.19843	74.37536
1998	0.068223	0.091879	0.31661	0.252782	76.33469	69.67883
1999	0.071078	0.103979	0.343219	0.280705	69.67883	61.47476
2000	0.072707	0.101422	0.373005	0.311306	54.23188	48.35162
2001	0.079981	0.113459	0.407039	0.33113	49.52076	44.94791
2002	0.078599	0.108372	0.438666	0.376091	44.81377	41.0496
2003	0.089058	0.127317	0.475007	0.403963	42.63445	36.46586
2004	0.096438	0.139236	0.506575	0.440129	44.85096	39.20174
2005	0.098199	0.144939	0.531632	0.470181	46.96252	38.7642
2006	0.103634	0.152379	0.578338	0.503228	55.34027	42.47298

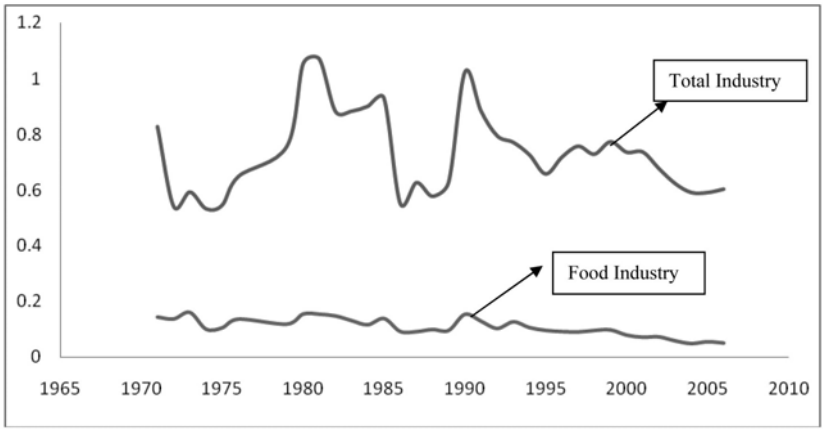

Figure 1. Total factor productivity in food industries and total industries

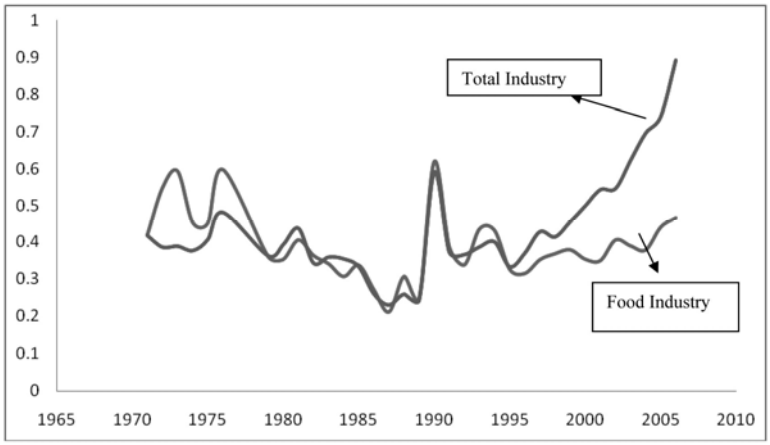

Figure 2. Labour productivity in food industries and total industries

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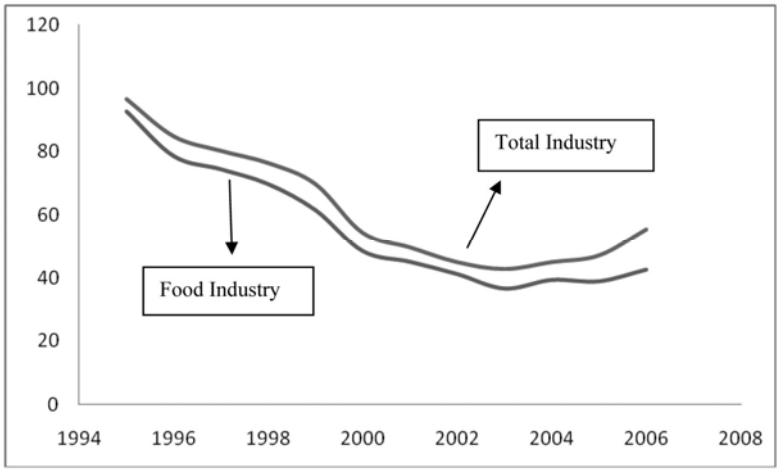

Figure 3. Capital per worker in food and total industries of Iran

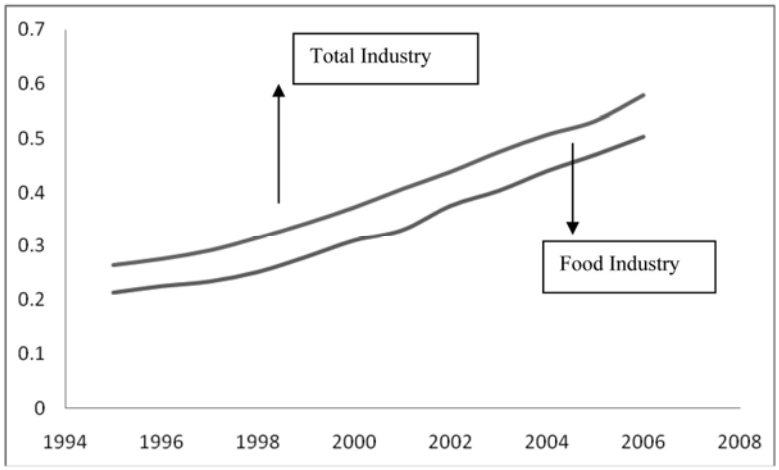

Figure 4.The ratio of educated workers to total workers

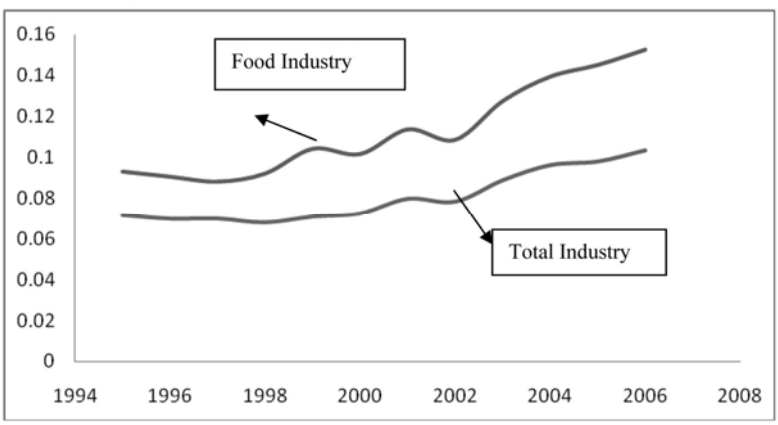

Figure 5.The ratio of women workers to men workers

Evidence on a New Stock Trading Rule that Produces Higher Returns with Lower Risk

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Abstract

This new stock market trading rule uses three steps to remove random unsystemic risk from stock price data to smooth volatility. Proving empirically that a technical analysis relative maxima and minima trading rule for an S&P 500 Index portfolio substantially beats a naïve buy-and-hold policy, at significantly lower risk. Calling key theories in economics and finance into question. The new trading rule succeeds because of market participants' emotions. Investor fear and panic selling plunges stock prices downward below equity intrinsic values at market bottoms. Investor greed brings prices above equity intrinsic values at market tops.

Keywords: Stock market, Rational expectations theory, Efficient market theory, Technical analysis

1. Introduction

This research empirically tests the Rational Expectations Theory (RET) and the Efficient Market Theory (EMT), key theories in economics and finance. The important question is, are markets efficient? If markets are inefficient, a key premise becomes questionable.

Existing research on the efficiency of the United States (US) stock market—using either statistical inference or trading rules—is inconclusive. This empirical research on a new technical analysis relative maxima and minima trading rule tests the RET and EMT—and is the first to report in the literature, clear evidence of substantially beating the US stock market at significantly lower risk—over 81 years of data. Calling the RET and EMT into question.

The rest of the paper's organization is as follows: Section 2 discusses the relevant literature. Section 3 explains the new stock trading rule. Section 4 presents the data selection and research method. Section 5 analyses the empirical results while Section 6 offers final remarks.

2. Literature Review

Is the US stock market efficient? The Rational Expectations Theory (RET) (Muth, 1961), and (Lucas, 1972) and the Efficient Market Theory (EMT) (Samuelson, 1965) and (Fama, 1965, 1970) define efficient markets and are the dominant theories in economics and finance (Fama, 1991, 1998), (Malkiel, 2005), and (Peress, 2010).

A major RET tenet—supporting the EMT—assumes organizations and individuals who engage in an institutional marketplace, even when their decisions and actions are irrational, produces systemically correct markets. The marketplace produces rational results through the regulating influence of other rational participants. A critique of this RET assumption points out that it does not maximize utility for rational investors who understand irrational market forces and decide the current price trend advance does not match market fundamentals. And—based on correct timing—want to make more money during the market run-up and get out of the stock market or go short—at the correct time—before the market plummets downward (Graham, Harvey, and Huang, 2009).

The EMT defines markets as: 1) being in equilibrium and if unexpected events cause disequilibrium, it is only temporary, markets are self-equilibrating; 2) asset prices "fully reflect" all available information, properly represent each asset's intrinsic value, and as a result, prices are always accurate signals for capital allocation; and 3) stock prices move randomly or are uncorrelated with, if not independent of the prior period's price change. So, beating the stock market is impossible to achieve using either technical analysis or stock charts. Therefore, says the EMT, if investors want to earn more money than the stock market, they have to take on more risk. This research empirically tests this third EMT tenet.

Grossman and Stiglitz (1980) challenge tenet number one. A stock market always in equilibrium and efficient is impossible because traders have different endowments, beliefs and preferences. Arbitrage costs throw markets out of equilibrium, making markets necessary which calls the EMT into question. The current credit crisis and the US government's use of anywhere from $3-to-$24 trillion taxpayer dollars and Federal debt guarantees to stabilize the financial system is a recent real-life example that markets are not self-equilibrating.

In tenet number two, of the EMT's definition of markets—that stock prices "fully reflect" all information—has long been challenged in the literature (Ball and Brown, 1968). Post-earnings-announcement drift survives robustness checks, including extensions to more recent data. Bernard and Thomas (1990) study earnings announcements and find evidence of three-day abnormal return predictability, based on one-to-four prior quarterly earnings announcements. Gift, Gift and Yang (2010) report the stock market responds only gradually to new information.

Critiques in the literature of the EMT's tenet number two—of asset prices always being at their intrinsic values and accurate signals for correct capital allocation—stress that this EMT assumption does not account for human nature and inherent herding behavioral instincts. Where speculating occurs in response to the madness of crowd behavior rather than on market fundamentals, resulting in market bubbles (Shiller, 2000), (Blasco and Ferreruela, 2008), and (Hsieh, Yang and Yang, 2010). The Technology Bubble in 2000, the Oil Bubble in July, 2008, as well as many bubbles throughout history (i.e., John Law's Mississippi Scheme, the South Sea Bubble and Holland's Tulip Mania) and now the Real Estate Bubble. Where nationally, US home prices have on average declined about 30% since June, 2006, with a further weakening in home prices expected. Are compelling real-life examples that market bubbles do occur and that market prices cannot always be counted on for correct capital allocation.

Lo and MacKinlay (1988) challenge tenet number three—that stock prices follow a random walk. Rosenberg and Rudd (1982), Ashley (1986), and Summers (1986) test and critically question the serial independence of stock prices. The risk and return of individual company common stock prices are compared with a buy-and-hold benchmark S&P 500 Index portfolio and presented in the literature (Basak, Jagannathan and Ma, 2009), but—on market efficiency—researchers report uncertain results.

Trading rules in the literature also examine tenet number three. Curcio, Goodhart, Guillaume and Payne (1997) test filter rules, reporting poor to average daily return results. Sullivan, Timmermann and White (1999) test 7,846 trading rules, including moving averages, support and resistance, filter rules, channel breakouts, benchmark, span-of-the-trading rules and on-balance volume averages—on Dow Jones Industrial Average data over 90 years—and report inconclusive results. Lento (2009) tests nine trading rules on data from fifteen of the largest global equity markets, reporting indefinite results. The existing research does NOT convincingly evaluate the third EMT tenet for the US stock market, until now.

Scientific testing of the third EMT tenet takes place in this research—using a new technical analysis relative maxima and minima trading rule to make buy and sell decisions, consistently applied over 81 years. This empirical research shows how to beat, by a wide margin, the US stock market (i.e., a naïve buy-and-hold policy) at significantly lower risk. Calling the RET and EMT into question.

3. New Stock Trading Rule

The underlying motivation for this new technical analysis trading rule comes from Edwards, Magee, and Bassetti (2001). Investors use a 200-day simple moving average (SMA) trend line to identify the long-term direction of the stock market. If up-trending, a bull market and investing in equities is the correct choice. If down-trending, a bear market and NOT investing in equities is the correct choice. This study uses monthly data, the nine-month SMA trend line is close to the 200-day duration. The 50-day SMA trend line is used for crossovers and penetrations, to decide turning points in the long-term direction of the stock market. With monthly data, the two-month SMA trend line is close to the 50-day duration.

Using calculus, the nine and two-month SMA trend lines are converted into a mathematical model. Nine and two-month SMA trend lines are NOT used with individual company common stock price data, because of individual stock's random unsystemic risk behavior. But rather, only with the steady, systemic market risk of large company, capitalization-weighted, well diversified S&P 500 Index portfolios.

3.1 Relative Maxima: Sell Stock

To identify a change in the long-term uptrend in the stock market, the first derivative (f') of the S&P 500 Index portfolio B nine-month SMA trend line function $f(L_9)$ is calculated immediately after the close of trading on the last trading day of each month—at time t. The S&P 500 Index nine-month SMA trend line function $f(L_9)$ is increasing and positive when its first derivative is greater than zero:

$$f'(L_9) > 0 \tag{1}$$

The transition from topping or rounding over to a long-term downtrend is identified by finding the relative maxima for the S&P 500 Index nine-month SMA trend line function $f(L_9)$, where its first derivative $f'(L_9) > 0$ changes to a negative slope:

$$f'(L_9) < 0 \tag{2}$$

Find:

$$m_9 \leq \tan(355°), \text{ at time t} \tag{3}$$

Equation (3) is valid when the S&P 500 Index nine-month SMA trend line function $f(L_9)$ slope (m_9), at time t, is less than or equal to the slope of a 355 degree tangent line. A transition from topping or rounding over to long-term downtrend is partially confirmed and subject to the following two conditions—both of which are needed for the "relative maxima: sell stock" decision to be declared.

Subject to,

First:

$$m_2 \leq \tan(353°), \text{ at time t} \tag{4}$$

Equation (4) is valid when the S&P 500 Index two-month SMA trend line function $f(L_2)$ slope (m_2), at time t, is less than or equal to the slope of a 353 degree tangent line. A "relative maxima: sell stock" transition from topping or rounding over to long-term downtrend is partially confirmed, and:

Second:

$$X_1 \text{ and/or } X_2 \leq f(L_9), \text{ for month t} \quad (5)$$

X_1 is the opening S&P 500 Index price for month t, while X_2 is the closing price for month t. When either the opening price for month t or the closing price for month t—or both the opening and closing prices for month t—are less than (below) or equal to the S&P 500 Index nine-month SMA trend line function $f(L_9)$, equation (5) is valid.

A transition from topping or rounding over to a long-term downtrend is confirmed for the S&P 500 Index portfolio B nine and two-month SMA trend lines when equations (2), (3), (4) and (5), for month t, are all valid. A "relative maxima: sell stock" decision is declared. All portfolio B shares are redeemed from the S&P 500 Index no-load mutual fund and invested in the risk-free 3-month Treasury bill (T-bill) interest bearing account, at the close of trading on the first trading day of the following month (i.e., t + 1).

3.2 Relative Minima: Buy Stock

To identify a change in the long-term downtrend in the stock market, the first derivative (f') of the S&P 500 Index portfolio B nine-month SMA trend line function $f(L_9)$ is calculated immediately after the close of trading on the last trading day of each month—at time t. The S&P 500 Index nine-month SMA trend line function $f(L_9)$ is decreasing and negative when its first derivative is less than zero:

$$f'(L_9) < 0 \quad (6)$$

The transition from accumulation or bottoming to a long-term uptrend is identified by finding the relative minima for the S&P 500 Index nine-month SMA trend line function $f(L_9)$, where its first derivative $f'(L_9) < 0$ changes to a positive slope:

$$f'(L_9) > 0 \quad (7)$$

Find:

$$m_9 \geq \tan(5°), \text{ at time t} \quad (8)$$

Equation (8) is valid when the S&P 500 Index nine-month SMA trend line function $f(L_9)$ slope (m_9), at time t, is greater than or equal to the slope of a five-degree tangent line. A transition from accumulation or bottoming to long-term uptrend is partially confirmed and subject to the following condition which is needed for the "relative minima: buy stock" decision to be declared.

Subject to,

$$\text{If (2), (3), (4) and (5) at time t; then } f`(L_9) < 0, \text{ for months t + 1 and t + 2} \quad (9)$$

Once a transition from topping or rounding over to a long-term downtrend is confirmed as valid, for month t, that declaration shall remain in force for the next two months (i.e., t + 1 and t + 2), defining a negative slope for $f`(L_9)$. At stock market peaks, $f`(L_9)$ can fluctuate: down, up, down. Therefore, a "relative minima: buy stock" decision should not be declared within two months of a "relative maxima: sell stock" declaration.

A transition from accumulation or bottoming to a long-term uptrend is confirmed for the S&P 500 Index portfolio B nine and two-month SMA trend lines when equations (7), (8) and (9), for month t, are all valid. A "relative minima: buy stock" decision is declared. All portfolio B funds are taken from the risk-free 3-month T-bill interest bearing account and invested in the S&P 500 Index no-load mutual fund, at the close of trading on the first trading day of the following month (i.e., t + 1).

Once the long-term stock market trend is identified—dependent on the S&P 500 Index portfolio B "relative maxima: sell stock" or "relative minima: buy stock" trading rule declarations—there is a higher likelihood the long-term stock market trend will continue, either upward or downward.

3.3 Flowchart: New Stock Trading Rule Method

A flowchart of the relative maxima and minima trading rule's method is drawn in Figure 1. Portfolio B: relative maxima and minima trading rule flowchart. This diagrams how the relative maxima and minima trading rule equations decide when to move actively managed portfolio B from the S&P 500 Index no-load mutual fund to the risk-free 3-month T-bill interest bearing account, and back.

The portfolio B switching program is run in Figure 1, between the overall starting and ending points of this empirical research, once the starting and ending investment positions for this study are established. The beginning point of this study is January 3, 1928, the stock market was then up-trending (equation (1) $f'(L_9) > 0$). Therefore, both portfolios A and B begin this study originally invested in S&P 500 Index no-load mutual funds. At this study's

conclusion, on December 31, 2008, all portfolio A and B S&P 500 Index no-load mutual fund shares or 3-month T-bills are redeemed for cash—for comparison purposes.

To explain relative timing labels: this month's data is at time t, last month's data is t-1and next month's data is t+1. When next month's new data becomes available, that is now the data at month t, and this month's data becomes one-month old and labeled, t-1. A detailed description of what occurs in Figure 1 standard flowchart symbols—each month the portfolio B switching program is run—follows:

Start Program, for Month t.—Immediately after the close of trading on the last trading day of month t—the relative maxima and minima trading rule program is run. Go to the NEXT STEP.

Enter New Data, for Month t.—Enter, after the close of trading on the last trading day of month t, the new month's open, high, low and closing prices for the S&P 500 Index. Go to the NEXT STEP.

Has the Stock Market Been Up-Trending?—If YES, the S&P 500 Index nine-month SMA trend line function $f(L_9)$ has been increasing and positive, its first derivative has been greater than zero: (1) $f'(L_9) > 0$, for t-1. Resulting in portfolio B being invested during the prior month in the S&P 500 Index no-load mutual fund. When portfolio B has been invested at t-1 in the S&P 500 Index no-load mutual fund, Go to the NEXT STEP.

Equations: Are (2), (3), (4) and (5) Valid?—If YES, a transition from topping or rounding over to a long-term downtrend is confirmed for portfolio B. Based on the nine and two-month SMA trend lines and the opening and closing prices for month t. From here, a "relative maxima: sell stock" decision is declared. Go to the NEXT STEP.

Switch Portfolio B from Investing in the S&P 500 Index Into 3-month T-bills.—All portfolio B shares are redeemed from the S&P 500 Index no-load mutual fund and invested in interest bearing, risk-free 3-month T-bills—at the close of trading on the first trading day of the following month (i.e., t + 1). Go to End Program for Month t.

Equations: Are (2), (3), (4) and (5) Valid?—If NO, no investment change decision is made, for month t. Portfolio B remains invested in the S&P 500 Index no-load mutual fund. Go to End Program for Month t.

Has the Stock Market Been Up-Trending?—If NO, the S&P 500 Index nine-month SMA trend line function $f(L_9)$ has been decreasing and negative, its first derivative has been less than zero: (6) $f'(L_9) < 0$, for t-1. Resulting in portfolio B being invested during the prior month in interest bearing, risk-free 3-month T-bills. When portfolio B has been invested at t-1 in interest bearing, risk-free 3-month T-bills, Go to the NEXT STEP.

Down-trending Stock Market.—The stock market was down-trending at t-1. When portfolio B has been invested at t-1 in interest bearing, risk-free 3-month T-bills, Go to the NEXT STEP.

Equations: Are (7), (8) and (9) Valid?—If YES, a transition from accumulation or bottoming to a long-term uptrend is confirmed for the S&P 500 Index portfolio B nine-month SMA trend line for month t—and a "relative maxima: sell stock" decision has not been declared within the last two months. From here, a "relative minima: buy stock" decision is declared. Go to the NEXT STEP.

Switch Portfolio B from Investing in 3-month T-bills Into the S&P 500 Index.—All portfolio B funds are taken from the risk-free 3-month T-bill interest bearing account and invested in the S&P 500 Index no-load mutual fund—at the close of trading on the first trading day of the following month (i.e., t + 1). Go to End Program for Month t.

Equations: Are (7), (8) and (9) Valid?—If NO, no investment change decision is made, for month t. Portfolio B remains invested in interest bearing, risk-free 3-month T-bills. Go to End Program for Month t.

End Program, for Month t.—Program stops, for month t.

4. Data and Method

4.1 S&P Index Services Data: 1928 through 2008

S&P Index Services supply the S&P 500 Index open, high, low and closing price data. The price data set—as received—begins in 1928 and goes through 2008. This research uses the entire data set from S&P Index Services. Nine and two month simple moving average (SMA) trend lines are fit to the supplied data.

Using a long-term study of 81 years assures that stock market data are collected during normal times. As well as when the stock market is either panicking, and plunging lower under duress—or booming and surging higher with confidence—because of either fear or greed controlling investors' emotions (Lo, 2002).

Two identical S&P 500 Index mutual funds are used, both with beta values equal to one ($B = 1$). Representing only steady, systemic market risk. S&P 500 Index portfolio A is the buy-and-hold benchmark. Actively managed S&P 500 Index portfolio B uses only the S&P 500 Index nine and two-month SMA trend lines and technical analysis model—consisting of the new relative maxima and minima trading rule—to decide when to be either invested in the stock market or out and invested in interest bearing, risk-free 3-month T-bills.

4.2 Dividend and Interest Payments

When portfolios A and B are invested in the S&P 500 Index, they both receive identical dividend payments. For this study, no accounting for either portfolio's accrued dividends is made during these concurrent time periods in the

stock market. When portfolio B is transferred out of the stock market into an interest bearing account, the interest earned is at the risk-free 3-month T-bill rate. Therefore, a determination of whether 3-month T-bill interest rates are either higher or lower than S&P 500 Index dividend yield payments is needed.

Over this empirical study from January 3, 1928 to December 31, 2008 (i.e., 972-months), S&P 500 Index dividend yields average 3.98%, based on S&P 500 Index historical annual dividend data supplied by S&P Index Services. During the same time period, 3-month T-bill interest rates average 3.70%, based on data from the Federal Reserve Statistical Release. Average 3-month T-bill interest rates less than S&P 500 Index dividend yields are expected over the entire 972-month planning horizon, given the risk-free nature of T-bills. However, the timing of dividend and interest payments concern investors.

S&P 500 Index dividend yields and 3-month T-bill interest rates fall into two distinct main phases. The first phase is from 1928 through 1959, S&P 500 Index dividend yields average 5.28% and 3-month T-bills average 1.02%. Beginning in 1960, a marked shift in corporate dividend governance lowers dividend yields and at the same time events in the economy increase 3-month T-bill interest rates. During the second phase—from 1960 through December 31, 2008—S&P 500 Index dividend yields average 3.12% and 3-month T-bill interest rates average 5.46%.

From 1928 through 1959, portfolio B is at times out of the S&P 500 Index no-load mutual fund and invested at the risk-free 3-month T-bill interest rate. Dividends accrue to the buy-and-hold S&P 500 Index portfolio A at the dividend yield to interest rate differential of 4.26% (i.e., 5.28% - 1.02%) each year or 0.00355 each month. The number of S&P portfolio A shares increase by dividing the dividend-interest differential earned by the S&P 500 Index share price, when the S&P portfolio B portfolio is reinvested.

Similarly—from 1960 through 2008—when portfolio B is periodically out of the S&P 500 Index no-load mutual fund and invested at the risk-free 3-month T-bill interest rate. Interest accrues to portfolio B at the interest rate to dividend yield differential of 2.34% (i.e., 5.46% - 3.12%) each year or 0.00195 each month. The number of portfolio B shares increase by dividing the interest-dividend differential earned, by the S&P 500 Index share price, when portfolio B is reinvested in the S&P 500 Index no-load mutual fund.

4.3 Why Statistical Tests Are Not Used, and the New Trading Rule Is

When using statistical analysis to test whether individual company common stock price data are independent, it is difficult to distinguish between a rootless series and one where the steady systemic quality is faint. Summers (1986) estimates that 5,000 years of data are needed to identify independence. Five thousand years of market data are unavailable. Thus, this study does NOT use statistical inference. Instead, this paper's empirical research method directly tests stock market price independence using technical analysis. The relative maxima and minima trading rule determines whether profits are greater than a benchmark naïve buy and hold policy which Fama (1965, 1995) calls, "an equally valid scientific method versus statistical inference."

The technical analysis relative maxima and minima trading rule decides when portfolio B should be either in a S&P 500 Index no-load mutual fund, or out, and invested in interest bearing, risk-free 3-month T-bills. The new technical analysis trading rule is the primary difference between this research and the statistical inference and trading rule papers found in the referenced RET and EMT research.

4.4 EMT Theorists' Concerns Addressed

The anomalies and direct challenges to the EMT in the referenced literature seem convincing, but have failed to satisfy EMT theorists (Fama, 1998) and (Malkiel, 2003). Their concerns are: 1) stock selection bias; 2) not adjusting returns based on greater security risk; 3) not calculating economic gains once transaction costs are considered; 4) not properly accounting for bid-ask spreads and a bias in recording prices; 5) not using a naïve buy-and-hold control portfolio for comparison purposes; 6) survivorship bias; 7) not testing for consistency over a long-duration time period; and 8) data-snooping biases.

EMT theorists' concerns are specifically addressed in the design of the empirical testing method and technical analysis relative maxima and minima trading rule used in this research, as follows:

Random unsystemic risk, associated with individual company common stock prices, is removed from the research data and only steady, systemic market risk remains when comparing this empirical study's two S&P 500 Index portfolios. Thus, active portfolio management selection bias of an individual company common stock is impossible in this research.

The S&P 500 Index buy-and-hold portfolio is portfolio A. The technical analysis relative maxima and minima trading rule S&P 500 Index portfolio is portfolio B. The beta value of the trading S&P 500 Index portfolio B—providing excess returns—never exceeds the beta value for the S&P 500 Index buy-and-hold portfolio A. Therefore, there is no need to adjust returns based on greater risk.

No-load mutual fund transaction costs are zero, for both S&P 500 Index portfolios A and B.

The bid-ask spread and whether closing prices can be realized are NOT issues in this research. Because, no-load mutual fund companies calculate their net asset values at the trading day's close which is the trading point in this

study. In addition, the buy or sell trading signal is given one business day before the stock mutual fund trading day in this empirical research, allowing enough time to make the trade. Thus, a bias in recording prices is impossible.

The S&P 500 Index has long been employed as a control benchmark by researchers to evaluate specific portfolio selection methods. As an important variation in this empirical research, two S&P 500 Index portfolios are used for comparison purposes, one for trading and the other as the naïve buy-and-hold control portfolio. Identical investment portfolios are compared, consisting of two S&P 500 Index no-load mutual funds. Distinguished solely by a technical analysis relative maxima and minima trading rule. Thus, a naïve buy-and-hold control portfolio is used in this research.

Survivorship bias is not an issue in this study; because, the S&P 500 Index does not go bankrupt, as with the possibility for an individual company.

A long-duration empirical study of the data from 1928 through 2008, totaling 81 years, proves that long-term trends are reliable over an extended time period, covering both good economic times and bad.

Data snooping is a "statistical testing bias" where an extensive number of hypotheses are checked by computer against a single data set. Fishing for statistically significant correlations between various combinations of variables, hoping that one will eventually become obvious—even though there are no "real correlations." This research does NOT use statistical inference testing. But rather, a technical analysis relative maxima and minima trading rule, consistently applied over 81 years. Therefore, data snooping can NOT and does NOT occur in this research. In addition, the data sets in this study are split in two. Beginning with a random start date for results comparison, and each segment is reported on separately which reproduces an out-of-sample study. Confirming this research's reported results.

This research specifically accounts for, and overcomes, all of Fama (1998) and Malkiel's (2003) empirical design testing objections. Thus, testing tenet number three in this empirical research is complete.

Fama's (1965, 1995) 45-year old challenge for technical analysis is to "rigorously test a trading rule to show it can consistently make better than chance predictions of stock prices." For conclusive results, the technical analysis trading rule should beat a benchmark naïve buy and hold policy, at less risk, which would then call the EMT into question. Fama (1965, 1995) says testing a technical analysis trading rule, when compared with a benchmark naïve buy-and-hold policy, is empirical. So, no new financial theories are needed.

4.5 Three Steps Remove Random Unsystemic Risk from the Data and Smoothes Price Volatility

Steady, systemic market risk and random unsystemic risk make up individual company stock price movements. As much as 50% of a company's stock price actions are random unsystemic risk variations associated with the internal circumstances within that particular company. The remaining 50% of a company's stock price movements represent only steady, systemic market risk. The random unsystemic risk factor is the chaotic portion of the stock price data—that if removed, leaves only the steady, systemic market risk of the overall market which may then be analyzed to test the EMT's third tenet.

Rather than studying individual company stock price behavior which includes the randomness of unsystemic risk—as evaluated in the many referenced research articles in the literature, including Alexander's filter rule tests (Fama, 1995). Instead, only steady, systemic market risk is analyzed by using proxies for the stock market. This research employs two S&P 500 Index portfolios. Portfolio B for active trading and portfolio A as the benchmark portfolio. Focusing only on steady, systemic market risk which removes much of the random or chance stock market price behavior from the research data.

When investing over 1, 2, 3, 4, 5 years or more—day-to-day stock price movements are immaterial to trading success and may be thought of as just daily market chatter. Concentrating on daily price movements of individual company stock or the stock market is not the correct question. Day-to-day stock price action is volatile. To dampen out this daily chatter and give perspective to what is occurring long-term in the stock market, S&P 500 Index "monthly price data" are used to smooth out stock price volatility.

Monthly price data are important in dampening out day-to-day price movements. However, using last month's price to predict next month's price is also not conducive to long-term trend development. To further smooth price variations and focus on steady, systemic market risk in the stock market. Nine and two-month simple moving average (SMA) trend lines are fit to the S&P 500 Index monthly price data for actively managed portfolio B, smoothing out data volatility. Thus, giving an overall view of the long-term stock market trend which is the third step in removing much of the random stock market price behavior from the research data. Focusing only on steady, systemic market risk in the data and smoothing stock price volatility—to lessen random variations—is a major difference between this paper and the referenced RET and EMT research.

5. Empirical Results

Portfolios A and B—when invested in the stock market—are in identical S&P 500 Index no-load mutual funds. Portfolios A and B, each originally invest $1,000 dollars. Portfolio B may trade into the S&P 500 Index no-load mutual fund or out, earning interest on risk-free 3-month T-bills. All S&P 500 Index no-load mutual fund shares or

3-month T-bills are redeemed for cash at the study's conclusion, on December 31, 2008. All stock market trades are performed at the close of trading on the first trading day of month t + 1.

Portfolio A is the buy and hold strategy. One thousand dollars are invested—at the close of trading on the first trading day of 1928, on January 3rd —in a S&P 500 Index no-load mutual fund at the S&P 500 Index price of $17.76 dollars for each share. The 56.306 shares bought are held until redeemed on Dec. 31, 2008 for the S&P 500 Index price of $903.25 dollars for each share, equaling $50,858.39 dollars.

When portfolios A and B are concurrently invested in S&P 500 Index mutual funds, identical dividends are paid to both portfolios which are excluded from these results. From 1928 through 1959, portfolio B is periodically invested at the risk-free 3-month T-bill interest rate. Shares are added to portfolio A because S&P 500 Index dividend yields are higher than 3-month T-bill interest rates. Portfolio A adds dividend-interest differential payments at the rate of 4.26% each year or 0.00355 each month. Table 1. S&P 500 Index portfolio A: added shares – 1928 through 1959, steps through the added share calculations.

The added portfolio A shares, because of dividend-interest differential payments, increase from 56.306 to 91.817 shares, up through the end of 1959. Each time portfolio B is traded out of the S&P 500 Index no-load mutual fund into 3-month T-bills, portfolio A receives higher dividends than portfolio B receives in interest. Dividend-interest differential accrues on Mar. 1, 1933 by taking portfolio A's 56.306 shares, times S&P 500 Index share price of $5.77, equaling $324.89 dollars, times 27 months. Which represents the total time period before portfolio B is transferred back into the S&P 500 Index no-load mutual fund—times 0.00355, to equal $31.14 dollars. Representing the dividend-interest differential earned and credited to portfolio A. The 5.397 shares added to portfolio A—shown in the last column of Table 1—is calculated by dividing the $31.14 dollars of dividend-interest differential earned, by the S&P 500 Index share price of $5.77. From 1928 through 1959, each time portfolio B earns interest by trading out of the stock market, portfolio A is credited with the difference because dividend yields are higher than interest payments.

Calculating portfolio A's total final value is as follows. The added S&P 500 shares, because of dividend-interest differential payment calculations, are 35.511 shares (i.e., 91.817 ending shares, minus the 56.306 shares originally bought), times the S&P 500 Index redemption price on December 31, 2008 of $903.25—shown on Table 2—equaling $32,075.31 dollars. The total value of buy-and-hold S&P 500 Index portfolio A on December 31, 2008 is $82,933.70 dollars (i.e., $50,858.39 + $32,075.31).

The results for portfolio B are determined by trading in-and-out of the S&P 500 Index no-load mutual fund. Based on S&P 500 Index nine and two-month SMA trend lines and relative maxima and minima trading rule, shown in Table 2. S&P 500 Index portfolio B: gain from trading - 1928 through 2008.

The beginning $1,000 dollar investment in S&P 500 Index portfolio B on Jan. 3, 1928 of 56.306 shares, at $17.76 dollars for each share, is redeemed on Dec. 2, 1929 at $20.95 for each share. Totaling $1,179.61 dollars. From Dec. 2, 1929 to Mar. 1, 1933, portfolio B is out of the stock market and invested in risk-free 3-month T-bills. Portfolio B is reinvested in the S&P 500 Index on Mar. 1, 1933, at $5.77 dollars for each share—buying 204.438 shares. Portfolio B is redeemed on May 1, 1934 for $2,138.42 dollars (i.e., 204.438 shares, times $10.46 for each share).

The original $1,000 investment in the S&P 500 Index portfolio B grows to $151,484.00 dollars (i.e., 108.558 shares, times $1,395.42 for each share). When redeemed on Feb. 1, 2008 for 3-month T-bills which earn interest until the close of this study, on Dec. 31, 2008. The interest-dividend differential payment calculations for portfolio B are included in Table 3. S&P 500 Index portfolio B: added shares – 1960 through 2008.

Beginning in 1960, 3-month T-bill interest rates on average are higher than S&P 500 Index dividend yields. The interest rate versus dividend yield differential advantage shifts to portfolio B which adds interest-dividend differential payments at the rate of 2.34% each year or 0.00195 each month. When S&P 500 Index portfolio B is invested in 3-month T-bills.

Portfolio B total shares from trading, shown in Table 2 (which are transferred and listed for the correct date in the second column on Table 3)—begin the added shares earned from interest-dividend differential calculations. Portfolio B redeems all S&P 500 Index shares on Mar. 1, 1960 and buys 3-month T-bills, holding them for 11 months, and then reenters the stock market on Feb. 1, 1961. The added share calculation for the interest-dividend differential payment on Feb. 1, 1961 is: 137.826 shares, times the each share S&P 500 Index price of $61.90, equaling $8,531.43 dollars—times 11 months invested in T-bills, times 0.00195 each month, to equal $183.00 dollars earned—which is listed in the second to last column on Table 3. The interest-dividend differential payment of $183.00 dollars is divided by the S&P 500 Index price of $61.90, resulting in 2.956 added shares which is shown in the last column of Table 3. The added portfolio B shares, because of interest-dividend differential payments from 1960 through 2008, totals 39.032 shares—shown in the lower right-hand corner of Table 3.

Portfolio B is traded out of the S&P 500 Index no-load mutual fund into 3-month T-bills on Feb. 1, 2008. With added shares earned because of the interest-dividend differential, equaling 35.435 shares (i.e., 39.032 shares, minus 3.597 shares earned after Feb. 1, 2008), times $1,395.42 (i.e., the S&P 500 Index share price on Feb. 1, 2008, shown on Table 2). Equaling $49,446.71 dollars. Adding in portfolio B's interest-dividend differential earned over 11 months, from Feb. 1, 2008 to Dec. 31, 2008, totals $3,249.33 dollars. As shown in row C-12/31/08 on Table 3. The

total value of interest-dividend differential payments for portfolio B is $52,696.04 dollars (i.e.,$49,446.71 + $3,249.33).

Money in the relative maxima and minima trading rule S&P 500 Index portfolio B account, on Dec. 31, 2008, equals $204,180.04 dollars (i.e., $151,484.00 + $52,696.04). Relative maxima and minima trading rule S&P 500 Index portfolio B—by $121,246.34 dollars (i.e., $204,180.04 - $82,933.70)—is +146% superior to buy-and-hold S&P 500 Index portfolio A, from Jan. 3, 1928 to Dec. 31, 2008.

5.1 Risk-Adjusted Returns

Portfolio B is superior to portfolio A by +146%. In addition, each portfolio has a different risk profile. When either portfolio A or B is invested in a S&P 500 Index no-load mutual fund—a proxy for the stock market—each has a beta value equal to one (B_A=1) (B_B=1). When portfolio B is invested in risk-free 3-month T-bills, its beta value is equal to zero (B_B=0). Portfolio B is in 3-month T-bills for 327-months out of a total planning horizon of 972-months, or 34% of the time. And is invested in a S&P 500 Index no-load mutual fund the remaining 66% of the time.

Using a proportionate portfolio risk weighting measure for 3-month T-bills and the S&P 500 Index no-load mutual fund, results in a beta value for portfolio B (B_B) that is linearly additive over the entire 972-months. Equaling: B_B = 0.34 (0) + 0.66 (1) = 0.66. The buy-and-hold S&P 500 Index portfolio A has a beta value equal to one (B_A=1), throughout this study's planning horizon.

Relative maxima and minima trading rule S&P 500 Index portfolio B—makes +146% more money than buy-and-hold S&P 500 Index portfolio A—and is only 66% as risky—from Jan. 3, 1928 to Dec. 31, 2008.

5.2 Out-of-Sample Study Confirms Results

S&P Index Services and Federal Reserve Statistical Release, 1928 through 2008, data sets are evenly split in two, and each segment is reported on separately which reproduces an out-of-sample study. The planning horizon for this research is 972-months, from Jan. 3, 1928 to Dec. 31, 2008. The midpoint occurs after 486 months, on May 1, 1967, that coincidently, is an existing reinvestment date, shown on Table 2. For portfolios A and B, on May 1, 1967, the data are divided in half: Segment 1: (Jan. 3, 1928 to May 1, 1967) and Segment 2: (May 1, 1967 to Dec. 31, 2008).

Segment 1: Portfolio A: (Jan. 3, 1928 to May 1, 1967). The value of buy-and-hold S&P 500 Index portfolio A at the close of trading on May 1, 1967 is 91.817 shares, from Table 1, times the S&P 500 Index share price of $93.87 on May 1, 1967, from Table 2, equaling $8,618.86 dollars.

Segment 1: Portfolio B: (Jan. 3, 1928 to May 1, 1967). The value of relative maxima and minima trading rule S&P 500 Index portfolio B at the close of trading on May 1, 1967 is 111.652 shares, from Table 2. Times the S&P 500 Index share price of $93.87, on May 1, 1967, equaling $10,480.77 dollars. Added shares bought with interest-dividend differentials earned, from Table 3, amounts to 7.520 shares, times the S&P 500 Index share price of $93.87, equaling $705.90 dollars. The grand total is $11,186.67 dollars (i.e., $10,480.77 + $705.90).

Conclusion for Segment 1: (Jan. 3, 1928 to May 1, 1967). The gain of the relative maxima and minima trading rule S&P 500 Index portfolio B, over buy-and-hold S&P 500 Index portfolio A, is $2,567.81 dollars (i.e., $11,186.67 - $8,618.86) or +30%, at only 64% of the risk (B_B = 0.64). Portfolio B is in risk-free 3-month T-bills for 173-months, out of 486-months.

Segment 2: Portfolio A: (May 1, 1967 to Dec. 31, 2008). On May 1, 1967, buy-and-hold S&P 500 Index portfolio A's value is $8,618.86 dollars, while relative maxima and minima trading rule S&P 500 Index portfolio B's value is $11,186.67 dollars. Portfolio A's value on Dec. 31, 2008 is $82,933.70, less portfolio A's value on May 1, 1967 of $8,618.86, equaling $74,314.84 dollars of profit earned, from May 1, 1967 to Dec. 31, 2008.

Segment 2: Portfolio B: (May 1, 1967 to Dec. 31, 2008). Portfolio B's value on Dec. 31, 2008 is $204,180.04, less portfolio B's value on May 1, 1967 of $11,186.67, equaling $192,993.37 dollars of profit earned, from May 1, 1967 to Dec. 31, 2008.

Conclusion for Segment 2: (May 1, 1967 to Dec. 31, 2008). The gain of the relative maxima and minima trading rule S&P 500 Index portfolio B, over buy-and-hold S&P 500 Index portfolio A, is $118,678.53 dollars (i.e., $192,993.37 - $74,314.84) or +160%, at just 68% of the risk (B_B = 0.68). Portfolio B is in 3-month T-bills for 154-months, out of 486-months.

Splitting the data sets at their midpoints show that actively managed portfolio B is +30% superior to buy-and-hold portfolio A, from Jan. 3, 1928 to May 1, 1967—at only 64% of the risk. Increasing to +160% superior from May 1, 1967 to Dec. 31, 2008—at just 68% of the risk. The out-of-sample study confirms this research's conclusion, calling the RET and EMT into question.

6. Conclusion

This research empirically tests the Rational Expectations Theory (RET) and the Efficient Market Theory (EMT) using a new technical analysis relative maxima and minima trading rule. The new trading rule decides when portfolio B should be either in a S&P 500 Index no-load mutual fund—or out, and invested in interest bearing, risk-free 3-month Treasury bills (T-bills)—from 1928 through 2008—and compares results to a benchmark naïve buy-and-hold policy.

Relative maxima and minima trading rule S&P 500 Index portfolio B is +146% superior to the buy-and-hold benchmark S&P 500 Index portfolio A (i.e., $82,933.70 versus $204,180.04 dollars), over a duration of 81 years. And is only 66% as risky as the buy-and-hold benchmark S&P 500 Index portfolio A—because of investing in risk-free 3-month T-bills for 327 out of 972-months. The out-of-sample study confirms this research's conclusion which calls the RET and EMT into question.

The explanation offered about why the new relative maxima and minima trading rule succeeds is because of market participants' emotions. Investor fear and panic selling plunges stock prices downward below equity intrinsic values at market bottoms. Investor greed brings stock prices above equity intrinsic values at market tops. Where investors act with a herd mind-set and trade based on the madness of crowd behavior rather than on market fundamentals—spurred on by the financial media—resulting in market bubbles.

The relative maxima and minima trading rule is not a short-term or intermediate term trading strategy; nor does it apply to specific company stock. Interest in this new rule is not limited solely to trading the S&P 500 Index. Once an investor identifies the long-term stock market trend—long or short positions in individual common stock may be determined using other methods. Future research in economics and finance should focus on improving the Rational Expectations Theory and Efficient Market Theory.

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Table 1. S&P 500 Index portfolio A: added shares – 1928 through 1959

Date	**Total Shares (Rounded)**	**S&P 500 Index Price**	**Portfolio A Value**	**Months**	**Dividend-Interest Diff.**	**Added Shares**
(R)12/2/29						
(I) 3/1/33	56.306	$5.77	$324.89	27 mo	31.14	5.397
(R) 5/1/34						
(I) 8/1/35	61.703	11.04	681.20	15	36.27	3.285
(R) 8/2/37						
(I) 10/1/38	64.988	12.46	809.75	14	40.24	3.230
(R) 5/1/39						
(I) 12/1/39	68.218	12.29	838.40	8	23.81	1.937
(R) 7/1/40						
(I) 12/1/42	70.155	9.28	651.04	30	69.34	7.472
(R)10/1/46						
(I) 8/1/47	77.627	15.80	1226.51	10	43.54	2.756
(R) 1/2/48						
(I) 7/1/48	80.383	16.70	1342.40	6	28.59	1.712
(R) 4/1/49						
(I)10/1/49	82.095	15.52	1274.11	6	27.14	1.749
(R) 6/1/53						
(I) 3/1/54	83.844	26.25	2200.91	11	85.95	3.274
(R) 2/1/57						
(I) 8/1/57	87.118	47.79	4163.37	6	88.68	1.856
(R)11/1/57						
(I) 8/1/58	88.974	47.49	4225.38	9	135.00	2.843
Totals	91.817 sh			142 mo	$632.32	35.511 sh

Table 2. S&P 500 Index portfolio B: gain from trading - 1928 through 2008

Date	Total Shares (Rounded)	S&P 500 Index Price	Portfolio B Value
(I) 1/3/28	56.306	$ 17.76	$1000.00
(R) 12/2/29		20.95	1179.61
(I) 3/1/33	204.438	5.77	
(R) 5/1/34		10.46	2138.42
(I) 8/1/35	193.697	11.04	
(R) 8/2/37		17.07	3306.41
(I) 10/1/38	265.362	12.46	
(R) 5/1/39		10.86	2881.83
(I) 12/1/39	234.486	12.29	
(R) 7/1/40		9.87	2314.38
(I) 12/1/42	249.394	9.28	
(R)10/1/46		14.92	3720.96
(I) 8/1/47	235.504	15.80	
(R) 1/2/48		15.34	3612.63
(I) 7/1/48	216.325	16.70	
(R) 4/1/49		14.94	3231.90
(I) 10/1/49	208.241	15.52	
(R) 6/1/53		24.15	5029.02
(I) 3/1/54	191.582	26.25	
(R) 2/1/57		44.62	8548.39
(I) 8/1/57	178.874	47.79	
(R) 11/1/57		40.44	7233.66
(I) 8/1/58	152.320	47.49	
(R) 3/1/60		56.01	8531.44
(I) 2/1/61	137.826	61.90	
(R) 6/1/62		59.38	8184.11
(I) 4/1/63	122.425	66.85	
(R) 7/1/66		85.61	10480.80
(I) 5/1/67	111.652	93.87	
(R) 8/1/69		93.47	10436.11
(I) 3/1/71	107.589	97.00	
(R) 1/3/72		101.67	10938.57
(I) 4/3/72	101.773	107.48	
(R) 7/2/73		102.90	10472.44
(I) 6/2/75	113.118	92.58	
(R) 5/2/77		98.93	11190.76
(I) 9/1/78	107.936	103.68	
(R) 10/1/81		117.08	12637.15
(I) 12/1/82	91.098	138.72	
(R) 3/1/84		158.19	14410.79
(I) 12/3/84	88.507	162.82	
(R) 12/1/87		232.00	20533.62
(I) 9/1/88	79.480	258.35	
(R) 6/1/90		363.16	28863.96
(I) 3/1/91	77.912	370.47	
(R) 5/2/94		453.02	35295.69
(I) 2/1/95	75.033	470.40	
(R) 11/1/00		1421.22	106638.40
(I) 7/1/03	108.558	982.32	
(R) 2/1/08		1395.42	$151484.00
(C) 12/31/08	167.710	903.25	

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Table 3. S&P 500 Index portfolio B: added shares – 1960 through 2008

Date	**Total Shares - Table 2**	**S&P 500 Index Price**	**Portfolio B Value**	**Months**	**Interest-Dividend Diff.**	**Added Shares**
(R) 3/1/60						
(I) 2/1/61	137.826	$ 61.90	$8531.43	11 mo	$183.00	2.956
(R) 6/1/62						
(I) 4/1/63	122.425	66.85	8184.11	10	159.59	2.387
(R) 7/1/66						
(I) 5/1/67	111.652	93.87	10480.77	10	204.38	2.177
(R) 8/1/69						
(I) 3/1/71	107.589	97.00	10436.13	19	386.66	3.986
(R) 1/3/72						
(I) 4/3/72	101.773	107.48	10938.56	3	63.99	0.595
(R) 7/2/73						
(I) 6/2/75	113.118	92.58	10472.46	23	469.69	5.073
(R) 5/2/77						
(I) 9/1/78	107.936	103.68	11190.80	16	349.15	3.368
(R)10/1/81						
(I) 12/1/82	91.098	138.72	12637.11	14	344.99	2.487
(R) 3/1/84						
(I) 12/3/84	88.507	162.82	14410.71	9	252.91	1.553
(R)12/1/87						
(I) 9/1/88	79.480	258.35	20533.66	9	360.37	1.395
(R) 6/1/90						
(I) 3/1/91	77.912	370.47	28864.06	9	506.56	1.367
(R) 5/2/94						
(I) 2/1/95	75.033	470.40	35295.52	9	619.44	1.317
(R)11/1/00						
(I) 7/1/03	108.558	982.32	106638.69	32	6654.25	6.774
(R) 2/1/08						
C-12/31/08	167.710	903.25	151484.05	11	3249.33	3.597
Totals				185 mo	$13804.31	39.032sh

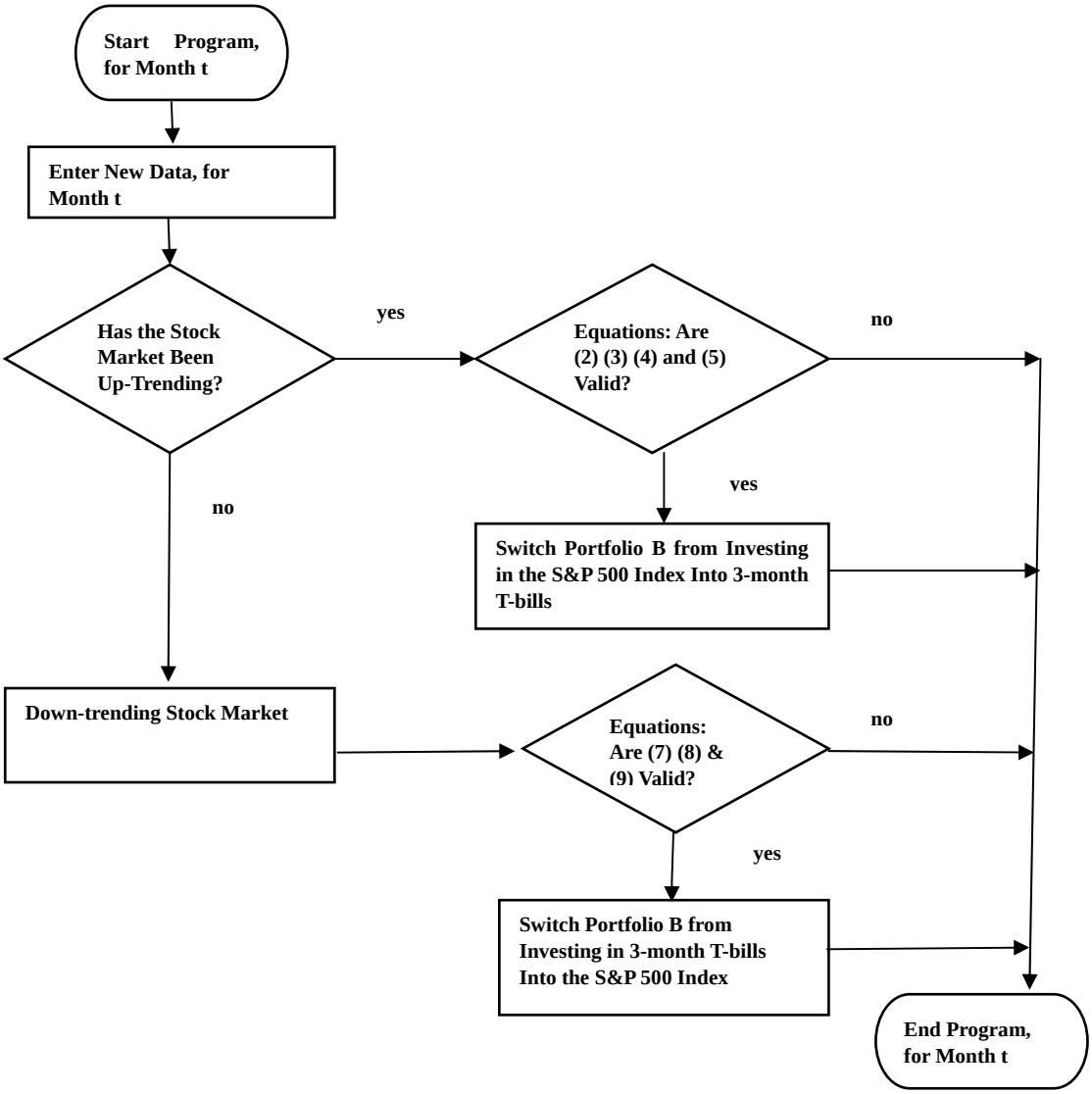

Figure 1. Portfolio B: relative maxima and minima trading rule flowchart

Corporate Governance Mechanisms and Performance of Public-Listed Family-Ownership in Malaysia

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Abstract

The study examines the relationship of corporate governance mechanisms and performance between family and non-family ownership of public-listed firm in Malaysia from 1999 through 2005 as measured by Tobin's Q, ROA and ROE. The findings show that on average, family ownership experiences a higher value than non-family ownership based on ROE. On the other hand, based on Tobin's Q and ROA, the study finds that firm value is lower in family than non- family ownership. In addition, the corporate governance mechanisms such as the board size, independent director and duality for family and non-family ownership has a strong significant influence on firm performance.

Keywords: Corporate governance, Family-ownership, Ownership structure

1. Introduction

The family controlled firm or family ownership is the most common form of business organization in the world. Family-owned or controlled businesses account for over 80 percent of all firms in the U.S. and families are present in one third of the S&P 500 and hold nearly 18 percent of firms' equity stake (Anderson and Reeb, 2003). Other studies from different countries like Sraer and Thesmar (2006) in French, Favero, Giglio, Honorati, and Panunzi (2006) in Italy, Gursoy and Aydogan (2002) in Turkey, Mishra, Randoy and Jenssen (2001) in Norway, Yeh, Lee and Woidtke (2001) in Taiwan and Gorriz and Fumas (1996) in Spain, conduct research on the performance of family-controlled firms based on a sample of listed firms in their countries. The results show that family firms have superior performance compared to non-family firms.

Ownership structure has been widely debated since Berle and Means (1932). According to Jensen (2000), ownership structure is significant in determining firms' objectives, shareholders wealth and the disciplined of manager. Both managers and shareholders should have a single objective of maximizing firm value. The ownership structure can be grouped into widely held firms and firms with controlling owners or concentrated ownership. A widely held corporation does not have any owners with substantial control rights. Basically, firms with controlling owners are divided into four groups which are widely held corporations, widely held financial institutions, families and state categories (Claessens, Djankov, and Lang, 2000; La Porta, Lopez-De-Silanes, and Shleifer, 1999). La Porta et al. (1999) study the 20 largest publicly traded companies in the richest 27 countries worldwide. They find that most companies are private and that ownership of listed firms is highly concentrated, thereby highlighting family ownership as significant corporations.

According to the study of Claessens et al. (2000) on the separation of ownership and control in nine East Asian corporations (Hong Kong, Indonesia, Japan, South Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand), Malaysia has the third highest concentration of control after Thailand and Indonesia. Family control in Malaysia increased from 57.7 percent to 67.2 percent as the cut off level of voting rights increased from 10 percent to 20 percent.

In Asia, various literature shows that family firms reflect a high performance in Taiwan, Australia, Hong Kong, Singapore, and mainland China (Filatotchev, Lien and Piesse, 2005; Chen, 2001; and La Porta et al., 1999). Names like Ayala Families, (Phillipines), Li Ka-Shing (Hong Kong) and Kyuk Ho Shin (South Korea) are well known among the family group companies. In Malaysia, names like Robert Kuok (Kuok Brothers), Lim Goh Tong and

Quek Leng Chan are synonymous with Malaysian corporate industries. In other words, family firms seem to dominate the corporate world with prevalent performance.

In Malaysia, family ownership constitutes over 43 percent of the main board companies of the Bursa Malaysia (formerly known as the Kuala Lumpur Stock Exchange (KLSE)) from 1999 through 2005 yet studies examining the performance of family ownership are very limited specifically in the area of corporate governance. Thus, the study intends to investigate the impact of corporate governance mechanisms such as board size, independent director and duality on performance between family and non-family ownership in Malaysia. The results show that, on average, firm value of family-owned firms is lower than non family based on Tobin's Q and ROA. However, family ownership experiences a higher value than non-family ownership as measured by ROE. The findings find a strong relationship between firms with smaller boards and firm value for both family and non-family ownership. While family ownership needs less independent director as compared to non-family ownership. The firm value of family ownership is weaker but non-family ownership gains more profitability when duality exists on the board. This is consistent with the previous studies by Florackis and Ozkan (2004), McKnight and Mira (2003), and Jensen and Meckling (1976).

2. Literature Review

2.1 Family-Ownership Scenario in Malaysia

Various studies have been done on the effect of ownership structure and firm performance in Malaysia. Abdul Rahman (2006) indicates that many listed firms in Malaysia are owned or controlled by family and that these companies appear to be inherited by their own descendants. Since independence, most Malaysian companies are controlled by foreigners from European countries, particularly the U.K.

Jasani (2002) finds that Small and Medium Scale Enterprises (SME) are managed by the founder and anchored to the family in terms of funding and employment. Indeed, the firms are conducted by the founder with activities concentrating on trading, manufacturing and retailing. He finds that 59 percent, that is the majority of the businesses in Malaysia, are still managed by the founder while 30 percent are run by the second generation where the majority are the founder's children. The founder's reign is highlighted with 65 percent of them linked to the SME.

According to Gomez (2004), most of the Small and Medium Enterprises (SMEs) owners prefer their heirs to become professionals and do not encourage passing their businesses to them. Sometimes the SMEs founders reject joining the enterprise, which might cause the firms to be sold off or close down. It shows that the paradigm shift towards generation plays a significant direction on the firm's development. In other words, the prospects of family firms will be threatened.

Indeed, Claessens et al. (2000) also find that most concentrated firms in Malaysia are dominated by family founders and their descendants. Perhaps, older and smaller companies tend to be controlled by family instead of vice versa.

In Malaysia, the list of the 40 richest Malaysians 2009 is obviously dominated by family as issued by the Malaysian Business in February 2009 edition. From the list, 28 out of the 40 richest people are family based and account for 70 percent of the top 40. According to the top 40 list of Malaysia's richest people, Tan Sri Robert Kuok appears to dominate the chart and he was well ahead of his rivals. His outstanding wealth accounted for RM26.6 billion or 27.6 percent of the wealth of the 40 richest declining from RM58.1 billion in 2008, however no other tycoon is yet able to unseat him as the country's wealthiest individual (Singh, 2009).

2.2 Corporate Governance Mechanisms and Firms Performance

Denis and McConnell (2003) define corporate governance as the set of mechanisms, for both institutional and market based, that influence the self-interested controllers of a firm (those that make decisions regarding how the firm will be operated) to make decisions that maximize the value of the firm for its owners (the suppliers of capital). In other words, Shleifer and Vishny (1997) describe "Corporate governance deals with the ways in which suppliers of finance to corporations assure themselves of getting a return on their investment."

The influence of the board size and composition are significant to board involvement in corporate affairs. The board size and composition should be controlled since it may influence the impact of insiders and block ownership on firm's performance. Both the board size and composition could act as either a complement or substitute for ownership structure. Singh and Davidson III (2003) state that the size and composition of the board may reflect its ability to be an efficient guide and their findings show that firm performance is increased by smaller boards consistent with Hermalin and Weisbach (2003), Jensen (1993) and Lipton and Lorsh (1992).

Indeed, previous studies in several other countries also find a negative relationship between board size and firm performance. Mak and Yuanto (2002) examine the relationship between the size of the board and firm performance in Singapore and Malaysia, and find that board size is negative in relation to Tobin's Q. Similarly in Finland,

Eisenberg et al. (1998) find evidence that there is a negative relationship between board size and profitability for small and medium size firms. The result is also consistent with Mishra et al.'s (2001) study on the corporate governance of family firms in Norway. Their findings showed that the board size has a negative significant coefficient indicating that firms with a smaller board size achieve higher q values. This is further supported by numerous other studies, which confirmed that large boards are not as effective as small boards (Lipton and Lorssch, 1992; Gladstein, 1984; Olson, 1982; and Jensen and Meckling, 1976).

Conversely, Pearce and Zahra (1991) and Pfeffer (1973) suggest that an increase in size of board and diversity may yield an advantage by building a network with the external environment and securing a broader resource platform, hence, creating a corporate identity. Adam and Mehran (2003) also find a positive and significant relationship between the size of the board and firm performance as measured by Tobin's Q. While, Brewer III et al. (2000) mention that there is no empirical evidence on the impact of the board size on bid premiums in the case of mergers and acquisitions.

Fama and Jensen (1983) explain that board outsiders could strengthen the firm's value by lending experience and monitoring services. Outside directors are supposed to be guardians of the shareholders' interests via monitoring. Hermalin and Weishbach (1991) and Coughlan and Schmidt (1985) support the argument that outside directors are more effective monitors and a critical disciplining device for managers. This evidence is further supported by McKnight and Mira (2003). They find a positive and significant relationship between outsiders' proportion and firm value as measured by Tobin's Q

However, Klein et al. (2004), Subrahmanyam et al. (1997), and Agrawal and Knoeber (1996) find that board independence is in fact negatively correlated with performance. This evidence is further supported by Weir and Laing (1999) and Yermack (1996) who find a negative relationship between the proportion of outside directors and firm performance. Haniffa and Hudaib (2006), Klein (1998), and Hermalin and Weishbach (1991) posit no significant relationship between performance and outsiders' proportion on the board of directors as measured by Tobin's Q and ROA.

Previous studies analyzing the impact of duality on firm performance have been mixed. Weir et al. (2002) find that duality has no role in enhancing firm performance in U.K firms and this result is similar with Dalton et al. (1998), Vafeas and Theodorou (1998) and Brickley et al. (1997).Haniffa and Hudaib (2006) find that the duality role is not significant in relation to firm value as measured by Tobin's Q. However, the duality is found to be significant in a negative direction with firm performance as measured by return on assets (ROA). This result implies that it is significant if the position of CEO and Chairman is held by a different person as recommended by the Malaysian Institute of Corporate Governance (MICG). This evidence is supported by McKnight and Mira (2003) who find that duality has a moderately strong and negative impact on quality values. In other words, firms where duality did exist performed poorly compared to those firms where the CEO did not occupy both positions.

On the other hand, Rechner and Dalton (1991) find that the firms where the CEO also serves as chairman have a higher ROE, ROI and profit margins. This result is consistent with previous studies (Pi and Timme, 1993; and Donaldson and Davis, 1991). Boyd (1994) claims that role duality could increase firm performance. . This is because non duality dilutes the top management power and increases the probability of conflict between the board of directors and management.

3. Data and Methodology

As at 31 December 1999, a total of 474 companies were listed on the main board of the Bursa Malaysia and all financial companies were omitted from the sample because of differences in regulatory requirements. In addition, the study excluded the companies which fail to comply with any obligations under Practice Note such as Practice Note 4 (PN4) and Practice Note 17 (PN17) and also companies with incomplete data. As a result, we selected 2030 observations for 290 companies across seven years from 1999 to 2005 as our sample (Note 1).

This study uses secondary data regarding ownership structure and financial indicators for the period of 1999 to 2005. The data was taken from the annual reports of company and financial databases such as Worldscope, Datastream, and Perfect Analysis. Information on corporate governance mechanisms such as board size, independent directors, and duality were collected from the Companies Annual Reports. This information was obtained manually by calculating the number of directors on the board, the number of independent directors on the board, and determining the duality role of CEO and chairman of the company for the years 1999 to 2005.

In Malaysia, information on lists of family ownership is unavailable and not recorded. Therefore, this pioneering study had to determine by using the name of board members as the procedure to determine the family ties or relationship. The family ties, which are considered to be family members, include anyone who has a blood relationship and also family-in-law. In addition, this study uses the fraction of equity stake held by all family

members as being at least 20 percent or more. The fraction of equity ownership is calculated by referring to the direct and indirect shareholdings of the family members extracted from the Company Annual Reports. This data collection is considered to be appropriate since it has also been adopted by previous studies (Sraer and Thesmar, 2006; Favero et al., 2006; Anderson and Reeb, 2003; La Porta et al., 1998; and Berle and Means, 1932).

Several control variables used to control for companies characteristics such as firm size, firm risk and firm age. Firm size is the natural log of total asset (lnasset) of the company. We also control for companies debt ratio as a firm leverage (Lev) by calculating total debt over total asset of the company. Firm age (Age) is measured as the number of years since the company is incorporated.

The study used market measure such as Tobin's Q which is computed as the ratio of the market capitalization plus total debt divided by total asset of the company. Also, accounting measures such as Return on Assets (ROA) which is the ratio of net income divided by the total assets and Return on Equity (ROE), the ratio of the net income divided by the shareholder's equity as a performance measurement. These performance measures have been widely used as proxies for firm performance (Sraer and Thesmar, 2006; Favero et al., 2006; Haniffa and Hudaib, 2006; Anderson and Reeb, 2003). Furthermore, the study uses the Fixed effects approach for the model of the study thus, the following model has been developed to analyze the relationship between corporate governance and performance for both family and non-family ownership.

Firm Value = $\alpha_0 + \beta_1 Lev + \beta_2 Age + \beta_3 Lnasset + \beta_4 Bsize + \beta_5 OutDir + \beta_6 Duality + \varepsilon$

4. Results and Discussion

4.1 Descriptive Statistics

Table 1 presents the descriptive statistics for full and individual sample for family and non family ownership in Malaysia. It reports the values of means and the t-statistics that test the differences of means of these variables between family and non family. The descriptive statistics show an average value of leverage (the proportion of total debt to total asset) for the full sample of 26.0 percent while the leverage ratio for family and non-family are 25.6 percent and 26.2 percent respectively. The results show that the family ownership uses less debt, however, family firms do not appear to use debt differently than non-family, which is consistent with the findings of Sraer and Thesmar (2006), Anderson and Reeb (2003) and Mishra et al. (2001)..

The average of firm age in all samples of the study is nearly 30 years old and is not statistically significant different between family and non-family ownership in this sample. Even though there is no significant difference in age between family and non-family, family firms are younger than non-family firms (29 versus 30 years old) consistent with Amit and Villalonga (2006), Sraer and Thesmar (2006) and Anderson and Reeb (2003).

The descriptive statistics also show that an average value of total assets for all firms amounts to RM1,936.36 million. In relation to ownership structure, on average, family ownerships are smaller than non-family ownership but still of large size with average total assets of RM1,700.71 million relative to RM2,114.88 million, and statistically insignificantly different in mean. This result is similar with other empirical studies on family and non-family firms such as Sraer and Thesmar (2006), Favero et al. (2006), Amit and Villalonga (2006), Anderson and Reeb (2003) and Mishra et al. (2001).

The mean value of market capitalization for all firms amounts to RM1,100.95 million with the highest (lowest) level being RM33,611.57 million (RM27.56 million). In comparing the average value of market capitalization between family and non-family ownership, the results show that non-family has RM1,326.39 million more market value than family, which amounts to RM803.38 million. However, this result shows that there is no evidence of statistically significant differences in means for risk or leverage, age, total assets and market capitalization between family and non-family ($\rho > 0.01$).

Market measures as indicated by Tobin's q shows that non-family ownership have greater valuations than family ownership and significant at 1 percent level. By using ROA, family ownership also has lower value than non-family but insignificant difference in mean. However, with respect to ROE, family ownership experiences higher value than non-family ownership but statistically insignificant difference in mean.

For corporate governance structure, we found that board size for full sample, family and non family ownership is similar with an average of 8 persons on board. However, there is no difference in mean for board size between family and non family ownership. However, independent director shows a significant difference in mean between family and non-family. The independent directors are more common in non family than family ownership. The frequency of the duality shows that only 6.5 percent of the samples have not separated the role of chairman and CEO on the board and significant difference in mean for duality between family and non family.

Table 2 presents the correlation matrix for the dependent and independent variables of the study. Firm value as measured by Tobin's Q and ROA appears to bear a negative and positive relationship to board size and a positive

and negative relationship to independent directors of the company. The results are consistent with Haniffa and Hudaib's (2006) study on corporate governance and performance of Malaysian listed companies. In addition, family ownership presence shows that there is a significantly negative relationship with Tobin's Q and the independent directors and significantly positively related to duality. This study finds a negative 23.5 percent correlation between independent director and family ownership, which is quite similar to a negative 36 percent in Mishra et al's (2001) study on Norwegian firms.

Furthermore, family ownership is insignificantly negatively correlated to the following variables: ROA, firm leverage (total debt to total asset), firm size, firm age and board size. With respect to the relationship between family ownership and board size, this result is inconsistent with Mishra et al. (2001) and Yermack's (1996) study on Norwegian and U.S family firms respectively. However, board size is quite highly significantly positively correlated to firm size and significantly negatively correlated to the firm age indicating that as the size of the firm becomes larger, the number of directors on the board also increases.

4.2 Corporate Governance Mechanisms and Firm Performance

This study has done an analysis on the corporate governance mechanisms to see their influence on firm performance, focusing on the ownership variable of family and non-family firms. Indeed, the study uses Tobin's Q, ROA and ROE as performance measures to evaluate the firm performance and the results are tabulated in Table 3, Table 4 and Table 5 respectively. The study finds that governance mechanisms such as board size, independent directors and duality have a significant effect on firm performance. Generally, board size of public listed companies in Malaysia is found to be significantly negatively related to Tobin's Q and ROE. This result is consistent with Haniffa and Hudaib (2006) and Mak and Yuanto (2002) who conducted a similar research on Malaysian listed companies and is also supported by other studies (Singh and Davidson III, 2003; Hermalin and Weisbach, 2003; Mishra et al., 2001). It implies that companies with a small board of directors accomplish higher values in the capital markets and are also more profitable than their counterparts with a large board of directors. However, board size is found to have a positive but not significant relationship to ROA for all samples of companies, which is supported by previous studies (Haniffa and Hudaib, 2006 and Adam and Mehran, 2003)).

By looking at the individual ownership of family and non-family, both groups show a significantly negative relationship between board size and firm performance based on Tobin's Q and ROE. It indicates that smaller boards bring superior performance to companies. Concerning family ownership, this finding is consistent with Mishra et al. (2001) and Yermack (1996) who suggest that small boards are common in family firms as firms can be managed effectively because of the interrelationship between board members that facilitates quick decision making. Based on the ROA, both groups are not significant in relation to board size. In Malaysia, the Malaysian Code of Corporate Governance (MCCG) does not provide any guidance regarding the size of the boards in its code. Indeed, the companies might adjust or change board size in response to past performance as suggested by Gilson (1990) and Hermalin and Weisbach (1988).

With respect to independent directors, the study finds no significant relationship between the proportion of independent directors and performance based on Tobin's Q, and ROE for all firms and consistent with Haniffa and Hudaib (2006) and Weir et al. (2002). According to Hermalin and Weisbach (2003), a higher proportion of outside directors does not directly lead to superior performance, but it is good in decision making, which is related to executive remuneration, CEO turnover, and also acquisitions. However, the study finds the proportion of outside directors of all firms is found to be statistically significantly positively related to ROA only, suggesting that directors may stabilize and moderately improve a firm's profitability.

Interesting results are found between family and non-family ownership concerning the relationship between outside directors and performance. For family ownership, the results show a significantly negative relationship between the fraction of outside directors and firm performance based on ROA and ROE. The results are supported by Anderson and Reeb (2003), Mishra et al. (2001), Subrahmanyam et al. (1997), and Agrawal and Knoeber (1996). It implies that firm performance is decreased as outside directors are added to the board. More specifically, family firms may require a prudent balance between the objectivity of independent directors and the interests of family directors in order to pursue family members' interest.

The representation of outside directors or board independents does not improve corporate governance for family firms (Mishra et al., 2001). Based on recent studies, family values like altruism, trust and paternalism can deliver a commitment towards future success (Wu, 2001). For family firms, the expropriation of wealth and nepotism are kept at bay by the need for success in a competitive business. Perhaps, the need for outside directors decreases when the commitment of inside directors, who know the company very well, benefit the firm. According to Mishra et al. (2001), board members in family firms are perceived less as a governing mechanism and more as a top level strategy

group. Indeed, Kang (1998) explains that family members serve as active monitors of their managers and the information flow between managers and family members serve as a control mechanism. In other words, the decisions made by managers are eventually justified and have mutual agreement with the owners.

In contrast, firms with non-family ownership have a significant positive relationship between the fraction of independent directors and performance based on Tobin's Q, ROA and ROE. This evidence is consistent with the view that outside directors improve board effectiveness and firm performance because of their efficiency in monitoring managers (Adams and Mehran, 2003). It indicates that non-family ownership prefers a higher presence of independent directors who could bring in their prestige, expertise and contacts to the firms. Additionally, outside directors could influence the quality of decisions and thoughtfulness in providing a strategic direction for the companies (Pearce and Zahra, 1992).

The role of duality is one of the corporate governance mechanisms and previous studies have raised this issue due to their belief that duality could make a difference to corporate governance and performance (Anderson and Anthony, 1986; and Alibrandi, 1985). According to Dahya, Lonie, and Power (1996) and Anderson and Anthony (1986), the duality role could assist the CEO in creating a good strategic vision for the firm in order to achieve its objectives, with minimal board interference. Thereby enhancing decision making and creating stability and continuity for the firm leading to superior firm performance.

However, generally, this study finds that duality for all firms is not significantly related to firm performance as measured by Tobin's Q and ROE. Hence, this finding is consistent with Haniffa and Hudaib (2006), Weir et al. (2002) and Vafeas and Theodorou (1998). It implies that there is no significant impact on firm value or decision making when someone holds both the CEO and chairman position. But, as measured by ROA, duality of all firms is found to be significantly negatively related, which is similar with the findings of Haniffa and Hudaib (2006) for a similar study in Malaysia. This evidence is also supported by Jensen (1986) who suggests that it gives too much power to someone holding two top positions and thereby allows decisions to be based on their personal interest with a consequent drop in firm performance. Moreover, it is better to separate the two roles in order to make sure that the top leadership of the firms have a proper check and balance as suggested by the MCCG.

The duality role of firms with family ownership is found to be significantly negatively related to Tobin's Q, ROA and ROE, which is consistent with Haniffa and Hudaib (2006) and McKnight and Mira (2003). It suggests that the existence of a duality role on the board could lead to poor performance compared to firms where both positions are separated.

In contrast, duality in firms with non-family ownership is significantly positively related with ROA and ROE. This finding is confirmed by Sridharan and Marsinko (1997) and Rechner and Dalton (1991) who find that firms with the existence of a duality role experience higher profitability and may also avoid some costs of conflict between the CEO and the board by having strong consistent leadership at the top. In addition, when more power is held by one person it may lead to better decisions and directly improve firm performance (Rechner and Dalton, 1991; Donaldson and Davis, 1991).

5. Conclusion

Our main objective in this study is to investigate the relationship between corporate governance and firm performance between family and non family ownership. The findings of the study reveal that, on average, firm value is lower in family ownership than non-family ownership and shows a significant difference only as measured by Tobin's Q. However, family ownership shows a higher value than non-family ownership based on ROE. Therefore, this evidence further confirms that family firms basically invest a high share of their assets in a certain firm, which might then subsequently invest in lower-risk-lower-return businesses where the return is less profitable (Mohd. Sehat and Abdul Rahman, 2005). Furthermore, family ownership is basically concerned with family interest and the survival of the firm as family firms tend to be small and risk averse.

We also find a strong relationship between firms with smaller boards and firm value suggesting that small board size could be a good and superior corporate governance mechanism for firms to improve performance. Furthermore, the study provide significant evidence that representation of independent directors is viewed differently by family and non-family ownership. The representation of independent directors in family firms does not improve firm performance and basic family values like altruism, trust and paternalism can deliver a commitment towards future success. Conversely, non-family ownership needs more independent directors to counsel and monitor the company. This strong evidence implies that a higher presence of independent directors in a non-family owned firm could improve the firm's value by bringing in their expertise and contacts to the firm. Generally, the relationship between the duality role and performance for all Malaysian listed firms is not significant, which is consistent with Haniffa and Hudaib (2006), but the study discovers different results by focusing on different types of ownership. The study

finds that the firm value of family ownership is weaker when a duality role exists, however, non-family ownership experience higher profitability when the CEO also serves as chairman of the board. In conclusion, the research findings imply that family ownership is valuable as well as non-family ownership and significant findings also show that family ownership is governed differently than non-family ownership.

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Notes

Note 1. PN4 and PN17 are the criteria and obligations pursuant to paragraph 8.14 and 8.14c respectively of the listing requirements in the Bursa Malaysia. Both PN4 and PN17 occur when the firms having financial difficulties. PN4 is further amended to PN17 and effective on 3 January 2005.

Table 1. Descriptive Statistics for Full Sample, Family, and Non Family for Year 1999 to 2005

Variables	**Full Sample (N=290)**		**Family (N=125)**	**Non Family (N=165)**	**t-statistics of Differences**
	Mean	**Std Dev**	**Mean**	**Mean**	
Firms Characteristics					
Firm Leverage	0.260	0.255	0.256	0.262	-0.199
Firm Age (years)	29.617	17.798	29.2	29.8	-0.280
Firm Size (total asset) ('000)	1,936,356.6	4,517,151.2	1,700,708.6	2,114,877.7	-0.773
Market Capitalization ('000)	1,100,952.6	3,189,398.3	803,379.0	1,326,387.1	-1.524
Performances Characteristics					
Market Measures:					
Tobin's Q	0.948	0.991	0.788	1.069	**-2.697***
Accounting Measures:					
Return on Assets (ROA)	0.032	0.249	0.026	0.036	-0.350
Return on Equity (ROE)	0.013	0.927	0.087	-0.042	1.175
Governance (Board Structure) Characteristics					
Board Size	8	1.875	8	8	0.373
Independent Director	0.385	0.088	0.361	0.403	**-4.341***
Percentage of Duality in sample:	Non-Duality (0)	Duality (1)			
Full Sample	93.5%	6.5%			
Family	87.5%	12.5%			
Non-Family	98.2%	1.8%			

* Significant at 0.01 level

Table 2. Pearson's Correlation Matrix

Variables	Q	ROA	ROE	LEV	LN-ASSET	AGE	BSIZE	OUTDIR	DUALITY	FAMILY
Q	1									
ROA	0.029	1								
ROE	0.084	**0.386****	1							
LEV	**0.446****	**-0.143***	-0.089	1						
LNASSET	**-0.281****	-0.039	0.025	-0.021	1					
AGE	0.112	-0.051	0.002	0.058	-0.019	1				
BSIZE	-0.064	0.038	0.066	**-0.145***	**0.378****	**-0.150***	1			
OUTDIR	0.007	-0.012	-0.027	0.100	-0.019	**0.215****	**-0.400****	1		
DUALITY	0.004	-0.027	0.003	0.038	0.108	-0.005	0.003	-0.003	1	
FAMILY	**-0.134***	-0.021	0.068	-0.010	-0.009	-0.009	0.016	**-0.235****	**0.261****	1

** significant at 0.01 level (2-tailed).

* significant at the 0.05 level (2-tailed)

Table 3. The Fixed Effect Models by Using Tobin's Q

Variables	Full Sample (N=290)		Family (N=125)		Non Family (N=165)	
Intercept	4.904	(27.626)***	3.047	(16.101)***	5.563	(19.694)***
Firm Leverage	0.655	(27.988)***	0.673	(17.862)***	0.596	(18.518)***
Firm Age (years)	-0.018	(-13.524)***	-0.015	(-8.984)***	-0.024	(-10.097)***
Firm Size (lnasset)	-0.262	(-20.186)***	-0.139	(-10.510)***	-0.289	(-14.359)***
BSize	-0.006	(-2.274)**	-0.013	(-3.614)***	-0.008	(-1.907)*
OutDir	0.003	(0.071)	-0.026	(-0.551)	0.102	(1.717)*
Duality	-0.020	(-0.890)	-0.044	(-1.753)*	0.049	(0.731)
Observation	2030		875		1155	
R^2	0.888		0.850		0.895	
Adj. R^2	0.869		0.824		0.877	
F-stat (p-value)	46.560 (0.000)		32.551 (0.000)		49.435 (0.000)	

*** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

t-statistics are in parentheses

Table 4. The Fixed Effect Models by Using Return on Asset (ROA)

Variables	Full Sample (N=290)		Family (N=125)		Non Family (N=165)			
Intercept	0.384	(7.066)***	0.098	(2.341)**	0.342 (3.803)***			
Firm Leverage	-0.150	(-17.868)***	-0.121	(-11.017)***	-0.187	(-14.576)***	-0.004	(-4.857)***
Firm Age (years)	-0.002	(-4.290)***	0.0001	(0.235)	-0.013	(-1.946)*		
Firm Size (lnasset)	-0.021	(-4.881)***	-0.002	(-0.448)	0.001	(0.930)		
BSize	0.001	(1.473)	-0.001	(-0.795)	0.052	(2.649)***		
OutDir	0.044	(3.953)***	-0.039	(-3.497)***	0.050	(2.156)**		
Duality	-0.018	(-2.432)**	-0.024	(-2.169)**				
Observation	2030		875		1155			
R^2	0.760		0.716		0.754			
Adj. R^2	0.719		0.666		0.712			
F-stat (p-value)	18.601 (0.000)		14.434 (0.000)		17.752 (0.000)			

*** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

t-statistics are in parentheses

Table 5. The Fixed Effect Models by Using Return on Equity (ROE)

Variables	Full Sample (N=290)		Family (N=125)		Non Family (N=165)	
Intercept	0.888	(8.333)***	0.515	(4.119)***	0.895	(5.731)***
Firm Leverage	0.032	(2.220)**	-0.016	(-0.471)	0.010	(0.472)
Firm Age (years)	0.004	(3.771)***	0.0001 (	0.070)	0.006	(3.518)***
Firm Size (lnasset)	-0.071	(-7.604)***	-0.022	(-2.107)**	-0.082	(-5.773)***
BSize	-0.009	(-4.885)***	-0.012	(-4.709)***	-0.011	(-4.383)***
OutDir	0.064	(2.371)**	-0.072	(-2.489)**	0.130	(2.925)***
Duality	0.018	(0.780)	-0.036	(-2.280)**	0.147	(1.850)*
Observation	2030		875		1155	
R^2	0.542		0.571		0.516	
Adj. R^2	0.464		0.496		0.433	
F-stat (p-value)	6.958 (0.000)		7.608 (0.000)		6.183 (0.000)	

*** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.
t-statistics are in parentheses

Monetary Aggregates and Price Stability in the BEAC Zone

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Abstract

The main objective of this study is to evaluate the relevance of the use of monetary aggregates to achieve price stability in the BEAC zone. More precisely, the aim of the study is to examine the properties of stability, controllability and information content of monetary aggregates within the periods 1985- 2005 and 1992- 2005 using quarterly data. The econometric investigation leads to the following results: (a) the stability of monetary aggregates of the BEAC zone is verified; (b) the hypothesis of controllability of monetary aggregates is confirmed; (c) the contribution of monetary aggregates to the explanation of inflation is weak in short run and shows some improvement in the long run.

Keywords: Stability of monetary aggregates, Controllability of monetary aggregates, Information content of monetary aggregates.

1. Introduction

As a result of inflation pressures, monetary targeting policy became the key anchor of monetary policy of most Central Banks in Developed Countries during the 1970s. The usual relationship between monetary aggregates and the final objectives of monetary policy shift sharply during the middle 1970s and in the early 1980s due to innovations in the financial system. Opinions are divided between those for and against the use of monetary aggregates in the conduct of monetary policy. Friedman (1997) demonstrates that monetary aggregates are no more useful. According to McPhail (2000), the use of monetary targeting policy still makes sense since monetary aggregates fulfil the properties of stability, controllability and information content.

Since 1990, the final objective of price stability is explicitly defined in the BEAC zone. To achieve this final objective, monetary aggregates became the main focus of monetary policy strategy with the introduction of monetary programming (note 1). The data show that, since this period, the BEAC zone has been enjoying relative price stability. For about a decade, the inflation rate of the BEAC has been rotating between 0.5% and 6% with the highest rate of 5.9% obtained in 1997 and the lowest rate, 0.5%, in 1999. However, some periods of inflationary tension are hidden behind this relative stability. This is the case with some countries that suffered from two digit inflation. Except the period of inflationary tension due to the devaluation of the CFA in 1994, countries like Chad and Congo record an inflation of 12.4% in 2001 and 16.6% in 1997 respectively. Equatorial Guinea has equally been suffering from a high inflation rate of 8.8%, 7.6% and 7.3% in 2001, 2002 and 2003 respectively. It is also important to emphasise that certain countries have sometimes experienced periods of negative inflation rates. This occurred in 1998 and 1999 in Central Africa Republic with inflation rates of -1.9% and -1.5% respectively. This has been also observed in Congo in 1998 (-1.6%), 2000 (-0.34%) and 2003 (-0.2%); in Gabon and Chad in 1999 with inflation rates of -0.7% and -8% respectively.

Also, the conduct of monetary policy, since the reform of 1990, stresses two stylised facts. The first one highlights the gap between the announced monetary objectives and the realized one. Statistics show that the growth of money supply is 9% while the prevision is 1.5% in 1999; also, in the 2001, the prevision of money growth lies between 7.8% and 9.8% for a realisation of 7.1%. The second stylised fact indicates the contrast between the variation of money supply and the evolution of inflation. In 1999 and 2000 for example, M_2 had a growth rate of 19.45% and 18.06% respectively whereas inflation was at a level of 0.3% and 1.5%. Then, we can observe that an increase of 9% in money supply leads to an inflation of 1.5%. Moreover, we realise that a fall in the growth rate of money supply is not always followed by an equally fall in inflation. Between 2000 and 2001, the growth rate of M_2 fell from 22.4% to 7.1% whereas the inflation rate moved from 1.5% in 2000 to 3% in 2002.

The main objective of this study is to evaluate the relevance of the use of monetary aggregates to achieve price stability in the BEAC zone. More precisely, the aim of the study is to examine the properties of stability, controllability and information content of monetary aggregates.

The paper proceeds as follow. Section 2 provides a review of the literature. In section 3, we present the models used for the empirical verification. Section 4 describes the data of the study. In the fifth section, the main results of the study are presented and discussed. Section 6 concludes.

2. Literature review

Many studies have attempted to analyze the properties of monetary aggregates in the conduct of monetary policy. Two major features characterize the existing literature. On one hand, there is no study which looks at the three properties together. Except the work of Bordes and Marimoutou (2001), Serletis and Molik (2000) which deal with

the question of stability and information content, the other studies look at the properties separately. On the second hand, the issue of empirical verification of the controllability of monetary aggregates is absent in the literature.

The stability of monetary aggregates is studied in the literature following many concepts and methods. In this sense, examine the stability of monetary aggregates refers as to look at the stability of money demand functions (Carlson and al, 2000), the stability of money velocity (Bordes and Marimoutou, 2001) or the stability of the relation between monetary aggregate and the final objectives of monetary policy (Estrella and Mishkin, 1997). The empirical methods used are one hand econometric using partial adjustment model, buffer stocks models and cointegration techniques. On the other hand, there are studies which used statistic test like chow test (Fielding, 1994), cusum test (Bahmani- Oskooee and Bohl, 2000) and Hansen test (Haug and Lucas, 1996). During the early of 1970s, the stability of monetary aggregates is well documented in the empirical literature. By the middle of the decennia, empirical studies conclude that money demand functions are instable and since then the results on the stability of monetary aggregates are mixed.

The empirical evaluation of the information content of monetary aggregates can be divided in two main streams. The first line of the research answer to the following question: can the variations of monetary aggregates cause the fluctuations of prices? While the second line focuses on the contribution of monetary aggregates in the evolution of inflation. Granger causality test (Gerlach and Svensson, 2003), correlation test (De Grauwe and Polan, 2001) and the estimation of a relation of cointegration (Serletis and Molik, 2000) are various approaches used to study the cause effect analysis. The cause effect approach does not give the real contribution of monetary aggregates in the variation of prices. Therefore, variance decomposition analysis gives more insight on this issue. We can enumerate two studies made in this line that is Roberds and Whiteman (1992) and Bordes and Marimoutou (2001).

3. A brief description of estimation methodology

3.1 The stability of the relation between money and price stability: the empirical model

The stability of monetary aggregates is verified by studying the stability of money velocity. In this sense, both univariate and multivariate approaches can be used. The appropriate method to estimate the univariate trend depends on the stationary properties of money velocity. Bordes and al (2007) argue that if money velocity is stationary, on can conclude that this variable is stable. According to the multivariate approach, the stability of the relation between money velocity and its determinants is studied using the technique of cointegration of Johansen (1988) and Johansen and Juselius (1990).

Following Bordes and Marimoutou (2001), the specification of the long-run relation between money velocity and its determinants is as follow:

$$v_t = \alpha_0 + \beta_0 \inf_t + \gamma_0 r_t + u_t \quad (1)$$

with v_t: money velocity (in logarithm), π_t: inflation (in logarithm) and r_t: the main interest rate. Equation 1 is completed by equations which describe the short term relation between the variables.

Two steps are implemented for the empirical verification. The first step is to test the existence of a cointegrating relation between money velocity, inflation and the main interest rate using trace statistic test. If such relation exists, one proceeds to the estimation of the long run relation giving the expression of money velocity. The long run relation is completed by equations which describe the short term relation between the variables.

3.2 The controllability of monetary aggregates

The empirical verification of the controllability of monetary aggregates supposes the existence of a causal relationship between the monetary aggregate and the main interest rate. This is done by looking first at the cross coefficient correlation which measures how tight the relation is. Second, we use Granger causality test to indicate the effectiveness of the causal relationship.

3.3 The evaluation of information content of monetary aggregates

The empirical method to evaluate the information content of monetary aggregates is double. First, we examine the existence of a causal relationship between monetary aggregate and inflation using cross correlation coefficient and Granger causality test. Second, we check to what extent monetary aggregates can help to forecast prices using variance decomposition; this is made by using the methodology of Johansen (1988) and Johansen and Juselius (1990).

The Johansen and Juselius model (1990) has in this case three variables that are main interest rate, inflation rate and money growth. Three steps are followed by the Johansen (1988) and Johansen and Juselius (1990) procedure. The first one is to test of the hypothesis of the existence of one or more cointegration relations using trace statistic test. If the hypothesis cannot be rejected, we estimate the model which describes the long run relationship between growth rate of monetary aggregate, inflation rate and main interest rate (equation 5) and the short run relation between the variables. Finally, we use variance decomposition to evaluate the contribution of the monetary aggregates in explaining the general price level.

$$\pi_t = \alpha_0 + \beta_0 r_t + v_o m_t + u_t \quad (2)$$

The estimation of the VAR model leads to the variance decomposition analysis. Variance decomposition evaluates the contribution of the monetary aggregates in explaining the general price level.

4. Data and sample period

The variables used in the study are money velocity of M_1 (V_1BEAC) and M_2, (V_2BEAC), inflation (CPIBEAC), the main interest rate (TIDBEAC), monetary aggregate M_1 (M_1BEAC) and M_2 (M_2BEAC). Inflation is approximated by consumer price index. Monetary aggregates used in the study are those composing the money supply of the BEAC. Money velocity M_1 is defined as the ratio between GDP and monetary aggregate M_1 and the money velocity of M_2 is obtained by dividing GDP by monetary aggregate M_2. We use quarterly data and the statistics are obtained from IFS CD- ROM. Concerning data of GDP, we use the procedure of Goldstein and Khan (1976) to obtain quarterly data from annual data.

The sample period of the study lies within the periods 1985- 2005 and 1992- 2005 using quarterly data. This distinction in the sample period is made to show if the introduction of monetary programming has lead to significant change in the behaviour of monetary aggregates in the BEAC zone.

5. Results and discussions

The ADF test shows that the variables are non stationary in levels but they become stationary after first differencing.

5.1 The stability of BEAC's monetary aggregates

Figure 1 and figure 2 describe respectively the evolution of money growth rate and money velocity of the two monetary aggregates. Figure 1 show the evolution of M_1 and M_2 are similar. We can observe that the evolution of the money growth rate is laid within a band. This insight proves a certain stability in the evolution of the two monetary aggregates.

Figure 2 emphases the parallel evolution of money velocity of M_1 and M_2. They show a downward tendency since the first quarter of 1985. This reflects that the progression of monetary aggregate is faster than the one of GDP. This tendency is more accentuated from 1995 and reveals the monetization of the economy due to the amelioration of bank system in terms of number of bank and the confidence of economic agents.

Also, we observe that money velocity M_1 and M_2 deviate from the general trend between the first quarter of 1992 and the fourth quarter of 1994. This period coincide with the introduction of monetary programming and the devaluation of the CFA franc in January 1994. Except this temporary deviation, figure 2 shows that within the period, money velocity M_1 and M_2 are characterized by a stable evolution.

The econometric procedure begins with the test of the existence of one cointegrating relation between money velocity of each monetary aggregate, interest rate and inflation. The results show that there is no cointegrating relation between these variables between the first quarter of 1985 and the fourth quarter of 2005. Therefore, the hypothesis of stability of money velocity of the two monetary aggregates is rejected. This conclusion is justified since figure 2 show a temporary instability in the behavior of monetary aggregates. According to the literature, a temporary instability does not compromise the long term stability of monetary aggregates. In order to take account this instability, we introduce a dummy variable which takes the value zero from first quarter of 1985 to fourth quarter of 1991 and one from first quarter of 1992 to the end of the period. The existence of one cointegrating relation is then established.

Table 1 presents the results of the estimation of the long run relation between money velocity M_1, inflation and interest rate on one side and the estimation of the long run relation between money velocity M_2, interest and rate inflation on the other side within the two periods of analysis. The results of error corrections models do not have particular comments here. Table 1 reveals that, the two explanatory variables that are inflation and interest rate have the expected sign. The acceleration of inflation, which is significant at 1%, reduces the demand of cash and *ceteris paribus* increases the money velocity. An increase of the main interest rate, which have a positive impact on deposit interest rate, bring the economic agents to hold money in terms of saving and term deposits; the implication is a negative impact on money velocity of M_2 *ceteris paribus*. The holding of more money in term of saving and deposits can lead to an increase in M_1's monetary assets and explain *ceteris paribus* the decrease of money velocicy of M_1. However, table 1 shows that the dummy variable is significant in the two regressions. The intuition behind this result is that the introduction of monetary programming has a significant impact on the evolution of money velocity of monetary aggregates. Bordes and al (2007), which study question the existence of a structural break in the evolution of monetary velocity in Euro zone, arrive to a similar result. After all, the results show that there exists one cointegrating relation between the different money velocity, inflation and the interest rate. We can then conclude on the stability of monetary aggregates of the BEAC.

The question is now to compare the stability of the two monetary aggregates M_1 and M_2 on one hand and the stability of the monetary aggregates within the two periods of analysis on the other hand. Table 2 shows that M_2 is more stable within the two periods. In fact, the coefficient of variation of both the money growth rate and money velocity is weaker for M_2. The theoretical background of this result is that substitution between monetary assets does not relatively affect the stability of large monetary aggregates. Looking at the result of the comparison of the stability of the monetary aggregates within the result shows that there is a paradox. In fact, when we are looking the

coefficient of variation of the money growth rate, the monetary aggregates are more stable between the first quarter of 1992 and fourth quarter of 2005. If we refer to the results obtained by the money velocity, the stability of the aggregates is better on the other period. This paradox is justified in the sense that the ratio between GDP and monetary aggregates take into account both the incidence of GDP on monetary aggregate and the impact of monetary aggregate on GDP.

5.2 The controllability of BEAC's monetary aggregates

The result of cross correlation (table 3) shows that there is strong correlation between the main interest rate and the monetary aggregates within the period of analysis. The negative sign of the coefficient of correlation confirm theoretical prediction of the inverse relation between interest rate and money supply. The increase of the main interest rate is associated with a restrictive monetary policy. However, the coefficient of correlation is higher in the case of M_1 in the two period of the sample. This result emphases that monetary authorities have a better control on narrow monetary aggregates as the theory has predicted. The comparison of the results within the period shows that, since the reform, the controllability of monetary aggregates is better. This result is justified in the sense that with the institution of monetary market, monetary authorities of the BEAC zone influence the quantity of the money in the economy by manipulating the main interest rate.

The Granger causality test permits to determine rigorously whether the relation between the main interest rate and the monetary aggregates M_1 and M_2 is tight. Table 4 gives the result of different Granger causality test and the results show that there is cause effect relation between the main interest rate the two monetary aggregates. In fact, the hypothesis of the non existence of causal relation is rejected at different level of significativity.

Thus, the results show that the two monetary aggregates can be controlled by the monetary authorities of the BEAC zone. This result is not surprising since, in the literature, the stability of monetary aggregates, as it's observed in the BEAC zone, implies the control of money supply by the manipulation of interest rates (Herwartz and Reimers, 2001).

5.3The information content of BEAC's monetary aggregates.

The restitution of the results on the information content of BEAC's monetary aggregates is made following three ways. Firstly, we proceed to a graphical observation. Figure 3 describes the group of dots between inflation rate and monetary aggregate M_2 (figure a) and between inflation rate and monetary aggregate M_1 (figure b). In general, we can observe a strong concentration of the points except a few of them which coincide with the high rate of inflation due to the devaluation of the CFA franc.

Secondly, cross correlation tests are tabulated (see table 5) and Granger causality test are run (table 6). The different values of cross correlation test are positive reflecting the classical theory of the existence of a positive relation between money growth and inflation. But the values are less than one. Therefore, there is not a proportional relationship between the variation of money supply and inflation. This result confirm the fact the relation between money and inflation is not strong in the countries where inflation is low (McCandless and Weber, 1995) as it's the case in the BEAC zone. However, coefficients of correlation obtained between the money growth rate of M_2 and the inflation rate are higher than the one obtained between the money growth rate of M_1 and inflation rate. Therefore, fluctuations of prices are more explain by the monetary aggregate M_2. Concerning the period, table 5 shows that price fluctuations are more explained by the two monetary aggregates since the instauration of monetary programming. The intuition behind this result is that since the instauration of monetary programming there is an improvement in the information content of monetary aggregates. Table 6 describes the results of Granger causality test. At 5% of significativity, the null hypothesis of the test is rejected. The result shows that the two monetary aggregates Granger cause inflation. This conclusion is on the line with the quantitative theory of money and it's well documented in the literature.

Thirdly, we evaluate the contribution of monetary aggregates in the fluctuations of prices using variance decomposition analysis. The results of variance decomposition analysis are presented on table 7. These results shows that the evolution of inflation is better explained as the time is going. This confirms the existence of lags in the conduct of monetary policy (note 3). In the short run, the qualities of monetary aggregates as indicator are worse. Within the first quarter of 1985 and the fourth quarter of 2005, monetary aggregate M_1 explain 10.11%, 14.22% and 22.15% of inflation respectively at a horizon of four, six and eight quarters. The variations of inflation due to monetary aggregates M_2 are respectively 19.19%, 21.09% and 31.89% for the same horizon. These findings are the same with those of Roffia and Zaghini (2007), Assenmacher-Wesche and Gerlach (2006) which show that the capacity of prevision of monetary aggregate is weak in the short run.

The information content of monetary aggregate M_2 is higher than the one of monetary aggregate M_1 irrespectively of the period and the horizon. This result is justified since large monetary aggregates comprise more monetary assets than narrow monetary aggregates. It's then straightforward to think that the information content of M_2 adds to the information content of M_1 the one of quasi money. The study of McPhail (2000) reaches to the same result.

A comparison of the result within the two period of analysis highlights the fact the information contact of the monetary aggregates has not fundamentally improve with the adoption of monetary targeting policy. One justification is that the composition of monetary aggregates has not changed with the introduction of monetary

programming. However, the variance decomposition analysis shows that, for the horizon relevant for the conduct of monetary policy, the qualities of monetary aggregates as indicators are better since the adoption of monetary targeting policy. This result make sense since, with the introduction of monetary programming, monetary authorities decide the quantity of money supply they put in the economy compatible with the objective of price stability.

In the long run, the ability of monetary aggregates to forecast the evolution of inflation improves. For example, between the first quarter of 1985 and the fourth quarter of 2005, the inflation rate is explained at thirty and forty quarters by monetary aggregate M_1 respectively at 42.25% and 47.42%. The percentages are 44.54% and 48.50% in the case of monetary aggregate M_2. This improvement is justified by the fact that in the long run, money supply increases more rapidly than the GDP which traduce a high impact of money on the general price level.

6. Conclusion

The objective of this paper was to evaluate the relevance of use of monetary aggregates to achieve price stability in the BEAC zone. More precisely, the aim of the study is to examine the properties of stability, controllability and information content of monetary aggregates.

Looking at the stability of the monetary aggregates, the paper highlights the fact that the two monetary aggregates M_1 and M_2 of the BEAC are stable within the period of the study. Moreover, the monetary aggregates are more stable between the first quarter of 1992 and the fourth quarter of 2005. Also, M_2 has a better stability within the two periods. The results confirm the hypothesis of controllability of BEAC's monetary aggregates. This controllability is better for the narrow monetary aggregate on one hand and since the adoption of monetary targeting policy. The evaluation of the information content emphasizes that the qualities of monetary aggregates in term of the explanation of price fluctuations are weak in the short run. But, there is some improvement in the long run. A comparison of the information content of M_1 and M_2 reveal that M_2 explain more price fluctuations irrespective of the horizon and the period of analysis. Moreover, the paper highlights the fact that the information content of monetary aggregates has fundamentally improve with the introduction of monetary programming.

The main result of the study is that the use of monetary aggregates to achieve price stability in the BEAC zone is relevant. This result is confirmed by the fact that the empirical performances of monetary aggregates are improved with the introduction of monetary programming in 1992. However, monetary authorities of the BEAC should focus on the two monetary aggregates (M_1 and M_2) since in terms of controllability, M_1 has better empirical results.

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Notes

Note 1. With the introduction of monetary programming, monetary aggregates became the intermediate targets in the conduct of monetary policy of the BEAC, especially M_2.

Note 2. Granger (1983, 1986) shows that the stability of a long run equilibrium relationship is equivalent to the concept of cointegration.

Table 1. Results of the estimation of the long- run relation between money velocity, inflation and interest rate.

1985Q1- 2005Q4	V_1BEAC				V_2BEAC			
	Coef.	Std.	z	P>|z|	Coef.	Std.	z	P>|z|
CPIBEAC	0.734803 (*)	0.1468371	5.00	0.000	1.41495 (*)	0.3632868	3.89	0.000
TIDBEAC	-0.175003 (*)	0.0290307	-6.03	0.000	-0.2997721(*)	0.071861	-4.17	0.000
DUMMY	-0.470121 (*)	0.1259607	-3.73	0.000	-0.714866 (**)	0.3174359	-2.25	0.024
1992Q1- 2005Q4	V_1BEAC				V_2BEAC			
	Coef.	Std.	z	P>|z|	Coef.	Std.	z	P>|z|
CPIBEAC	0.173882 (*)	0.0382482	4.55	0.000	0.3693087 (*)	0.0892466	4.14	0.000
TIDBEAC	-0.056681 (*)	0.0096456	-5.88	0.000	-0.0856097 (*)	0.0223742	-3.83	0.000

(*), (**) and (***) represent the level of significativity of the variables respectively at 1%, 5% and 10%.

Table 2. Mean, standard deviation and coefficient of variation of money growth rate and money velocity

	1985Q1- 2005Q4			1992Q1- 2005Q4		
	Mean	Standard deviation	Coef. of variation	Mean	Standard deviation	Coef. of variation
M_1BEAC	1.309489	5.005784	3.8228	1.885846	5.67215	3.0077
M_2BEAC	1.133753	3.829617	3.3779	1.672964	4.157124	2.4849
V_1BEAC	1.348875	0.249402	0.1848	1.278139	0.278349	0.2177
V_2BEAC	0.858988	0.132527	0.1542	0.828664	0.150512	0.1816

Table 3. Results of the correlation test between the main interest rate and the monetary aggregates M_1 and M_2

	1985Q1- 2005Q4		1992Q1- 2005Q4	
	M1BEAC	M2BEAC	M1BEAC	M2BEAC
TIDBEAC	-0.8034	-0.7842	-0.8216	-0.7910

Table 4. Results of the Granger causality test between the main interest rate and the monetary aggregates M_1 and M_2

Null Hypothesis:	F-Statistic	Probability
TIDBEAC does not Granger Cause M1BEAC	0.29485	0.58864
TIDBEAC does not Granger Cause M2BEAC	0.10462	0.74720
TIDBEAC does not Granger Cause M1BEAC	0.51050	0.47806
TIDBEAC does not Granger Cause M2BEAC	0.44581	0.50723

Table 5. Results of cross correlation test between money growth and inflation rate.

	1985Q1- 2005Q4		1992Q1- 2005Q4	
	M1BEAC	M2BEAC	M1BEAC	M2BEAC
Taux d'inflation	0.3402	0.4142	0.3602	0.4424

Table 6. Results of the Granger causality test between monetary aggregates M_1 and M_2 and inflation

Null Hypothesis:	F-Statistic	Probability
M1BEAC does not Granger Cause CPIBEAC	1.40477	0.24140
M2BEAC does not Granger Cause CPIBEAC	1.10108	0.36298
M1BEAC does not Granger Cause CPIBEAC	0.06242	0.93956
M2BEAC does not Granger Cause CPIBEAC	1.23164	0.31031

Table 7. Results of variance decomposition analysis

Horizon	1985Q1- 2005Q4		1992Q1- 2005Q4	
	M1BEAC	M2BEAC	M1BEAC	M2BEAC
1	7.362880	11.75009	18.81588	23.80654
4	10.11892	19.19529	12.77472	19.20553
6	14.22271	21.0915	14.22881	22.14099
8	22.15080	31.89268	20.40403	31.91070
10	27.28112	34.81000	24.35053	33.99147
20	35.39091	39.85769	30.33624	38.28488
30	42.25608	44.54431	35.77442	42.18187
40	47.42708	48.50881	40.19111	45.54975

Figure (a)

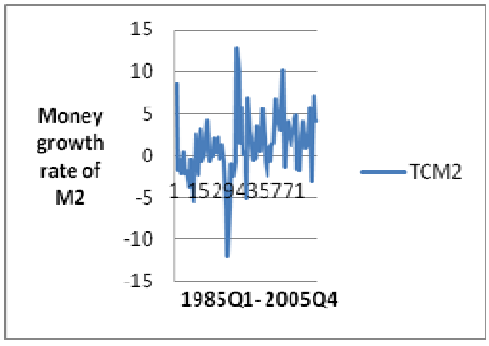
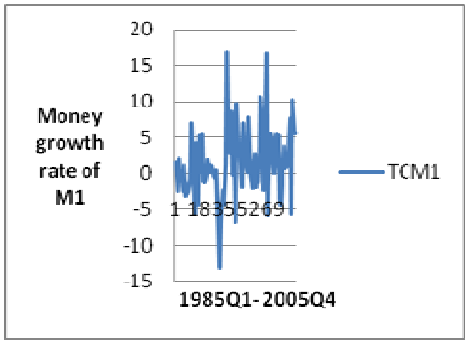
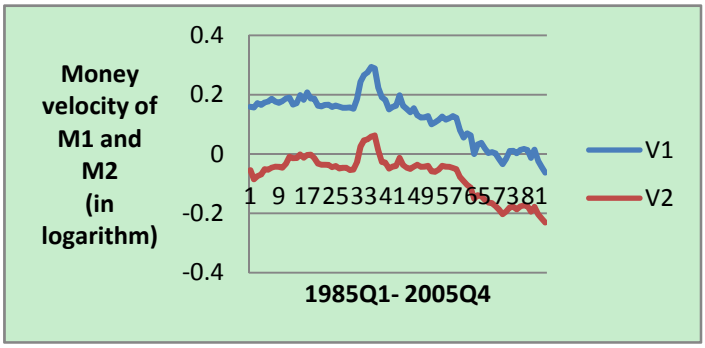


Figure (b)



Source: Author

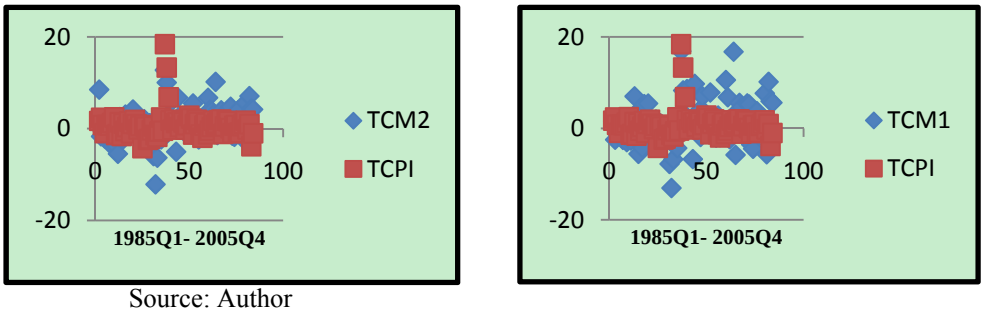
Figure 1. Evolution of money growth rate M1 and money growth rate M2 in the BEAC zone from 1985 to 2005 using quarterly data



Source: Author

Figure 2. Evolution of money velocity M1 et money velocity M2 in the BEAC zone from 1985 to 2005 using quarterly data

Figure (a) Figure (b)



Source: Author

Figure 3. Evolution of inflation rate and money growth rate of M1 and money growth rate of M2 (group of dots)

Intrinsic Bubbles in the American Stock Exchange: The case of the S&P 500 Index

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Abstract

The aim of this paper is to test the presence of rational intrinsic bubbles in the S&P 500 index. To this effect, we used two econometric techniques. The first technique applies stationarity and cointegration tests to real prices and dividends series. The second technique consists in directly estimating intrinsic bubbles coefficients. Studying a sample of annual real price and dividends indices, observed during the 1871 to 2009 period, we note the presence of a bubble with features consistent with intrinsic bubbles theory.

Keywords: Rational bubbles, Intrinsic bubbles, Fundamentals-dependent bubbles, Stationarity and cointegration test.

JEL classification: C22; E31; G12

1. Introduction

The Efficient Market Hypothesis (EMH) stipulates that the observed price entirely and accurately reflects all the information disclosed on the market. From this perspective, the observed price should be compatible with its fundamental value. However, when a stock price deviates from this value, arbitrage mechanisms prevail in terms of selling overvalued stocks and buying undervalued stocks. The aim of such behavior is to permanently adjust prices to their fundamental values. Shiller (1981) and LeRoy and Porter (1981), studying the US market and using variance bound tests, note that market prices exhibit an excessive volatility compared to their fundamental values. The idea behind this test is that in an efficient market stock prices variance should be bound by a theoretical value which depends solely on the variability of the price's fundamental determinants. Mankiw, Romer and Shapiro (1985) developed an alternative measure of stock prices volatility, called the second generation test. This latter is a new reformulation of the variance bound test based on a naive prediction of fundamental values that are issued from naive information. Market prices' excessive volatility is the main reason for the emergence of the speculative bubbles theory. Accordingly, we distinguish between two categories of rational bubbles. Those exogenous to the economic fundamentals and those directly issued from these fundamentals.

As for the exogenous rational bubbles, they exhibit an evolution pattern bound by time. This type of bubbles rests on the idea that prices are guided by self-fulfilling predictions causing the bubble to increase exponentially to interest rate (Blanchard and Watson (1982), Fung (1999a, 1999b), Schaller and Norden (2002) and Evans (1991)). Several studies have been conducted on exogenous rational bubbles. The use of stationarity and cointegration tests is pervasive in these studies (Diba and Grossman (1987, 1988), Craine (1993), Campbell, Lo and Mackinlay (1997), Sarno and Taylor (1999), Psaradakis , Sola and Spagnolo (2001) and Gürkaynak (2005)). The obtained results often reject the absence of bubbles hypothesis without nevertheless confirming their presence. Gurkaynak (2008) proposes an excellent review of the different tests used to detect rational bubbles. Geiecke and Trede (2010), studying the Dow Jones Euro Stoxx 50 Price Index, note that the presence of rational bubbles is consistent with investors' rationality hypothesis. Watanapalachaikul and Islam (2003) checked for the presence of rational bubbles in the Thai market using the duration technique. The authors find out that this market is influenced by a rational bubble, specifically after the 1997 Asian crisis.

Despite their contribution in explaining deviation of prices from their fundamental value, exogenous deterministic and multi-regime rational bubbles are unable to explain several speculation-related behaviours, notably in a case where market prices fluctuations are with minimum effects. Furthermore, the absence of a measure for the different classes of exogenous rational bubbles is a major difficulty facing researchers. Consequently, research has refocused attention on a new venue with a double concern of developing, on the one hand, a new class of rational bubbles able to accurately reproduce fluctuation of prices and, on the other hand, including fundamentals in this development process. It took then some years to see the emergence of fundamentals-dependent bubbles (intrinsic bubbles) thanks mainly to the works of Ikeda and Shibata (1992) and Froot and Obstfeld (1991).

The dynamics, properties and shape of these bubbles, labelled endogenous, greatly depend on fundamentals. In order to detect the presence of fundamentals-dependent bubbles, it is enough to assume that fundamentals' random fluctuations (essentially dividends) carry information reflected both in the fundamental value and the bubble. Moreover, to meet the growth restriction, it is convenient to assume that investors use information disclosed by dividends so as to feed their predictions of the direction of the volatility of prices.

This paper is structured as follows. Section two presents the mathematical formulation used to compute the stock's fundamental value and the intrinsic bubble. Section three describes the sample and the study period. Section four reports the results and their discussion. Section five concludes the paper.

II. Rational Bubbles Specifications

By definition, the return rate R_{t+1}, of a stock is given by the sum of the most valued $(P_{t+1} - P_t)$, and of the dividend, D_{t+1}, adjusted to the stock price in t. Then,

$$R_t = \frac{P_{t+1} - P_t + D_{t+1}}{P_t} \tag{1}$$

where, R_{t+1} denotes the return on the stock held from time t to t + 1 and Dt+1 is the dividend in period t+1. The subscript t+1 denotes that only the return becomes known in period t + 1. Taking the mathematical expectation of (1), based on information available at time t, $E_t(.)$, we obtain:

$$E_t(R_{t+1}) = \frac{E(P_{t+1} + D_{t+1}) - P_t}{P_t} = R \tag{2a}$$

Where again $$E_t[P_{t+1}] - P_t + D_{t+1} = RP_t \tag{2b}$$

Rearranging (2), we obtain:

$$P_t = E_t\left[\left(\frac{1}{1+R}\right)D_{t+1}\right] + E_t\left[\left(\frac{1}{1+R}\right)P_{t+1}\right] \tag{3}$$

with $\left(\frac{1}{1+R}\right)$, denoting a discounting factor

Solving (2) forward k periods yield the semi-reduced form:

$$P_t = E_t\left[\sum_{i=1}^{k}\left(\frac{1}{1+R_{t+i}}\right)^i D_{t+i}\right] + E_t\left[\left(\frac{1}{1+R_{t+k}}\right)^k P_{t+k}\right] \tag{4}$$

In order to obtain a unique solution to (4) we need to assume that the expected discounted value of the stock in the indefinite future converges to zero:

$$\lim_{k\to\infty} E_t\left[\left(\frac{1}{1+R_{t+k}}\right)^k P_{t+k}\right] = 0 \tag{5}$$

The convergence assumption allows us to obtain the so-called fundamental value of the stock as the sum of the expected discounted dividend sequence:

$$F_t = E_t\left[\sum_{i=1}^{\infty}\left(\frac{1}{1+R_{t+i}}\right)^i D_{t+i}\right] \tag{6}$$

Abandoning the convergence assumption - equation (5) - leads to an infinite number of solutions any one of which can be written in the form of:

$$P_t = F_t + B_t \tag{7}$$

$$\text{with } B_t = E_t\left[\frac{B_{t+1}}{1+R_{t+1}}\right] \tag{8}$$

where F_t, denotes the dividend's future real value or the stock's fundamental value. The term B_t called a "rational bubble", as it is entirely consistent with rational expectations and the time path of expected returns. Blanchard and Watson (1981) define rational bubble as the difference between the observed price on the market and its fundamental value. In this regard, Gilles and Leroy (1992) insist that the term bubble translates the high increase in stock prices resulting from promises made by companies about future dividends. The higher the level of dividends is the higher will be the demand for the stock in such a way which intensifies pressures on prices. A dramatic decrease results in the non-fulfilment of these promises.

The literature distinguishes between several rational bubbles measures. Blanchard and Watson (1982) are the first to specify measures of exogenous rational bubbles. They proposed deterministic bubbles having an exponential increase and stochastic bubbles having an exponential inflation followed by a brutal collapse. Evans (1991) proposed the periodically collapsing bubbles which integrate the possibility of repetitive crashes. Fukuta (1998,

2002) proposed the incompletely bursting bubbles which are a generalisation of Blanchard and Watson's (1982) deterministic and stochastic bubbles and Evans' (1991) periodically collapsing bubbles.

Froot and Obstfeld (1991) specified a new set of bubbles, called intrinsic bubbles, which are exclusively bound in a nonlinear fashion to fundamentals, specifically dividends. Their deviation is explained by the fact that the component of stock prices which is unexplained by fundamental values is highly correlated with the dividends process. The authors insist that intrinsic bubbles provide an empirical measure of deviation of prices from their fundamental values. Froot and Obstfeld's intrinsic bubbles assume that the dividends' logarithmic function follows a geometric shape. Then,

$$d_{t+1} = \mu + d_t + \xi_{t+1} \tag{9}$$

where ;

μ , denotes the dividend's growth rate;

d_t , denotes the dividend's logarithm;

ξ_{t+1} , denotes a random null conditional prediction variable with a variance equal to σ^2 .

Then, when a dividend D_t , of a coming period is known at a moment t and if P_t is fixed by the market, the fundamental value of a stock will be directly proportional to dividends

$$P_t = kD_t \tag{10}$$

with $k = \left(e^r - e^{\mu + \frac{\sigma^2}{2}} \right)^{-1}$ et $r \succ \mu + \frac{\sigma^2}{2}$

The condition $r \succ \mu + \frac{\sigma^2}{2}$, indicates that interest rate, which is constant, should be superior to the dividends' growth rate.

The function of the intrinsic bubble specified by Froot and Obstfeld (1991) is written as

$$B(D_t) = cD_t^{\lambda} \tag{11}$$

where ;

c , is an arbitrary constant;

λ ,is the positive root of the following equation

$$\lambda^2 \frac{\sigma^2}{2} + \lambda\mu - r = 0 \tag{12}$$

At this level, it seems that the growth anticipation restriction imposed by equation (8) allows dividends to contribute in self-fulfilling predictions. Then, it is convenient to admit that dividends transmit information that investors use to ground their predictions.

By summing up the dividends' observed value, function (10), with the intrinsic bubble, function (11), we obtain the equation of the stock's fundamental price.

$$P_t = F_t + B_t = kD_t + cD_t^{\lambda} \tag{13}$$

Equation (13) indicates that the stock value is derived exclusively from fundamentals even in the presence of a speculative bubble. The presence of the intrinsic bubble allows, as suggested by equation (13), limiting the nonlinear dependencies that stock prices may exhibit. Likewise, it is clear that when the fundamental value varies, the stock price overreacts because of the bubble term which tends to amplify movement. Then, this bubble may cause an important and persistent deviation, yet it may remain stable during some periods.

3. Data and empirical results

3.1. Data

In this paper, we test the null hypothesis of no rational speculative bubbles in the US stock exchanges against the alternative hypothesis that bubbles do exist. This paper includes data for the years 1871 through 2009 of the US Stock Exchange. Data consist of real prices and real dividends of the S&P 500 index. Data is obtained from Robert Shiller's web page.

3.2. Empirical results

We test the presence of intrinsic bubbles for the S&P 500 index. First, we conduct a stationarity test. Then, we estimate the intrinsic bubble specification.

3.2.1. Descriptive Statistics

[Insert Table 1 here]

The real stock price series (S&P 500 composite stock price index) show a skewness coefficient different from zero and a kurtosis superior to 3. Consequently, the distribution of the real price is not normally distributed. It has rather a leptokurtic shape. Moreover, the Jaque Bera test rejects the normality hypothesis. It is possible to see that the real dividends series show a symmetry coefficient close to zero (skewness=0,75) and a flatness coefficient close to 3 (kurtosis=2,94). However, the jaque bera test rejects the normality hypothesis for the real dividends series.

3.2.2. Stationarity and cointegration

The main relationship between the cointegration test and the bubble is the following: presence of bubbles, which induces prices to deviate from their fundamental value, is assumed by an absence of cointegration between these two variables. Thus, testing the presence of cointegration (null hypothesis) is testing the absence of bubbles hypothesis. Cointegration and thus long-term equilibrium between prices and dividends, consequently exclude the presence of a speculative bubbles hypothesis.

Applying the cointegration technique on rational bubbles dates back to the works of Diba and Grossman (1988a). These authors noted that absence of cointegration may be due to the presence of a rational bubble which provoked a persistent deviation between the stock price and its fundamental value. Craine (1993), Campbell et al, (1997), Sarno and Taylor (1999) and Raymond (2001) further developed cointegration test techniques to adjust them to the rational bubbles theory. Table (2) reports the Phillips and Perron stationarity test applied on the two prices and real dividends series.

[Insert Table 2 here]

The PP test indicates that the two real prices and dividends series are non-stationary in level, yet they are stationary in first difference. Consequently, the two series are integrated at a 1, I(1) order. Prices and dividends stationarity in first difference excludes an explosive price hypothesis. According to Hamilton and Whiteman (1985), this assumption allows removing exogenous bubbles having an explosive growth. Indeed, Hamilton and Whiteman (1985) suggest that the presence of this type of explosive behaviour within stock prices, like Blanchard and Watson's deterministic bubble (1982, 1984), tends to make their process explosive.

Table (3) reports the results of the cointegration test in line with Johensen (1991, 1995).

[Insert Table 3 here]

The trace test indicates the absence of a cointegration relationship between the real price and the real dividend. This observation points to the presumption of the presence of a rational bubble.

At this level and in line with Diba and Grossman (1988) and Campell and Shiller (1987) and Sarno and Taylor (1999) and Raymond (2001), it is convenient to assume that these cointegration tests can only give a presumption of the presence of bubbles. It is necessary then to further refine the empirical specification through estimating the bubble's parameters. To this effect, we retain the intrinsic bubble's formal specification initially proposed by Froot and Obstfeld (1991). In order to assess the presence of this type of bubble, it is enough to assume that random fluctuations (essentially dividends) transmit information reflected in both the fundamental value and the bubble. Moreover, to be in line with the growth anticipation constraint, it is convenient to assume as well that investors use information transmitted by dividends to base their anticipation of stock prices' future evolution.

3.2.3. Intrinsic bubbles

From an econometric perspective, testing the presence of intrinsic bubbles is testing the following regression;

$$P_t = c_0 D_t + cD_t^{\lambda} + \varepsilon$$

where,

$$c_0 = K = \left(e^r - e^{\mu + \frac{\sigma^2}{2}} \right)^{-1} \text{ and } \qquad \lambda = \frac{-\mu \pm \sqrt{\mu^2 + 2r\sigma^2}}{\sigma^2}$$

In order to avoid the multi-collinearity problem facing the regression, it is necessary to estimate the following modified regression.

$$\frac{P_t}{D_t} = c_0 + cD_t^{\lambda - 1} + \eta_t$$

Where η_t are independent from dividends.

The null hypothesis of the absence of a bubble is H_0: $c_O = K$ and c=0 against the alternative hypothesis of the presence of a bubble H_1: $c_O = K$ et $c > 0$.

The retained methodology is that of Froot and Obstfeld's (1991). We estimate the intrinsic bubbles model by imposing the root λ in the regression. It is however necessary to estimate the priori market process by a geometric random imposed on the dividends to determine μ et σ^2.

The Dividends Process: the hypothesis of a geometric martingale plays a major role in the study of intrinsic bubbles. For this reason, we should be sure of its validity before moving ahead with our test.

$$d_{t+1} = \mu + d_t + \varepsilon_{t+1} \quad , \varepsilon_{t+1} \rightarrow N(0, \sigma^2)$$

The estimation of the process of dividends indicates that $\mu = 0{,}0137$ and that $\sigma = 0{,}1166$. These values, to which we add up the average return rate of the stocks which approximates 8,20 % during the whole study period, allow us to determine the roots of λ :

$$\lambda_1 = 2{,}608 \text{ et } \lambda_2 = -4{,}622$$

Taking into account these parameters, the theoretical K given by

$K = \left(e^r - e^{\mu + \frac{\sigma^2}{2}} \right)^{-1}$, is evaluated at 15,433. This value indicates, following equation (3.20), that the price should be 15,433 times higher than the dividend.

[Insert Table 4 and table 5 here]

It is possible then to conclude that the obtained results differ from the value of the λ parameter. Differently put, when $\lambda_1 = 2{,}608$ (table 4), the constant of the model c_0 is significantly different from zero and approximates the theoretical value ($c_0 = 12{,}47$ and K= 15,433). The intrinsic bubble coefficient is significant at the 1% level. The model shows an explanatory power of 53,4%. However, when $\lambda_2 = -4{,}622$ (table 5), the constant takes a value very far from the theoretical value. The explanatory power of the model is very low (Adjusted $R^2 = 3{,}73\%$). Then, we retain only the root $\lambda_1 = 2{,}608$.

4. Conclusion

The theoretical predictions of the EMH seem to be hardly reconcilable with the reality of financial markets' mechanisms. Speculative incidents throughout the economic and financial history and more specifically the periodic stock market crashes hitting international financial markets, starting from the "Tulip Bulb Mania" in Holland, the "South Sea Bubble", the 1929 or 1987 crisis, till the repetitive collapses of the stock markets during mars 2000, October 2002 and Mars 2003, are examples of anomalies inherent mainly to speculation mania. Moreover, the recent subprime crisis which first hit the real estate market in 2007, before spreading over the stock market is indeed another example of a speculative bubble explosion. With regard to this paper, we tested the presence of a rational intrinsic bubble in the S&P 500 index. Using a sample of real prices and dividends series observed over the 1871 to 2009 period, we noted the presence of an intrinsic bubble in line with the specifications suggested initially by Froot and Obstfeld (1992).

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Table (1). Descriptive Statistics

	P	DIV
Mean	339.8814	11.16683
Median	199.8170	9.945235
Maximum	1709.492	27.21658
Minimum	65.67299	4.052238
Std. Dev.	346.6378	5.142829
Skewness	2.192548	0.750292
Kurtosis	7.350007	2.942634
Jarque-Bera	219.3718	12.96651
Probability	0.000000	0.001529
Sum	46903.63	1541.022
Sum Sq. Dev.	16461611	3623.470
Observations	138	138

Table 2. Testing for stationarity

Real Price : level		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.396896	0.3795
Test critical values:	1% level	-4.025924	
	5% level	-3.442712	
	10% level	-3.146022	
Real Price : first difference		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.472102	0.0001
Test critical values:	1% level	-4.026429	
	5% level	-3.442955	
	10% level	-3.146165	
Real dividend: Level		**Adj. t-Stat**	**Prob.***
Phillips-Perron test statistic		-1.890196	0.6542
Test critical values:	1% level	-4.026429	
	5% level	-3.442955	
	10% level	-3.146165	
*MacKinnon (1996) one-sided p-values.			
Residual variance (no correction)			1.015502
HAC corrected variance (Bartlett kernel)			1.267939
Real dividend: First difference		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.779100	0.0000
Test critical values:	1% level	-4.026942	
	5% level	-3.443201	
	10% level	-3.146309	

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Table 3. Johansen Cointegration Test

Date: 06/07/10 Time: 16:42				
Sample (adjusted): 1876 2008				
Included observations: 133 after adjustments				
Trend assumption: No deterministic trend (restricted constant)				
Series: P DIV				
Lags interval (in first differences): 1 to 4				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.084048	17.21833	20.26184	0.1246
At most 1	0.040814	5.542105	9.164546	0.2292
Trace test indicates no cointegration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.084048	11.67622	15.89210	0.2056
At most 1	0.040814	5.542105	9.164546	0.2292
Max-eigenvalue test indicates no cointegration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):				
P	DIV	C		
0.005881	-0.307445	1.959895		
0.002458	-0.286570	1.610360		
Unrestricted Adjustment Coefficients (alpha):				
D(P)	-2.720114	-13.33925		
D(DIV)	0.260235	-0.081382		
1 Cointegrating Equation(s):		Log likelihood	-922.7402	
Normalized cointegrating coefficients (standard error in parentheses)				
P	DIV	C		
1.000000	-52.27532	333.2434		
	(11.5860)	(133.071)		
Adjustment coefficients (standard error in parentheses)				
D(P)	-0.015998			
	(0.03519)			
D(DIV)	0.001531			
	(0.00050)			

Table 4. intrinsic bubbles (λ_1 = 2,608)

$$\frac{P_t}{D_t} = c_0 + cD_t^{\lambda-1} + \eta_t$$

Variable	Coefficient	Std. Error	t-Statistic	Prob.
c_0	12.47335	1.795953	6.945255	0.0000
c	0.254180	0.051443	4.941031	0.0000
R-squared	0.537485	Mean dependent var		26.02589
Adjusted R-squared	0.534085	S.D. dependent var		13.62504
S.E. of regression	9.300181	Akaike info criterion		7.312332
Sum squared resid	11763.10	Schwarz criterion		7.354756
Log likelihood	-502.5509	Hannan-Quinn criter.		7.329572
F-statistic	158.0448	Durbin-Watson stat		0.306705
Prob(F-statistic)	0.000000			

Table 5 : intrinsic bubbles (λ_2 = - 4,622)

$$\frac{P_t}{D_t} = c_0 + cD_t^{\lambda-1} + \eta_t$$

Variable	Coefficient	Std. Error	t-Statistic	Prob.
c_0	27.20041	2.713767	10.02312	0.0000
c	-49758.75	20435.88	-2.434872	0.0162
R-squared	0.044345	Mean dependent var		26.02589
Adjusted R-squared	0.037318	S.D. dependent var		13.62504
S.E. of regression	13.36840	Akaike info criterion		8.038051
Sum squared resid	24305.11	Schwarz criterion		8.080475
Log likelihood	-552.6255	Hannan-Quinn criter.		8.055291
F-statistic	6.310743	Durbin-Watson stat		0.164389
Prob(F-statistic)	0.013170			

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Is Earnings Management Opportunistic or Beneficial in Taiwan? Application of Panel Smooth Transition Regression Model

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Abstract

This paper analyzes whether discretionary accruals affects firm value under the corporate governance mechanism via a panel of 277 Taiwanese listed companies from 1997 to 2007. Our results show that when managerial ownership is less than 9.67%, managers may engage in opportunistic earnings management. However, while managerial ownership higher than 9.67%, managers may tilt toward efficient earnings management. Only efficient earnings management is found in either board size less than 9 members or more than 12 members and institutional ownership less than 43.8%. Also, small board has greater impact on efficient earnings management than larger board. When the proportion of outside directors is below 38.73%, they can effectively supervise managers to engage in efficient earnings management.

Keywords: Firm value, Corporate Governance, Earnings Management

1. Introduction

Recently fraud cases have come out one after another in Taiwan, basically due to an unsound company operating system and the lack of corporate governance mechanism to control the behavior of managers, in which managers use earnings management to empty out the firms' assets, resulting in damages to investors' interests. However, would managers that engage in earnings management reduce firm value? Would sound corporate governance exert efficient supervising mechanism to make managers engaging in efficient earnings management?

Earnings management is divided into opportunistic earnings management and efficient earnings management. The purposes of opportunistic earnings management is that managers use judgment in financial reporting and in non-routine transactions to modify financial reports and attempt to mislead some shareholders about the viewpoint of the company or to affect the results of the accounting-based contract that depend on reported accounting numbers (Healy and Wahlen, 1999). The purposes of efficient earnings management is that managers want to convey private information to investors, to improve the informational content to earnings and promote communication between managers, shareholders and the public (Jiraporn et al., 2008; Siregar et al., 2008).

Several studies find evidence consistent with the opportunistic perspective. These studies suggest that managers will have the motivation to manipulate earnings when their compensation is more closely tied to the value of stock and option holdings (Bergstresser and Philippon, 2006) or in order to avoid the violation of the debt contract (Hakim and Zeghal, 2006), or avoid reporting losses and earnings declines (Park and Shin, 2004).However, other studies find evidence that is consistent with the efficient perspective. These literatures have pointed out that discretionary accruals add the informational content to earnings (Subrmanyam, 1996), help managers generate a reliable and more timely measure of firm performance (Guay et al., 1996). Anil et al. (2003) suggest that a managed earnings stream can convey more information than an unmanaged earnings stream in a decentralized organization, because information is dispersed across persons.

The purpose of this paper is in the same line as previous literature in investigating the earnings management and firm value using Taiwan data. Although their relationship has been the subject of considerable debate throughout the literature, particularly the West, little is known about Taiwan, an emerging market economy where legal, financial and economic institutions are different from the West. Unlike the past literature which use square of managerial ownership, board size, institutional ownership and proportion of outside directors to investigate the optimal level, we empirically divide the sample into two or three regimes based on the data. The present study applies a panel smooth transition regression model to observe the balanced panel data in order to test whether there is an optimal level of the managerial ownership, board size, proportion of outside directors and institutional ownership at which point the threshold effect and asymmetrical relationship between earnings management and firm value may be determined.

2. Literature Review and Hypotheses Development

As managerial ownership increases, there is greater alignment of interests of managers and outside shareholders (Jensen and Meckling,1976; Carl et al., 2003). At this time, managers based on the interest maximization of companies will engage in efficient earnings management. However, when managerial ownership is between 5% and 25% (Morck et al.,1988）or between 14% and 40%（Bhabra, 2007）, managers who control a substantial fraction of the firm's equity may have enough voting rights, pushing managers' self-wealth and shares price to be closely linked, in order to ensure their employment, at this time, consist with entrenchment hypothesis, managers will

engage in opportunistic earnings management. So we bring up hypothesis 1: If different regimes of managerial ownership exist, the relation between discretionary accruals and firm value will be non-linear.

The function of board of directors is to provide its strategy and oversight for managers. Larger boards of directors possessing financial and governance expertise to guide managers making maximizing-benefits decision of company in due course, so they can exert effect of supervise to increase firm value (Lee and Chuang, 2007; Louis, 2008； Hung et al, 2005). Therefore, large boards can effectively exert the functions of supervision to make managers to engage in efficient earnings management. But, small board is less differences of opinion within the organization and the advantages of better coordination, flexibility and communication (Andres et al., 2005). Smaller boards can provide better oversight functions (Rashidah and Ali, 2006 ; Jaggi and Leung, 2007). Earnings are more informative in smaller boards (Vafeas, 2000). Therefore, we bring up hypothesis 2: If different regimes of board size happen, the relation between discretionary accruals and firm value will be non-linear.

When companies have more outside directors, they can more effectively monitor and control managers (Chung et al., 2001; Xie et al., 2003; John et al.,2007) and reduce managers to adjust earnings for avoiding reporting losses and earnings reductions (Peasnell et al., 2005). Because of outside directors with independent, professional knowledge and experience, they can provide more impartial and objective recommendations to the company based on the benefits of company to enhance firm value (Fang et al., 2008). Thus, when the proportion of outside directors is high, managers will engage in efficient earnings management. Nevertheless, when outside directors based on the self-serving incentives or lack of financial knowledge, they are unable to effectively supervise managers, give valuable advice or detect the earnings management and inhibit opportunities earnings management (Park and Shin, 2004；Cheng, 2008). Therefore, we bring up hypothesis 3: If the proportion of outside directors is different, the relation between discretionary accruals and firm value will be non-linear.

In addition to internal oversight mechanisms, institutional investors belong to the external governance mechanism (Gillan, 2006; Kooyul and Soo, 2002; Carl et al., 2003). Managers' entrenchment would be increasingly difficult as more institutional investors monitor them; therefore, earnings informativeness increases with the holdings of institutions (Han and Suk, 1998), Large institutional shareholdings inhibit managers from increasing or decreasing reported profits towards the managers' desired level of profits (Chung et al., 2001). Thus, as the institutional ownership increases, managers are more likely to engage in efficient earnings management. However, when there is the conflict interests of institutional investors and company, institutional investors obtain information to engage in increasing their personal wealth by the identity of its shareholders (Lee and Chuang, 2007), or only focus on short-term profit (Hung et al, 2005),reducing institutional investors' monitoring quality. At this time, as the institutional ownership increases, institutional investors can not inhibit managers from engaging opportunities earnings management. So we bring up hypothesis 4: If different regimes of institutional ownership occur, relation between discretionary accruals and firm value will be non-linear.

3. Sample Selection and Research Methodology

3.1. Sample

We conduct our investigation using balanced panel data for a sample of 1,607 firms listed in Taiwan Stock Exchange covering the period from 1997 to 2007. All our data come from the *Taiwan Economic Journal* (TEJ) database of Taiwan. We exclude 131 financial, securities and insurance firms, because the nature of capital and investment in these industries are not comparable to those of non-financial firms. 573 firms with missing financial information and 626 firms with missing corporate governance information are excluded. After the exclusion, the final sample is 277 public trading companies, distributed across the eighteen industry sectors as follows: Electron (57), Textiles (37), Plastics (15), Steel and Iron (19), Construction (19), Chemical (16), Food (14), Transportation (12). The residual 88 companies are from the remaining sectors. The electronics and textiles industries together account for about one-third of the sample, while the remaining industries each makes up less than nine percent.

3.2. Variables

As the proxy for firm value, we adopt Tobin's Q developed by La Porta et al. (2002), which is calculated as the book value of assets minus the book value of equity minus deferred taxes plus the market value of common stock divided by the book value of total assets. Follow Jiraporn et al.(2008),we use absolute value of discretionary accruals as a proxy the degree of earning management. We use the modified Jones model (1991) to estimate discretionary accruals. The threshold variables include the managerial ownership (the percentage of equity owned by the board of directors and supervisors to total equity), the board size (the natural log of the number of directors and supervisors), the institutional ownership (the percentage of equity owned by the institution and corporation to total equity) and the proportion of outside directors (the proportion of outside directors on the firm board). We also include three control variables commonly used in the analysis of firm value, namely, the natural log of the book value of total assets (SIZE); the ratio of total liabilities to total assets (LEV); the rate of sales growth (Sales growth), which is calculated as the annual percentage change in sale.

3.3. Research Methodology

According to Gonza′lez, Teräsvirta and Dijk （2004、2005）, we set up the panel smooth transition regression

model as follows:

$$y_{it} = \mu_i + \beta_0' x_{it} + \beta_1' x_{it} g(q_{it};\gamma,c) + \varepsilon_{it} \quad (1)$$

$$y_{it} = (\text{Tobin's Q}_{it}) \qquad q_{it} = (MAN_{it}, LnBOA_{it}, INST_{it}, OUT_{it})$$

$$x_{it} = (q_{it}, ABSDAC_{it}, SIZE_{it}, LEV_{it}, GROWTH_{it})$$

Where y_{it} is Tobin's Q which is a proxy as firm value。 $g(q_{it},\gamma,c)$ is a transition function, q_{it} is transition variable which include the managerial ownership (MAN_{it}), the board size ($LnBOA_{it}$), the institutional ownership ($INST_{it}$) and the proportion of outside directors (OUT_{it}); γ determines the slope of the transition function; *c* is threshold parameter. x_{it} represents variable of influence on firm value, $ABSDAC_{it}$ is absolute value of discretionary accruals；control variables are firm size（$SIZE_{it}$）, leverage ratio（LEV_{it}）and sales growth ($GROWTH_{it}$).

In the panel smooth transition regression model, the transition function $g(q_{it},\gamma,c)$ is a continuous and bounded function of the threshold variable q_{it} and is normalized to be bounded between 0 and 1, and these extreme values are associated with regression coefficients β_0 and $\beta_0+\beta_1$. The value of q_{it} determines the value of $g(q_{it},\gamma,c)$ and thus the effective regression coefficients $\beta_0+\beta_1$, $g(q_{it},\gamma,c)$ for individual *i* at time *t*. Follow Granger and Teräsvirta（1993）、Teräsvirta（1994）and Jansen and Teräsvirta（1996）by using the logistic transition function:

$$g(q_{it}:\gamma,c) = (1+\exp(-\gamma\prod_{j=1}^{m}(q_{it}-c_j))^{-1}, \gamma>0, c_1 \le c_2 \le ...c_m \quad (2)$$

Where $c=(c_1,...,c_m)'$ is an m-dimensional vector of location parameters and the parameter γ determines the smoothness of the transitions. In practice it is usually sufficient to consider m = 1 or m = 2, as these values allow for commonly encountered types of variation in the parameters. When the m = 1 and $\gamma\to\infty$, the PSTR model is like of panel threshold model of Hansen (1999). When the m = 2 and $\gamma\to\infty$, the model becomes a three-regime threshold model whose outer regimes are identical and different from the middle regime. When m > 1 and $\gamma\to\infty$, the number of distinct regimes remains two, with the transition function switching back and forth between zero and one at $c_1,\cdots,c_m$. Finally, for any value of m the transition function (2) becomes constant when $\gamma\to 0$, in which case the model collapses into a homogenous or linear panel regression model with fixed effects. In the PSTR model (1) is a relatively straightforward application of the fixed effects estimator and nonlinear least squares (NLS).

4. Empirical Results

4.1. Descriptive Statistics

Table 1 presents the descriptive statistics for our pooled sample of 277 Taiwan listed companies during the 1997-2007. Tobin's Q is more evenly distributed with a pooled mean value of 1.41. The pooled mean absolute value of discretionary accruals is 0.07, which is not differences between Taiwan and other countries, Canada is 0.103 (Park and Shin, 2004), U.S is 0.069 (Jiraporn et al., 2008). The pooled mean managerial ownership is 21.27%. The pooled mean number of board of directors is 10 people. Institutional ownership has an average value of 36.65%. The proportion of outside directors has a mean value of 16.08%. As for the control variables, on average for the sample, the size distribution of our sample firm is also skewed by the large differences between mean (11,906.95 millions NTD) and median (4,143.21 millions NTD) total assets for the pooled sample, the rate of Sales growth is 10.61%, the ratio for Leverage is 40.41%. On the basis of the Jarque-Bera test results, we reject the normality of all the variables.

4.2. Empirical Results

4.2.1. Managerial Ownership

Table 2 presents that managerial ownership has a threshold effect on firm value, which is 9.67%, and it separate all of the observations into two regimes, the high managerial ownership (MAN_{it} > 9.67%) and the low managerial ownership ($MAN_{it} \leqq$ 9.67%) and are all significant at the 1% level. The coefficients of discretionary accruals, β_0 and β_1 in two regimes are -0.7521 and 1.5041, respectively and are all significant at the 5% level. In the low and

high managerial ownership regimes, firm value decrease by 0.7521% and increase by 0.7520% ($\beta_0 + \beta_1$) with a 1% increase in the discretionary accruals, respectively. Thus, consistent with entrenchment effect in low managerial ownership regimes, managers may engage in opportunistic earnings management and decrease firm value. In contrast, alignment effect is found in the high managerial ownership regime, suggesting that as managerial ownership increase, managers engage in efficient earnings management and increases firm value. The supportive of alignment effect can be accounted for the fact Taiwan corporate boards are dominated by controlling families who hold a large portion of equity, and generally have incentive to align outside shareholders' interest with maintaining the objective of contributing to firm value.

In the estimations of the coefficients of the control variables, the coefficients of firm size, β_0 and β_1 in two regimes are -0.1568 and 0.3137, respectively and are all significant at the 1% level. The result suggests that the lower the managerial ownership, the lower the degree of transparency of managerial actions (Bhabra, 2007) and inefficient operation is in large firm (Fama and French, 1992), also reducing firm value. However, as managerial ownership increases, managers have incentive to align outside shareholders' interest, and large firms have better disclosure, a high degree of trading liquidity, more attention from analysts and more supervision by the general (Claessens et al., 2002), then increasing firm value. However, the sales growth and leverage are not significantly related to Tobin's Q in low or high managerial ownership regime. The panel smooth transition regression model of managerial ownership is as follows:

$$\begin{aligned} Q_{it} = {} & \mu_i - 0.7521 ABSDA_{it} + 0.4551 MAN_{it} - 0.1568 Size_{it} + 0.0154 Growth_{it} + 0.2537 LEV_{it} \\ & + g(MAN_{it}, 1.5750e-005, 9.67\%)(1.5041 ABSDA_{it} - 0.9103 MAN_{it} + 0.3137 Size_{it} \\ & - 0.0309 Growth_{it} - 0.5074 LEV_{it}) + \varepsilon_{it} \end{aligned}$$

Table 3 presents the percentage of firms which fall into the two regimes of managerial ownership in each year. We find that approximately 17% of firms fall within the low managerial ownership regime. However, approximately 83% of firms fall within the high managerial ownership regime, because the securities and exchange law in Taiwan sets a minimum shareholding associated with all members of the board of directors and the supervisors (Note 1), so we further study the 83% firms in high managerial ownership regime according to the law. Table 4 presents that there are 168 (72.72%) , 46 (19.91%) and 17 (7.36%) firms' managerial ownership are excess of 5.5%, 8.25% and 11% statutory managerial ownership, when their capitalization (millions NTD) is more than 2,000, more than 1,000 but 2,000 or less and more than 300 but 1,000 or less, respectively. Therefore, the majority of firms' managerial ownership in high regime is excess of statutory managerial ownership. To achieve the statutory law, managers have incentive to engage in efficient earnings management to align outside shareholders' interest with maintaining the objective of contributing to firm value.

4.2.2. Board Size

Table 5 shows that board size has two threshold effects on firm value, which are 9 and 12 people. The coefficients of discretionary accruals, β_0 , β_1 and β_2 in three regimes are 2.7981, 3.438 and -1.4549, respectively, but only β_0 and β_2 are significant at the 1% and 5% level, respectively. When the board size is either less than 9 people or more than 12 persons, the coefficients of discretionary accruals is significant positive, β_0 and ($\beta_0 + \beta_1 + \beta_2$) are 2.7981 and 1.9908, respectively. Thus, only efficient earnings management is found in either small or larger board. Also, small board has greater impact on efficient earnings management than larger board. This suggest that small board is less differences of opinion within the organization and the advantages of better coordination, flexibility and communication (Andres et al., 2005) and can provide better oversight functions (Rashidah and Ali, 2006 ; Jaggi and Leung, 2007) to make managers engaging in efficient earnings management.

In the estimations of the coefficients of the control variables, the coefficients of firm size, β_0 , β_1 and β_2 in three regimes are -0.1951, -0.5094 and 0.1988, respectively, but only β_0 and β_2 are significant at the 1% and 5% level, respectively. When the board size is more than 12 people, the coefficients ($\beta_0 + \beta_1 + \beta_2$) of firm size is -0.5057. Thus, larger board has greater impact on larger firm than small firm. It has different opinion within the organization and worse coordination, flexibility and communication in large board and inefficient operation in large firm (Fama and French, 1992). When the board size is between 9 and 12 people, and more than 12 people, the coefficient of sales growth rate ($\beta_0 + \beta_1$), ($\beta_0 + \beta_1 + \beta_2$) are 1.2291 and 0.0614, respectively, both significantly and positively. This suggest that larger board size can effectively monitor the managers to increase the sales growth and firm value (Luo and Hachiya, 2005; Mak and Kusnadi, 2005). Finally, the coefficient (β_0) of leverage is significant negative, suggesting that small board cannot effectively supervise the managers to make high-risk decision to finance (Liao et

al., 2006); increasing the company's financial crisis and bankruptcy risk, thereby reducing the firm value (Maury and Pajuste, 2005; Carl et al., 2003). The panel smooth transition regression model of board size is as follows:

$$Q_{it} = \mu_i + 2.7981\,ABSDA_{it} - 0.2995\,LnBOA_{it} - 0.1951\,Size_{it} + 0.1274\,Growth_{it} - 12.604\,LEV_{it} + g(LnBOA_{it},34.2904,9)(1.4504\,ABSDA_{it} + 3.4380\,LnBOA_{it} - 0.5094\,Size_{it} + 1.1017\,Growth_{it} - 0.6003\,LEV_{it}) + g(LnBOA_{it},266.56,12)(-2.2577\,ABSDA_{it} - 1.4549\,LnBOA_{it} + 0.1988\,Size_{it} - 1.1677\,Growth_{it} + 0.3148\,LEV_{it}) + \varepsilon_{it}$$

Table 6 presents the percentage of firms which fall into the three regimes of the board size each year. We find that approximately 58%, 23 % and 19% of firms fall within the first, second and third regime, respectively. Therefore, the majority of firms are small board and it has stronger impact on efficient earnings management than greater board. The supportive of smaller board can be accounted for by the fact that according to the securities and exchange law in 2007, firms listed in Taiwan Stock Exchange shall set at least 5 directors (Note2).

4.2.3. Outside Directors

Table 7 shows that proportion of outside directors has a threshold effect on firm value, which is 38.73%, and it separate all of the observations into two regimes, the low proportion of outside directors (OUT $\leqq$ 38.37%) and the high proportion of outside directors (OUT> 38.37%), but only the low regime is significant at the 1% level. The coefficients of discretionary accruals, β_0 in low regime is 2.6318 and significant at the 1% level. In the low regimes, firm value increase by 2.6318% with a 1% increase in the discretionary accruals. The independence of outside directors with professional knowledge and experience, provide more impartial and objective recommendations to the company, and help managers to make decision (Fang et al., 2008), and effectively monitor and control managers (Chung et al., 2002; Xie et al., 2003) to engage efficient earnings management.

In the estimations of the coefficients of the control variables, the coefficient of sales growth rate and leverage, both β_0 in low regimes are 0.2980 and -1.0769, respectively, all significant at the 1% level, suggesting that low proportion of outside directors can effectively monitor managers to increase the sales growth rate (Luo and Hachiya, 2005; Mak and Kusnadi, 2005), decrease debt ratio and enhance firm value (Lee and Chuang, 2007). The panel smooth transition regression model of proportion of outside directors is as follows:

$$Q_{it} = \mu_i + 2.6318\,ABSDA_{it} + 0.0087\,OUT_{it} - 0.3424\,Size_{it} + 0.2980\,Growth_{it} - 1.0769\,LEV_{it} + g(OUT_{it},157.2170,14.91\%)(0.9638\,ABSDA_{it} + 0.0077\,OUT_{it} - 0.0070\,Size_{it} + 0.1515\,Growth_{it} - 0.8032\,LEV_{it}) + \varepsilon_{it}$$

Table 8 presents the percentage of firms which fall into the two regimes of the proportion of outside directors each year. We find that approximately 74% of firms fall within the low regime and 26% of firms fall within high regime. The supportive of low proportion of outside directors can be accounted for by the fact that according to the securities and exchange law in 2007, firms listed in Taiwan Stock Exchange shall set at least two independent directors in the board of directors and at least one-fifth of board seats (Note 3).

4.2.3. *Institutional ownership*

Table 9 presents that institutional ownership has two threshold effects on firm value, which are 43.8% and 48.8%. The coefficients of discretionary accruals, β_0 , β_1 and β_2 in three regimes are 3.2667, 0.2829 and -1.5726, respectively, but only β_0 is significant at the 1%. In the low regimes, firm value increase by 3.2667% with a 1% increase in the discretionary accruals. Thus, only efficient earnings management is found in low institutional ownership. Because institutional investors own more resources, they have incentive and ability to monitor managers (Chang et al., 2007) and to inhibit their selfish acts (Chung et al., 2001) to make managers engaging in efficient earnings management.

In the estimations of the coefficients of the control variables, the coefficients of firm size, β_0 , β_1 and β_2 in three regimes are -0.1981, -0.6184 and 0.1698, respectively, only β_1 is insignificant, β_0 and β_2 are significant at the 1%, respectively. When the institutional ownership is more than 48.8%, the coefficient ($\beta_0 + \beta_1 + \beta_2$) of firm size is -0.6467. Thus, higher institutional ownership has more negatively impact on larger firm than smaller firm. The institutional investors can obtain information by the identity of their shareholders and engage in self-beneficial activities (Lee and Chuang, 2007)and only focus on short-term profit, inefficiently supervise the managers (Hung et al, 2005) to operate efficiently in large firms (Fama and French, 1992), thereby reducing the firm value. The coefficients of sales growth rate, β_0 , β_1 and β_2 in three regimes are -0.301, 1.9454 and -1.0064, respectively, only

β_1 is insignificant, β_0 and β_2 are significantly negative at the 5% and 1%, respectively. The coefficient ($\beta_0 + \beta_1 + \beta_2$) of sales growth rate is 0.637 in high institutional ownership. Thus, the higher the institutional ownership, the higher the sales growth rate, thereby reducing the firm value (Luo and Hachiya, 2005; Mak and Kusnadi, 2005). The coefficients of leverage, β_0 , β_1 and β_2 in three regimes are -2.9818, 4.7465, and -0.9281, respectively and only β_2 is insignificant, β_1 and β_2 are significantly negative at the 1% and 5%, respectively. In low institutional ownership, the coefficient of leverage β_0 is -2.9818, but the coefficient ($\beta_0 + \beta_1 + \beta_2$) of leverage in high regime is 0.8366, suggesting that low institutional ownership cannot effectively supervise the manager to make high-risk decision to finance (Liao, 2006) ; increasing the company's financial crisis and bankruptcy risk, thereby reducing the firm value (Maury and Pajuste, 2005; Carl et al., 2003). The high institutional ownership, by contrast, effectively supervises the managers and obtains the confidence of creditors to finance, thereby increasing the firm value (Hung et al, 2005). The panel smooth transition regression model of institutional ownership is as follows:

$$
\begin{aligned}
Q_{it} = {} & \mu_i + 3.2667 ABSDA_{it} + 3.2433 INST_{it} - 0.1981 Size_{it} - 0.3015 Growth_{it} - 2.9818 LEV_{it} \\
& + g(INST_{it}, 5.2840, 43.8\%)(0.2829 ABSDA_{it} + 7.4215 INST_{it} - 0.6184 Size_{it} + 1.9454 Growth_{it} \\
& + 4.7465 LEV_{it}) + g(INST_{it}, 99.6327, 48.8\%)(-1.5726 ABSDA_{it} - 4.4214 INST_{it} + 0.1698 Size_{it} \\
& - 1.0064 Growth_{it} - 0.9281 LEV_{it}) + \varepsilon_{it}
\end{aligned}
$$

Table 10 presents the percentage of firms which fall into the three regimes of institutional ownership in each year. We find that approximate 63%, 8% and 29% of firms fall within low, middle and high regime, respectively. Therefore, the majority of firms are low institutional ownership in Taiwan and only efficient earnings management is found in low institutional ownership. The supportive of low institutional ownership can be accounted for the fact that the majority of investors are individual investor not the institutional investors(Note 4).

5. Conclusion

This paper analyzes whether discretionary accruals affects firm value under the corporate governance mechanism via a panel of 277 Taiwanese listed companies from 1997 to 2007. We employ a panel smooth transition regression model to test whether there is an "optimal" level of managerial ownership, board size, institutional ownership and proportion of outside directors, which may cause there to be threshold effects between managerial ownership, board size, institutional ownership and proportion of outside directors and firm value. Our results show that when managerial ownership is less than 9.67%, managers may engage in opportunistic earnings management. However, while managerial ownership higher than 9.67%, managers may tilt toward efficient earnings management. Only efficient earnings management is found in either small or larger board. Also, small board has greater impact on efficient earnings management than larger board. When the proportion of outside directors is below 38.73%, the outside directors can effectively supervise managers to engage in efficient earnings management. Also, only efficient earnings management is found when institutional ownership is less than 43.8%.We recommend that future research be conducted to continue this line of work. We use Tobin's Q as a proxy for firm value in this study, but future research can add the return on assets, return on equity of accounting performance indicators, the study can be complete. Second, it can be aimed at the industry classification to in-depth study and it will provide the industry with application of business strategy, because the situations are differences in various industries.

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Notes

Note1. The securities and exchange law in Taiwan sets a minimum shareholding of board of directors and supervisors. Where the firm capitalization is NT$300 million or less(more than NT$300 million but NT$1000 million or less), the minimum required shareholding of board of directors should not be less than 15% (10%)of the total issued shares; the minimum required shareholding of supervisors should not be less than 1.5%(1.0%) of the total issued shares. Where the firm capitalization is more than NT$1000 million but NT$2000 million or less (more than NT$2000 million), the minimum required shareholding of board of directors should not be less than 7.5% (5%)of the total issued shares; the minimum required shareholding of supervisors should not be less than 0.75% (0.5%) of the total issued shares.

Note2. Article 26-3 of the securities and exchange law in Taiwan.

Note 3. Article 14-2 of the securities and exchange law in Taiwan.

Note4. According to type of investors and trading value ratio of statistical data in the centralized market, domestic institutional investor holds 13.0 %, Foreign Institutional Investors owns about 17.6%, domestic individual stockowners holds 67.3%, and Foreign Individual Investors holds 2.1% in year 2007, so individual investors are the major participants of Taiwan stock market.(Major Indicators of Securities & Futures Markets, Taiwan District, ROC, Securities & Futures Bureau, Financial Supervisory Commission, Executive Yuan, December, 2007.)

Appendices

Table 1. Descriptive statistics of variables

Variables	Mean	Std. Dev.	Quartile 3	Median	Quartile 1	Jarque-Bera
Tobin's Q	1.41	1.16	1.58	1.08	0.82	234310.8***
ABSDA	0.07	0.07	0.09	0.05	0.02	99096.42***
MAN	21.27	12.69	27.53	18.14	11.77	897.1674***
BOA	10.00	3.00	12.00	9.00	7.00	2782.441***
INST	36.65	20.78	51.88	35.64	19.45	108.4061***
OUT	16.08	15.66	27.78	14.29	0	276.19***
SIZE	15.33	1.36	16.17	15.24	14.52	198.1389***
GROWTH	10.61	61.47	17.81	4.50	-6.49	7036031***
LEV	40.41	16.62	50.21	39.79	28.47	113.4259***
Assets($millions)	11906.95	25759.60	10571.43	4143.21	2015.69	318157.5***

Tobin's Q is firm value. ABSDA is absolute value of discretionary accruals. MAN is managerial ownership ; BOA is board size ; INST is institutional ownership ; OUT is proportion of outside directors, SIZE is firm size ; GROWTH is sales growth ; LEV is leverage ; Assets are total assets. ***, **, and * indicate significance at the 0.01, 0.05 and 0.1 levels, respectively.

Table 2. Estimation for threshold effects of managerial ownership

Threshold value C	C 1= 9.67%	Slopes parameters	γ1=1.5750e-005
	MAN≦9.67%	MAN＞9.67%	
	β_0		β_1
MAN_{it}	0.4551***		-0.9103***
$ABSDAC_{it}$	-0.7521**		1.5041**
$SIZE_{it}$	-0.1568***		0.3137
$GROWTH_{it}$	0.0154		-0.0309
LEV_{it}	0.2537		-0.5074

***, **, and * indicate significance at the 0.01, 0.05 and 0.1 levels, respectively. MAN is managerial ownership. ABSDA is absolute value of discretionary accruals. SIZE is firm size. GROWTH is sale growth. LEV is leverage.

Table 3. Number (Percentage) of Firms in Each Regime by Year

Regime Class	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Average
MAN≦ 9.67%	19 (7%)	29 (10	33 (12%)	32 (12	43 (16	52 (19	58 (21%)	56 (20%)	58 (21%)	61 (22%)	60 (22%)	46 (17%)
MAN＞ 9.67%	258 (93%)	248 (90	244 (88%)	245 (88	234 (84	225 (81	219 (79%)	221 (80%)	219 (79%)	216 (78%)	217 (78%)	231 (83%)

( )denotes annual sample of percentage。

Table 4. Number of firms' managerial ownership is excess of statutory in high regime by year

Capitalization (millions NTD)	statutory	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Average
Above 2,000	≧5.5%	156	171	175	185	177	172	165	166	161	158	159	168
1,000 to 2,000	≧8.25%	69	57	56	*51*	47	40	39	38	36	36	36	46
300 to 1,000	≧11%	31	20	13	9	9	11	13	16	21	22	21	17
Under 300	≧16.5%	1	0	0	0	0	0	1	0	0	0	1	0
Total		257*	248	244	245	233*	223**	218*	220*	218*	216	217	231

* and ** indicate a firm and two firms' managerial ownership not excess of statutory, respectively. Capitalization (millions New Taiwanese Dollars)

Table 5. Estimation for threshold effects and coefficients of board size

Threshold value C	C 1=9	C 2=12	
Slopes parameters γ	γ1=34.2904	γ2=266.5600	
	BOA≦9	9 < BOA≦12	BOA＞12
	β_0	β_1	β_2
$LnBOA_{it}$	-0.2995 *	3.4380 ***	-1.4549 **
$ABSDAC_{it}$	2.7981 ***	1.4504	-2.2577 **
$SIZE_{it}$	-0.1951 ***	-0.5094	0.1988 **
$GROWTH_{it}$	0.1274	1.1017 ***	-1.1677 ***
LEV_{it}	-1.2604 ***	-0.6003	0.3148

***, **, and * indicate significance at the 0.01, 0.05 and 0.1 levels, respectively. $LnBOA_{it}$ is board size. ABSDA is absolute value of discretionary accruals. SIZE is firm size. GROWTH is sale growth. LEV is leverage.

Table 6. Number (Percentage) of Firms in Each Regime by Year

Regime	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Average
BOA≦9	145	154	160	163	159	161	166	165	168	163	165	161
	(52%)	(56%)	(58%)	(59%)	(57%)	(58%)	(60%)	(60%)	(61%)	(59%)	(60%)	(58%)
9 < BOA≦12	63	63	60	58	63	67	64	64	65	73	71	65
	(23%)	(23%)	(22%)	(21%)	(23%)	(24%)	(23%)	(23%)	(23%)	(26%)	(25%)	(23%)
BOA＞12	69	60	57	56	55	49	47	48	44	41	41	51
	(25%)	(21%)	(20%)	(20%)	(20%)	(18%)	(17%)	(17%)	(16%)	(15%)	(15%)	(19%)

( )denotes annual sample of percentage。

Table 7. Estimation for threshold effects and coefficients of proportion of outside directors

Threshold value C	C 1=38.37%		
Slopes parametersγ	γ1=157.2170		
	OUT ≦38.37%		OUT>38.37%
	β_0		β_1
OUT_{it}	0.0087	***	0.0077
$ABSDAC_{it}$	2.6318	***	0.9638
$SIZE_{it}$	-0.3424		-0.0070
$GROWTH_{it}$	0.2980	***	0.1515
LEV_{it}	-1.0769	***	-0.8032

***, **, and * indicate significance at the 0.01, 0.05 and 0.1 levels, respectively. OUT is the proportion of outside directors. ABSDA is the absolute value of discretionary accruals. SIZE is firm size. GROWTH is sale growth. LEV is leverage.

Table 8. Number (Percentage) of Firms in Each Regime by Year

Regime**eeee**	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Average
OUT ≦	167	187	195	208	221	227	230	221	209	204	194	206
38.73%	(60%)	(68%)	(70%)	(75%)	(80%)	(82%)	(83%)	(80%)	(75%)	(74%)	(70%)	(74%)
OUT＞	110	90	82	69	56	50	47	56	68	73	83	71
38.73%	(40%)	(32%)	(30%)	(25%)	(20%)	(18%)	(17%)	(20%)	(25%)	(26%)	(30%)	(26%)

( )denotes annual sample of percentage。

Table 9. Estimation for threshold effects and coefficients of institutional ownership

Threshold value C	C 1=43.8%		C 2=48.8%		
Slopes parameters γ	γ1=5.2840		γ2=99.6327		
	INST≦43.8%		43.8%<INST≦48.8%		INST＞48.8%
	β_0		β_1		β_2
$INST_{it}$	3.2433	***	7.4215	*	-4.4214 ***
$ABSDAC_{it}$	3.2667	***	0.2829		-1.5726
$SIZE_{it}$	-0.1981	***	-0.6184		0.1698 ***
$GROWTH_{it}$	-0.3015	**	1.9454		-1.0064 ***
LEV_{it}	-2.9818	***	4.7465		-0.9281 **

***, **, and * indicate significance at the 0.01, 0.05 and 0.1 levels, respectively. INST is institutional ownership. ABSDA is absolute value of discretionary accruals. SIZE is firm size. GROWTH is sale growth. LEV is leverage.

Table 10. Number (Percentage) of Firms in Each Regime by Year

Regime	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Average
INST≦43.8%	197	193	186	182	176	173	170	175	164	154	146	174
	(71%)	(70%)	(67%)	(66%)	(64%)	(63%)	(62%)	(63%)	(59%)	(56%)	(52%)	(63%)
43.8%<INST≦48.8%	24	19	25	26	20	17	23	18	24	23	21	22
	(9%)	(7%)	(9%)	(9%)	(7%)	(6%)	(8%)	(7%)	(9%)	(8%)	(8%)	(8%)
INST＞48.8%	56	65	66	69	81	87	84	84	89	100	110	81
	(20%)	(23%)	(24%)	(25%)	(29%)	(31%)	(30%)	(30%)	(32%)	(36%)	(40%)	(29%)

( )denotes annual sample of percentage

The Causality between Financial Development and Economic Growth: Panel Data Cointegration and GMM System Approaches

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Abstract

The debate on the direction of causality between financial development and economic growth has been comprehensively growing since 1980s in theoretical and empirical literature. The existing literature provides conflicting views of this relationship. For this reason, the purpose of this paper is therefore to empirically investigate the direction of causality between finance and growth using panel data cointegration and GMM system approaches. If it is acknowledged that financial development stimulates growth, then economic growth may reciprocally stimulate financial development. The empirical analysis is based on a sample of 10 countries, 6 from the OECD region and 4 from the MENA region during 1990-2006, reports the following results: a panel data cointegration analysis confirms a long-term relationship between financial development and economic growth for the OECD and the MENA countries. The GMM system approach shows that financial development and real GDP per capita are positively and strongly linked. The error correction model approach shows that causality is bi-directional for the OECD countries and unidirectional for the MENA countries, i.e. economic growth stimulates financial development.

Keywords: Financial development, Economic growth, Causality, Cointegration and GMM system

Jel Classification : O16, G21, L11 et L25.

1. Introduction

The study of the relationship between economic growth and financial development has known a peak during these last decades, mainly with the works of King and Levine (1993). The authors' main thesis is that financial intermediaries are likely to push capital accumulation and economic factors' productivity growth, leading to economic growth. Subscribing to the belief that financial development is a key factor of economic growth, Levine (1997) notes that financial intermediaries improve risk management, making financial transactions, savings mobility and the exchange of goods and services easy to make. Ang (2008) finds that an efficient financial system positively contributes to economic growth. At the beginning of the 1990s, the endogenous growth literature stresses the significance of finance development for a long term economic growth. These studies seek to justify financial liberalization, reaching the same conclusion: the financial system should be liberalized to insure its good functioning, boost savings, encourage productive and profitable investments, push technology growth and sustain economic growth. Furthermore, these studies pointed to the positive effect that development of banks and financial markets have on economic growth as allocating a large proportion of savings to investment is made possible. Galindo et al (2007) highlight the positive role that financial liberalization may play in the development of banks by suppressing administrative fixation of interest rates and efficiently granting credits. Empirically, the positive relationship between financial development and growth is still scarce, and the causal link has not been resolved. A first wave of studies conducted by Spears (1992), Calderon and Lin (2003), De Gregorio and Guidotti (1995), Odedokun (1996), Habibullah and End (2006), Ang and Mckibbin (2007), Singh (2008) and Giuliano and Ruiz-Arranz (2009) note that financial system development is a condition for economic growth. These studies suggest that financial system liberalization is necessary to improve savings mobility, implement an efficient risk diversification, and to undertake an evaluation of investment projects. These advantages are visible only within a developed financial system which makes its positive influence on economic growth possible. However, other studies like those of Agbetsiafa (2003), Waqabaca (2004) and Odhiambo (2004) endorse a different stand and assume that economic growth does indeed lead to financial development. Finally, the last wave of studies represented by the work of Fowowe (2010) favors the existence of a bidirectional relationship between finance and growth. It is worth noting that the results reported in these studies are often inconclusive. This paper contributes and improves upon the existing literature by using panel data cointegration and GMM system in OECD and MENA countries.

The empirical results of the paper show: The panel results point to a long-term relationship between financial development and growth for the OECD and MENA countries. As a consistency check, we also used a GMM system dynamic panel estimator, like Levine et al (2000), to deal with key problems (omitted variable bias and simultaneity bias) plaguing past studies of the link between financial development and economic growth. We find that financial

development is positively and robustly linked with economic growth. For robustness tests, we have used the error correction approach. Our results support the idea that the causality is bi-directional for the OECD countries and unidirectional (economic growth- financial development) for the MENA countries.

The remainder of this paper is organized as follows: Section 2 presents a brief review of the literature and discusses the relationship between financial development and economic growth. Section 3 identifies the model specification, variables definitions, econometric approaches and reports the major empirical results. Section 4 concludes the paper.

2. Relationship between financial development and economic growth: a review of the literature

The crucial role of financial development in any process of economic development has been subject to numerous debates in the economics and finance literature. The early studies of Gurley and Shaw (1955), Goldsmith (1969) and Hicks (1969) seem to have suggested that financial development stimulates economic growth. Similar ideas are reported by Show (1973) who advocates that financial intermediaries promote investment and consequently contribute in boosting economic growth rates. Furthermore, Braun and Raddatz (2007), Ranciere et al (2007), Jung (1986), Roubini and Sala-I-Martin (1992) and King and Levine (1993) believe that level of financial intermediation is a good indicator of economic growth and that financial development is an important key to economic growth. In this line of thinking, Ang (2008), in a study on Malaysia, concludes that a developed financial system positively contributes to achieving higher economic growth rates through the increase of savings and private investments. Likewise, Baltagi et al (2009) advocate that banks development, sustained by a liberalization process, is an important mechanism of long-term growth in developed and developing countries.

Research suggests that causality depends on the level of development. According to the proponents of this thesis, financial development causes economic growth during the first phases of development. However, this effect gradually diminishes all along the development process till it reverses back. Subscribing to this idea, Greenwood and Smith (1998) elaborated models in which financial markets grow after a period of economic development, in turn promoting real growth. In some empirical studies, the causality thesis is very controversial despite the use of more elaborated econometric techniques. Time series analysis of causality has been the subject of several studies. Aretsis and Demetriades (1997), using an error correction model, examined causality on a sample of 12 individual countries, reaching mixed results (one-way and two-way causality). Moreover, the authors found out that for the same country results vary according to the financial development indicator used.

Beck et al (2000) attempted to examine the finance-growth nexus by considering regressors' simultaneity, yet they ignored the data's integration and cointegration features. Furthermore, their methodology did not consider the long-run and short-run relationships between variables. King and Levine (1993), studying a sample of 70 countries, introduced new measures of financial development and examined the impact of financial development on economic growth, capital accumulation pace and economic factors' productivity. The obtained results show an empirical link between financial development indicators and growth. Worth noting is that the regressions indicate that level of financial development offers an accurate prediction of economic growth rates and economic efficiency improvement in the future. Accordingly, Levine and Zevros (1998) reach the conclusion that financial development is an accurate indicator of economic growth. However, these studies did not mention the causality thesis, pointing out that levels of bank development and incoming liquidity are significantly and positively correlated with economic growth and productivity future rates. They further mentioned statistically significant relationships between savings rates and financial development variables.

Levine et al (2000) used the GMM estimator to delineate a positive relationship between the exogenous components of financial development and economic growth, productivity growth and capital accumulation. Differently from Levine et al (2000), Spiegel (2001), examining the relationship between financial development indicators and economic growth, used a panel data approach which allows for endogeneity of regressors and the optimum use of the lagged dependent variables. The results indicate that financial development indicators are correlated with total productivity growth and physical and human capital accumulation. Other studies like those of Rousseau and Wachtel (2000) and Beck and Levine (2004) conclude that exogenous components of bank and stock market development have a large economic effect on economic growth. With the same concerns, Demetriades and Hussein (1996), using the currency to GDP ratio as a measure of financial development, find out that causality is bidirectional, mainly for the developing countries.

Rousseau and Watchell (2000) applied time series tests on the variables financial development and economic growth in 5 countries. Using measures of financial development which include banking and non-banking assets, Rousseau and Watchell (2000) find out that the most dominant causality direction is financial development towards economic growth. The VAR approach allows the identification of long-term effects of financial development on growth and considers the dynamic interactions between the explanatory variables. Other authors like Xu (2000) reject the hypothesis that finance follows growth. Xu's analysis shows that financial development is crucial for long-term growth. Christopoulos and Tizianos (2004) devised an analysis using panel-based unitary roots and cointegration to examine the relationship between finance and growth in 10 developing countries. With the assumption that time series studies lack accurate results because of the short duration of data, they used time series tests to study causality on a panel by increasing sample size. The authors find evidence in favour of the financial development towards

growth causality thesis. No evidence was found for the opposite direction. The results point to a unique cointegration vector between financial development and growth, rejecting a short-term relationship between the two variables.

3. The Empirical Study

3.1. Presentation of the sample and model

The empirical association between financial development and growth is more robust than the theoretical literature. Several studies support this hypothesis. The model to be tested is the following:

$$y_{it} = \beta_{0,i} + \beta_{1,i} F_{i,t} + \beta_{2,i} GV_{i,t} + \beta_{3,i} P_{i,t} + \varepsilon_{it}$$

Where:

y is the logarithm of real GDP per capita.

F is the measure of financial development. Many indicators of financial development have been proposed in the literature. In this study, we will retain two indicators:

Private credit by deposit money banks and other financial institutions to GDP (PC): *Private credit by deposit money banks and other financial institutions to GDP, calculated using the following deflation method:{(0.5)*[Ft/P_et + Ft-1/P_et-1]}/[GDPt/P_at] where F is credit to the private sector, P_e is end-of period CPI, and P_a is average annual CPI.*

Liquid liabilities (LL): *Ratio of liquid liabilities to GDP, calculated using the following deflation method: {(0.5)*[Ft/P_et + Ft-1/P_et-1]}/[GDPt/P_at] where F is liquid liabilities, P_e is end-of period CPI, and P_a is average annual CPI.*

P denotes annual change in consumer price index (CPI).

GV is the log of the ratio of government consumption to GDP.

ε is the error term.

This equation is considered as a long-term relationship if it reproduces cointegration relationships. Data should be integrated at order 1. We will test the stationarity of the financial development indicators series, real GDP per capita, public expenditure indicators and inflation rate. We propose two types of tests: the univariate unitary root test for an individual country and the multivariate tests that examine stationarity for a panel of country. Panel dada unitary root and cointegration techniques require a minimum of homogeneity to draw representative conclusions. For this reason, we decompose our sample into several subgroups.

Our study targets two groups of countries: Middle East and North Africa (MENA) group (Egypt, Morocco, Tunisia and Turkey) and OECD group (Spain, Greece, Iceland, Italy, Portugal and Sweeden). Data cover the 1990-2006 period, taken from the World Bank (World Development Indicators 2009). Financial development variables are taken from Financial Structure Database (2008).

3.2. Econometric tests and main results

3.2.1. The unit root test

There are several panel data unit root tests. The most recommended tests are those of Persan and Shin (2003) and Maddala and Wu (2000). The non-stationarity test results for the two samples are reported in Table 1 below. All tests are in favour of the non-stationarity hypothesis. All variables are integrated at order 1.

3.2.2. The cointegration test

Worth noting is that for small samples, the ADF-Stat estimated by the between model is the most robust. It is this statistic that we use to test the cointegration relationship between financial development and economic growth. Under the alternative hypothesis ($H_1: \varrho_i < 1, for all\ i$), the value of Group-ADF inclines towards $-\infty$. The null hypothesis of non-cointegration is then rejected for the values closer to the left tail of the Gaussian distribution. Thus, at a 5% level, we accept the existence of a cointegration relationship when Group-ADF statistic is inferior to -1,645. The results seem to confirm a cointegration relationship between financial development and economic growth. The conducted cointegration tests based on geographical decomposition and development level indicate that financial development may characterize on the long-run economic growth. The Group-ADF tests are significant for all variables at the 5% level.

Using the fully modified ordinary least square method to test cointegration, the results for the OECD countries reported in Table 4 indicate that financial development has a positive effect on economic growth, except for Greece and Portugal which report insignificant negative coefficients. Positive but insignificant coefficients are reported as well for Spain and Ireland. The panel-based coefficient of PRCR (PC) is 0,79 with a t-student of 3,43, suggesting that the effect of financial development is significantly positive. The coefficients for public expenditure and inflation rate ratio report expected signs respectively positive and statistically significant at the 1% level. For the MENA countries, when PRCR (PC) is an indicator of financial development (Table 5), we note that Morocco reports a positive but statistically insignificant coefficient. Tunisia, Egypt and Turkey report a positive effect of financial

development respectively significant at the 1%, 5% and 10% levels. This positive effect becomes larger when the LL ratio is introduced into the cointegration equation. All countries report positive and statistically significant coefficients, except for Morocco whose t-student is 0, 84. Panel-based coefficients indicate that finance promotes economic growth as the coefficients of the two financial development measures PC and LL are positive and statistically significant at the 1% level. The first control variable introduced into the equation (public expenditure) reports a statistically significant and negative coefficient. As for the second variable (inflation rate), it reports negative and statistically insignificant coefficient. With reference to these results, and consistently with Baltagi et al (2009) and Fowowe (2010), there is a long-term relationship between financial development and economic growth for the MENA and OECD countries. Such a finding urges us to test causality between these two variables using a panel-based error correction model.

3.2.3. The GMM system approach

Similar to the seminal work of Levine et al (2000), we will use a dynamic panel model to test the causality between economic growth and financial development. The model to be estimate is described as follows:

$$y_{it} = a\ y_{it-1} + \beta_{0,i} + \beta_{1,i}F_{i,t} + \beta_{2,i}GV_{i,t} + \beta_{3,i}P_{i,t} + \varepsilon_{it}$$

We will use the method of GMM system because the Arellano and Bover (1995) and Blundell and Bond (1998) estimator augments Arellano and Bond (1991) by making an additional assumption, that first differences of instrumenting variables are uncorrelated with the fixed effects. It builds a system of two equations-the original equation as well as the transformed one-and is known as "system *GMM"*. The Arellano and Bond test for autocorrelation has a null hypothesis of no autocorrelation and is applied to the differenced residuals. The test for AR (2) in first differences is more important, because it will detect autocorrelation in levels. The validity of the instruments is tested using a Sargan test of over-identifying restrictions and a test of the absence of serial correlation of the residuals. As our data contain a small number of countries, we prefer to display the method one-step GMM-in-System estimator of Blundell and Bond (1998). Table 6 presents the results of the GMM system approach *(xtabond2)*.

First of all, the Sargan and serial-correlation tests do not reject the null hypothesis of correct specification (P-value of Sargan test and AR (2) test of Arellano and Bond are larger than 5% for OECD and MENA), lending support to our estimation results. For OECD countries, coefficients between economic growth and financial development are positive and statistically significant respectively 3.451 (liquid liabilities) and 2.266 (private credit). For MENA countries, coefficients between economic growth and financial development are positive and statistically significant respectively 0.219 (liquid liabilities) and 0.519 (private credit). This confirms results of Levine et al (2000) and implies that real sector and financial sector are interrelated to each other in OECD and MENA countries. The GMM system provides additional evidence of whether the finance development sector actually causes to higher rate of economic growth. Our findings are consistently with results of King & Levine (1993), Levine (1997), Demetriades & Hussein (1996) and Giuliano & Ruiz-Arranz (2009). A well-functioning financial sector can positively and strongly contribute to economic growth in both developing and developed countries.

3.3. Robustness tests: The error correction model

We will use the Granger causality test. This technique tests short-term causality and validates a long-term relationship. This test is twofold: it estimates the residual through the long-term relationship and the error correction model while incorporating the residual in the MCE equation. The model is written as follows:

$$\Delta GDP_{it} = a_{1i} + \sum_{j=1}^{k}\beta_{1j}\Delta GDP_{i,t\ \ j} + \sum_{j=1}^{k}\gamma_{1j}\Delta F_{i,t\ \ j} + \sum_{j=1}^{k}\eta_{1j}\Delta X_{i,t\ \ j} + \lambda_1 ECT_{i,t\ \ 1} + u_{it}$$

$$\Delta F_{it} = a_{2i} + \sum_{j=1}^{k}\beta_{2j}\Delta GDP_{i,t\ \ j} + \sum_{j=1}^{k}\gamma_{2j}\Delta F_{i,t\ \ j} + \sum_{j=1}^{k}\eta_{2j}\Delta X_{i,t\ \ j} + \lambda_2 ECT_{i,t\ \ 1} + v_{it}$$

With α_{1i} and α_{2i} are individual fixed effects, GDP and F_{it} are the two cointegrated variables, X_{it} is the set of control variables, ECT is the error correction term and u_{it} and v_{it} are error terms.

The parameters of the previous equation include the following important short-term and long-term implications:

λ_1 and λ_2 parameters denote mobility of the equilibrium relationship between GDP and F. They indicate the speed at which equilibrium is restored and useful to compute the Gonzalo-Granger statistic.

γ_{1j} and γ_{2j} parameters denote reactions to random shocks.

Tables 7, 8, 9 and 10 report the results of the error correction model for OECD and MENA countries. Using Fisher test (for the time series), we obtain the following results: Similar to Aretsis and Demetriades (1997), our results revealed a bi-directional Granger causality between financial development and economic growth for the OECD countries. These results sustain Fowowe's (2010) conclusions. Moreover, we note unidirectional economic growth-financial development causality for the MENA countries. Such a result may be explained by the intensive

interventions of the public authorities of these countries in the financial system, which made the contribution of the financial sector to capital accumulation very limited. Another explanation points to the efficiency of the reforms undertaken by the relevant institutions.

4. Conclusion

This paper examined the causality between financial development and economic growth. We use two econometric approaches. The first is panel data cointegration. The panel results point to a long-term relationship between financial development and growth for the OECD and MENA countries. As a consistency check, we also used a GMM system dynamic panel estimator, like Levine et al (2000), to deal with key problems (omitted variable bias and simultaneity bias) plaguing past studies of the link between financial development and economic growth. We find that finance development is positively and strongly correlated with real GDP. This implies that financial sector and real sector are interrelated to each other in OECD and MENA countries. For robustness tests, we have used the error correction approach. Our results support the idea that the causality is bidirectional for the OECD countries and unidirectional (economic growth- financial development) for the MENA countries. The MENA region results may be explained by the weak financial systems of these countries and the State's intensive interventions in them. Such interventions tend to limit the contribution of the financial sector in the process of real sector.

This research can be extended by introducing financial and banking crises because it is recently argued that crises have a negative impact on the development of financial system. The policy implications of our findings are straightforward: to maintain a sustainable economic growth, all economies have to deepen the financial sector and undertake essential measures to strengthen the relationship between financial sector and real sector. Also, countries must strengthen banking and financial governance. A well-functioning financial sector can positively contribute to promote economic growth in both developing and developed countries.

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Table 1. Unit root test for OECD countries

	Persan and Shin test		Maddala and Wu test	
	Level	Difference	Level	Difference
GDP	0,56	-5,45***	10,44	85,4***
PC	-0,6	-9,3***	32,55	129,8***
LL	-	-	-	-
GV	0,33	-6,3***	15,2	83,7***
P	-0,11	-12,23***	20,6	170,9***

*** panel data stationary at 1%, * panel data stationary at 5%

Table 2. Unit root test for MENA countries

	Persan and Shin test		Maddala and Wu test	
	Level	Difference	Level	Difference
GDP	0,5	-6,44***	7,34	77,33***
PC	-0,4	-7,78***	15,56	74,55***
LL	1,88	-6,39***	9,44	55,56***
GV	-0,23	-8,99***	13,88	94,19***
P	-1,13	-11,32	16,77	134,89***

*** panel data stationary at 1%, * panel data stationary at 5%

Table 3. Panel cointegration tests

Dependant variable: Real GDP per capita

	PC	LL
OECD: Group ADF	-2,11798*	-
MENA: Group ADF	-2,44119*	-2,13206*

* reject of the null hypothesis of non-cointegration at the level of 5%

Table 4. Results of cointegration for OECD countries (FMOLS)

	PC	GV	P
Spain	0,24 (0,56)	2,33*** (2,78)	-1,27* (-1,88)
Greece	0,76* (1,68)	0,93 (0,89)	-2,01* (-1,89)
Iceland	0,19 (0,69)	3,11*** (3,99)	0,36 (1,17)
Italy	1,42*** (3,97)	2,52*** (3,18)	-4,48*** (-3,68)
Portugal	-0,01 (-0,02)	2,44*** (2,66)	-0,88 (-0,49)
Sweden	0,49* (1,66)	2,39*** (2,62)	-6,89*** (-3,55)
Panel	0,79*** (3,43)	1,44*** (2,97)	-2,66*** (-3,87)

***, **, and * denote the significance level of 1%; 5%; and 10%, respectively. The numbers in parentheses represent t-statistics.

Table 5. Results of cointegration for MENA countries (FMOLS)

	PC	GV	P	LL	GV	P
Egypt	0.48***(3,19)	-1,11***(-3,09)	1,09**(2,33)	1,15***(3,88)	-0,68***(-2,48)	-1,79***(-3,13)
Morocco	0.19 (1.29)	-0.00 (-0.01)	1.46 (1.50)	0.19 (0.84)	0.03 (0.06)	1.49* (1.94)
Tunisia	3.68***(3.35)	-1.71 (-1.43)	-3.21 (-1.50)	4.78***(3.76)	-1.07 (-0.64)	-5.13 (-1.49)
Turkey	1.26* (1.83)	-0.41 (-0.78)	1.77***(5.00)	1.39***(4.04)	-0.25 (-0.65)	1.40*** (5.59)
Panel	1.16 **(2.04)	-0.76***(-3.08)	-0.07 (0.92)	1.78***(3.36)	-0.27***(-4.74)	-1.34* (-1.60)

***, **, and * denote the significance level of 1%; 5%; and 10%, respectively. The numbers in parentheses represent t-statistics.

Table 6. Financial development and economic growth: The GMM system approach of Blundell and Bond (1998)
Depend variable: Real GDP per capita

OECD		**OECD**		**MENA**		**MENA**	
Variables	Coefficient	Variables	Coefficient	Variables	Coefficient	Variables	Coefficient
GDP (-1)	0.573***	GDP (-1)	0.580***	GDP (-1)	0.340***	GDP (-1)	0.380***
	(4.47)		(4.93)		(3.33)		(4.19)
P	-0.017***	P	-0.016***	P	-0.032***	P	-0.038***
	(3.09)		(3.13)		(3.57)		(3.49)
GV	-0.025	GV	-0.011	GV	-0.070***	GV	-0.047***
	(0.50)		(0.16)		(3.12)		(2.75)
LL	**3.451****	PC	**2.266*****	LL	**0.219****	PC	**0.519****
	(2.06)		(2.95)		(2.02)		(2.10)
constant	3.927**	constant	3.213	constant	-0.606	constant	-1.102***
	(2.21)		(1.47)		(0.85)		(2.48)
Number of countries	06	Number of countries	06	Number of countries	04	Number of countries	04
Wald test	201.90	Wald test	283.03	Wald test	314.42	Wald test	28.55
P-value of Wald test	0.000	P-value of Wald test	0.000	P-value of Wald test	0.000	P-value of Wald test	0.000
AR (2) of Arellano and Bond test	-0.39	AR (2) of Arellano and Bond test	-0.43	AR (2) of Arellano and Bond test	-1.24	AR (2) of Arellano and Bond test	-1.25
P-value of AR (2)	0.693	P-value of AR (2)	0.665	P-value of AR (2)	0.213	P-value of AR (2)	0.211
Sargan test	13.72	Sargan test	13.40	Sargan test	16.06	Sargan test	17.25
P-value of Sargan test	0.394	P-value of Sargan test	0.417	P-value of Sargan test	0.246	P-value of Sargan test	0.188

Note: Estimation method is one-step GMM-in-System estimator of Blundell and Bond (1998).
AR (2): test of null of zero second-order serial correlation, distributed N (0, 1) under null.
The numbers in parentheses are t-statistics.
Sargan-statistics is the test of over-identifying restrictions.
*, **, and *** indicate statistical significance at the 1%, 5%, and 10% level.

Table 7. Causality test for MENA countries (Indicator of financial development: PC)

Null hypothesis	ECT_{t-1}	F-stat
Ho: Financial development don't causes growth	0.004 (0.24)	F= 0.262 (0.734)
Ho: Growth don't causes Financial development	0.49 (0.003)	F= 0.316 (0.624)

The numbers in parentheses represent P-value

Table 8. Causality test for MENA countries (Indicator of financial development: LL)

Null hypothesis	ECT_{t-1}	F-stat
Ho: Financial development don't causes growth	0.005 (0.45)	F= 0.61 (0.603)
Ho: Growth don't causes Financial development	0.39 (0.04)	F= 0.611 (0.364)

The numbers in parentheses represent P-value

Table 9. Causality test for OECD countries (Indicator of financial development: PC)

Null hypothesis	ECT_{t-1}	F-stat
Ho: Financial development don't causes growth	-0.02 (0.07)	F= 0.567 (0.533)
Ho: Growth don't causes Financial development	0.23 (0.004)	F= 0.328 (0.743)

The numbers in parentheses represent P-value

Table 10. Causality test for OECD countries (Indicator of financial development: LL)

Null hypothesis	ECT_{t-1}	F-stat
Ho: Financial development don't causes growth	-0.08 (0.09)	F= 0.433 (0.423)
Ho: Growth don't causes Financial development	0.19 (0.04)	F= 0.298 (0.147)

The numbers in parentheses represent P-value

Market Microstructure: The Components of Black-Box

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Abstract

During the last few decades, market microstructure has become an important discipline within the field of finance. The market microstructure literature have been enriched by theoretical, empirical and experimental studies relating to other areas of finance such as assets pricing, corporate finance, international finance and welfare. The processes and rules of exchanging securities are considered an important issue since they affect the way in which trades are determined, prices are formed and scope of asymmetric information. However, the ways of describing how exchange process occurs in the markets are varied. This paper determines the components of the market microstructure black-box in terms of trading mechanisms and regulations governing various aspects of trading process. Determining the components of the black-box allows researchers to identify and compare the themes in market microstructure and issues facing the process of trading securities. Thus, this paper may be used as a source for future research ideas in comparing the market microstructure of exchanges. It also provides necessary input to the regulatory bodies to enhance the design of better markets. Furthermore, this paper would help the investors and portfolio managers to make better trading decisions by understanding how markets work and how it regulated as well as the investors will be able to interpret how various rules affect price efficiency, liquidity, transaction costs and trading profits.

Keywords: Market Microstructure, Trading Mechanisms, Market Regulations

1. Introduction

Microstructure is usually very specific about the mechanism and regulation used to accomplish of trading. It has an impact on market efficiency, securities values, securities liquidity, market transparency and transaction costs. This area of finance is not new and it has long history but during the last few decades it acquired a distinct identity. The market microstructure covers the trading rules and trading system used by a market through which investors predictions of the future and their trading strategies are ultimately translated into the current assets prices and trading volumes. O'Hara (1995) has described market microstructure as the study of the process and outcomes of exchanging assets under explicit trading rules. Madhavan (2000) has defined the market microstructure as the process by which investors' latent demands are ultimately translated into prices and volumes. Spulber (1996) has provided a broader definition of market microstructure which is the study of the intermediation and the institutions of exchange. One important implication drawn from these definitions is that the market microstructure is shaped by trading mechanisms and trading regulations. Market microstructure theory challenged the traditional view of efficient market witch ignored the mechanisms by which prices of securities are formed (O'Hara, 1987). Thereof, the essential theme of the market microstructure theory is that securities prices need not fully reflect all available information because of a variety of fractions (Madhavan, 2000).

Securities markets over the entire world are currently structured in a myriad of ways in terms of trading mechanisms and regulations governing various aspects of trading. They are also transformed fundamentally and rapidly as the computerized trading of securities replaces the traditional open outcry trading (O'Hara, 2001). Determining how exactly a market is structured is an important for researchers to conduct a comparative studies in order to identify the optimal structure for trading securities in terms of market quality and efficiency (Comerton-Forde & Rydge, 2004), and for individuals investors to understand how markets work and regulate. Thus, the individual investors will improve their trading strategies, and they can better manage the brokers, who work for them. They will also be able to predict how various rules affect price efficiency, liquidity, and trading profits (Larry Harris, 2002).

Several studies explore the microstructure of securities exchanges in the world, a region and within a country. For example, Comerton-Forde and Rydge (2004) provide a review of the market microstructure of eighteen of the world's largest and most influential stock markets. They review the market microstructure based on trading mechanisms, level of transparency, trading structures, short selling, principal trading and crossing rules. They found that there are considerable differences in microstructure between regions as well as between individual exchanges in terms of trading mechanisms and market regulations. They also contend that historical economic and political developments are of major importance in explaining these differences. In their subsequent study Comerton-Forde and Rydge (2006) review the market microstructure of ten Asia-Pacific stock exchanges with regards to market type, market linkages, market fragmentation, market makers, order priority rules, price steps, short selling, market

transparency and price variation controls in the exchanges. They document significant differences in market design across Asia-Pacific stock exchanges. Demarchi and Foucault (2000) surveyed the changes in the market microstructure of the five largest European Stock Exchanges during the last decade of the twenty century. They describe the basic design of the trading systems and the criteria of segmenting the stock used by exchanges in terms of trading mechanisms with regard to type of stocks, order size and time of the trading. They found that the trading systems are similar whereas electronic order-driven markets are utilized in these markets. Further, they show that there are considerable differences between the exchanges with regard to the order flow consolidation, role of dealers, market transparency and clearing and settlement. Additionally, there are major differences in the trading rules including the price determination, order types and priority, trading halts and circuit-breakers, and tick size among the exchanges. In addition, Xu (2000) describes the microstructure of the Shanghai Securities Exchange and Shenzhen Securities Exchange; especially the trading method used in these markets regarding market type, trading sessions and price discovery, order types, and trading unit. They show that Chinese stock exchanges adopted a centralized computerized order matching system; however, differences between these exchanges regarding listing rules are exist. Such studies have taken a snapshot on the market microstructure in a specified time. However, in reality securities markets make major changes in their trading rules and new methods of trading arise with surprising frequency. This necessitates a comprehensive guideline to determine the components of the Black-Box of the microstructure. These components can be classified according to the trading mechanism and trading regulation, which shape the structure of market.

The needs for a standardized guide to allow researchers to identify and compare the differences between securities markets in a certain time or individual market over different times motivate us to conduct this research. The purpose of this descriptive paper is to identify and classify the components of the market microstructure by reviewing the prominent and important relevant studies on the market microstructure.

The remaining of this paper is organized as follows: Section two provides a brief summary of the important relevant studies on the market microstructure. Section three discusses the trading mechanism. Section four discusses trading regulation. Section five is the conclusion of the paper.

2. Literature on Market Microstructure

The market microstructure research is important for illustrating the behavior of prices and markets, which has direct influence on the market regulation, and on the design and formulation of trading mechanisms. O'Hara (1995) provides a detailed survey of the theoretical literature and considers the standard reference for the economic theory of market microstructure. Madhavan (2000) surveyed the literature on the microstructure studies, building on empirical, theoretical and experimental studies relating to markets and trading. Harris (2002) provides a detailed conceptual overview about trading, the people who trade securities and contracts, the marketplaces where they trade, and the rules that govern trading; his focus is on the practitioners not on the academic literature. Easley and O'Hara, (2003) surveyed the studies on the microstructure regarding the microstructure factors and asset price dynamics. Biais, et al. (2005) provide a comprehensive review analyzing the price formation and trading process, interrelation between institutional structure, strategic behavior, prices and welfare. Hasbrouck (2007) provides a detailed integrated introduction to the most important models of empirical market microstructure studies.

Several studies have focused on a comparison between two trading methods in a similar span of time. For instance, based on the differences in execution methods applied in the opening and closing transactions, Amihud and Mendelson (1987) have compared the behavior of call market and continuous auction returns on NYSE stocks. They have found that call market return variance is higher than continuous auction return variance. Comerton-Forde (1999) has compared the opening method used by the Australian Stock Exchange and the Jakarta Stock Exchange. She has documented that the trading method affects the securities liquidity and volatility. Theissen (1999) has compared the transaction cost in the trading mechanism used by Frankfurt Stock Exchange where trading conducted in floor and in electronic trading system at the same time. He has reported that the bid-ask spreads, tends to be larger on the floor than electronic trading system. Additionally, Chow, et al. (1996) have investigated the price and volume pattern around the point of mechanism switch from floor to automated system. The results indicated that the trading volume on the floor is more than that of automated system around the switch. Based on these results, they suggested that the traders tend to transact on the floor that may exist around the switch from floor to automated system. The forgoing mentioned studies have focused on the differences between two trading methods employed in the trading process. On the other hand, several studies have taken into accounts the differences in trading regulation. For example, Subrahmanyam (1994) examined the impact of the circuit breaker regulatory tool on market participants trading decisions and consequently on market liquidity and price variability. He showed that the circuit breaker may increase price variability and the probability of the price that cross the circuit breaker bounds. This takes place if the price is very close to the breaker limit and if agents place a high value on their desire to trade. Wong, et al. (2009) have investigated the magnet effects of price limit rules on the Shanghai Stock Exchange. They have found that security prices move towards limit bounds at faster rates and with increased volatility and higher trade frequency. Moreover, Onnela, et al. (2009) have studied the effect of changes in tick size on asset returns. They have proved that the traders do not use all price fractions as it is allowed by the tick size. This leads to a clustering of prices on certain fractions and a reduction in effective tick size and subsequently this phenomenon could potentially affect the

distribution of securities return.

Based on the studies in market microstructure reviewed above, it is plausible to classify the microstructure components according to the trading mechanism and trading regulation. Trading mechanism implies the method of accomplishing the trading process, while trading regulation dictates how and when orders can be submitted and processed. This classification of market microstructure components has twofold justifications. First, the securities markets that employ similar trading mechanism could be dissimilar with regard to trading regulation. For instance, securities exchanges such as Australian Stock Exchange, Bursa Malaysia, Tokyo Stock Exchange and Swiss Exchange operate a fully automated order driven trading system. However, the trading regulations that govern the trading process are varied in these exchanges. The second justification is that the changing in the market regulations can be simply implemented by securities exchanges. On the other hand, the changing in the trading mechanisms requires real investment which takes time to be implemented.

3. Trading Mechanisms

Trading mechanisms refer to the methods of trading securities. Trading mechanisms are determined by several dimensions including market type, price discovery, order forms and degree of transparency as illustrated in figure 1.

3.1 Market Type

Securities market type has three dimensions which are degree of continuity, reliance on market makers and degree of automation (Madhavan, 2000).With regard to the degree of continuity, there are two types of market: the first one is the 'call market' where selling and buying orders are grouped together during an interval period of time and transact at single price, which equates the quantity supplied to the quantity demanded. The second one is the continuous auction market, where selling and buying orders are executed whenever submitted. The executing price represents the highest price that a buyer is willing to pay and the lowest price that a seller is willing to sell Chang, et al. (1999). With respect to the reliance on market makers, securities exchange considered as quote-driven market where prices are determined from quotations made by market makers or specialists. While securities exchange considered as order-driven market or auction market where prices are determined by the publication of orders to buy or sell shares via public investors without market makers' intermediation (Madhavan, 2000).

Concerning the degree of automation, trading mechanisms can operate either on the floor or by means of electronic systems. Regarding the first type, trading mechanism relies on an open outcry method where exchange uses face to face verbal and hands signal. In the second type, trading mechanism employs an electronic trading system where participants key in the orders.

With these multidimensional market types a plethora of choices for the trading of securities are available to the securities exchanges. Therefore, most of the securities markets are actually hybrids, involving dealers, clearings, one- and two-sided auctions, and bilateral bargaining (Hasbrouck, 2007). Market microstructure researches have proved that the market type affect the performance of markets and prices of securities. For example, Huang and Stoll (1996) have investigated the executing costs in order-driven market as represented by NYSE and quote-driven market as represented NASDAQ. Their results indicate that the cost of executing transactions is higher on quote-driven market than on the order-driven market. Blennerhassett and Bowman (1998) have examined the changing of open outcry trading to an electronic screen trading system at New Zealand Stock Exchange. They found that the changing of market type lead to lower execution costs. Pagano and Schwartz (2003) have investigated the impact of utilizing call auctions at market closings on market quality at Euronext Paris. They revealed that the utilizing call auctions have a positive effect on market quality. Chelley-Steeley (2008) has examined the effect of introducing a closing call auction on market quality at the London Stock Exchange. She found that the introduction of call auction improves the market quality concerning the speed of price adjustments to new information and with respect to prices efficiency.

3.2 Trading Sessions

A trading session is a defined period of time, consists of several phases from the preopining phase to the closing phase where the trading of securities may take place. Each phase within trading session implies a process of trading and price discovery under explicit trading rules.

Trading in the securities exchange occurs frequently using periodic or continues auctions. It is open for specific days a week. Exchanges could splits the trading day up into a morning and afternoon session. Each trading session goes through a series of phases which are usually opening, continuous trading, preclosing, closing and trading at last. In addition, trading could include preopening phases. In each phase of trading specific orders types are allowed to be entered, modified or deleted, these orders are batched for execution at a certain execution price calculated by the trading system or set by the market makers. It is important to identify the process of price discovery in each trading phases and the rule of order priority whereas transactions are taken place.

Trading sessions is an important concern to securities prices. In line with this view, Ito and Lin (1992) have examined the differences of trading sessions on New York Stock Exchange and Tokyo Stock Exchange. They found that lower volatility on the Tokyo Stock Exchange when the market is closed for the lunch break and lower volatility around the noon hour in New York when the market is open.

3.3 Order Forms

A trader in stock market can contact a brokerage firm to place an order, which represents the intent of the trader to sell or buy a specific stock listed in the secondary market. In reality, traders have several options when it comes to placing an order to buy or sell securities with regards to order types. Orders are contingent on a variety of conditions concerning quantity, price and time, whereas the most commonly used types of order are the market and limit orders.

A market order is a quantity contingent order used to immediately buy or sell a stock at the best bid or ask price currently available in the market. Market orders are always guaranteed to be executed as long as there are active buyers or sellers in the market. The market order guarantees the quantity but not the price, especially in fast moving markets. The order in fast moving markets might be executed at different price from real-time obtained price. This drawback in market order can be overcome by placing a limit order. Limit order is price contingent order to buy or sell a stock at a specific price outside the range of the current quotes. This type of orders allows traders to control and guarantee the price at which the trade is executed, but it is not guaranteed to be executed unless the specified price is reached.

Another price contingent order is stop order which allows trader to protect profits or stop loss. The stop order is an order to buy or sell a stock when the price of the stock reaches a specified price known as the stop price. When a current price reaches stop price, the stop order becomes a market order. A buy stop order is always placed at a price above the current market price typically used to limit a loss or protects a profit on short sales. A stop sell order is always placed below the current market price and it is used to stop loss or protects profits.

Stop limit order is a price contingent order to buy or sell a stock that combines the features of a stop order and a limit order. This order turns into a limit order when the stop price is attained. Stop limit order gives traders more control of when and at what price the order will be executed.

Additionally, there are other types of orders used to control price, quantity or execution of trade, such as fill or kill order, which is a market or limit order to buy or sell a certain stock for a specified quantity immediately, in case the order is not executed in its entirety, it will be automatically cancelled. Another type orders is called all or nothing, which is a limit order used to a buy or sell full amount of quantity or not at all, in case there is insufficient quantity at a specified price the all or nothing order unlike the fill or kill order, it is not cancelled and it remains on the order book as a limit order.

All orders are day orders, that is, valid on and for the day when they are placed, unless otherwise specified. However, the trader can place good till cancelled order usually is a limit or stop order, which it remains valid until executed, cancelled or expired after a specified period. Moreover the trader can specify at what time the order will be executed. For example a trader can place market on opening order in the pre opining trading phase, this order would be executed at the opening of the trading session at an opening price; also the trader can place market on closing order in the pre closing trading phase, this order will be executed at the closing phase at closing price.

The types of order available at security exchange affect the performance of the market and thus the investors profits. Placing an order seems be the most decisive decision an investors make through the trading process regarding to the order types. Easley and O'Hara (1991) have examined the effect of order forms on security prices. They revealed that the possibility to trade using alternative order forms affect the performance of the market. In addition, Harris and Hasbrouck (1996) have investigated order forms execution performance. They found that the limit order placement strategies most commonly used by NYSE investors perform better than market orders.

3.4 Market Transparency

Market usually is transparent when high quantity and quality of information regarding current and past prices, quotes, depths, volumes and the identities of market participants are rapidly available to the public. In this sense ‘market transparency refers to the ability of market participants to observe information about the trading process’ (O'Hara, 1995).When discussing market transparency, it can be divided into pre-and post-trading dimension. Pre-trading transparency refers to the dissemination of information about the limit-order book, bid and ask quotations, orders flow, identities of market participants, market depth. Post-trading transparency refers to the availability and velocity of dissemination of the information to the public about trading details such as volumes, prices, trader identities and transaction time. Generally, electronic markets that communicate in real time the bids and offers of buyers and sellers and the prices of executed trades are considered highly transparent. On the other hand, the dealer markets often have no publicly visible bids or offers, nor any trade reporting, and are therefore usually considered opaque (Hasbrouck, 2007).

Several studies have investigated the effect of market transparency on market quality. However, the results are inconclusive. Pagano and Roell (1996) have investigated whether greater transparency improves market liquidity. They found that greater transparency lead to reduce the trading costs for uninformed traders. In addition, Chung and Chuwonganant (2009) have examined the effect of changing pretrade transparency on market quality. Their results indicate that both transaction cost and return volatility declined significantly after increasing market transparency. On the other hand, Bloomfield and O'Hara (1999) have investigated the effects of trade and quote dissemination on bid-ask spreads. Their results revealed that increased transparency increases opening bid-ask spreads. In addition,

Madhavan et al. (2005) have investigated the effects of disclose the limit order book to the public on market liquidity. One of the important conclusions that emerges from their analysis is that the increase in transparency has increased the execution costs in terms of the bid-ask spread.

4. Market Regulations

Market Regulations refer to the rules of trading securities defined by securities market to control various aspects of trading process, such as the rules of order priority, tick size and spread, listing, trading unit, price thresholds, trading status, short selling and off-market trading as illustrated in Figure 1.

4.1 Rules of Order Priority

Matching of the security orders priority is given according to certain criteria determined by securities exchange. Since the quantity contingent orders match at the best available prices, they are given priority and executed before price contingent orders. Demarchi and Foucault (2000) contend that the price priority and then time priority is most favorable as it leads to price competition among traders. For instance, price and time priority rules take place in the continuous auction markets where market rules often require the highest of bid or lowest of ask price order received to be executed first. In case of two bids or asks are received at the same price, the first entered bid or ask order is given priority and is executed first. Unlike the continuous auction markets, the dealer markets do not operate under price and time priority rules. In this type of markets, it is a sine qua non for brokerages to seek the preferable prices for trader orders.

4.2 Rules of Tick Size and Spread

The minimum change allowed by the stock exchanges in the price, a security could go either up or down, is known as a tick size. Angel (1997) contend that tick size rules are useful in explaining the prices variety across countries. Tick size could be in decimals or fractions such as ‘eighths or sixteenths’; it could also be fixed or varied within different price ranges. Tick size is an important factor determining the bid-ask spread, which is the difference between a security’s bid price and it’s ask price. Lau and McInish (1995) confirm that the reduction in the tick size decreased bid-ask spreads significantly and therefore reduced transactions costs. Ke, et al. (2004) revealed that increases tick size leads to increased the bid–ask spreads and volatility.

The size of the spread is attributed to liquidity and transparency of the market, that is, more liquidity and transparency in the market decrease the bid-ask spreads. Ascioglu, et al. (2010) argue that higher minimum tick size would generate high unnecessarily transactions costs. While lower minimum tick size may lead to low market liquidity. In quote driven markets, dealers buy stocks at the ask price and sell at the bid price. Thus, the size of the bid-ask spread is proportional to the size of the dealer’s profit.

4.3 Rules of Listing

Securities exchanges have listing requirements to approve listing shares of companies in accordance with listing rules. Securities exchanges have different sections where companies would be listed. Securities are allocated to a particular section of market whereby different trading mechanism and trading rules are carried out based on a number of criteria such as company size, disclosure levels, liquidity and trading activities. Biddle and Saudagaran (1989) contend that the financial disclosure levels are an important determinant of firms to list their securities on foreign exchanges. Huddart, et al. (1998) argue that lowering the listing requirement securities to attract new abroad listing would increases the trading costs to liquidity traders. The question of what makes some stock markets more attractive than others from the viewpoint of companies? is addressed by Pagano, et al. (2001). They found that the companies are preferred to be listed in more liquid and larger markets, and in markets where many companies from the same industry are listed. In addition, the companies are more likely to be listed in markets with better investor protection, and in countries with more efficient courts and bureaucracy. In contrast, the decision of listing is not associated with stringent accounting standards.

4.4 Rules of a Trading Unit

Trading of securities in exchanges could be conducted in a standard trading unit which is a number of securities that is generally accepted for ordinary trading purposes on the exchanges. However, trading securities could be conducted in odd-lot which is the quantity that differs from a standard trading unit. Securities exchanges usually employ different trading units of listed companies subject to trading prices. Amihud, et al. (1999) revealed that a reduction in the trading unit greatly increases the liquidity of securities and leads to a significant increase in the securities prices.

4.5 Rules of Price Thresholds (Limits)

A price threshold refers to the range of price movement (maximum price increases or decreases) from the previous closing price permitted by securities exchange during one trading session or one trading day. Kim and Rhee (1997) questioned the effectiveness of price limits and found that the price limits leads to increases price volatility, delays in equilibrium price discovery and disturb trading activity. Furthermore, Kim (2001) found that price limits caused more market volatility. Ryoo and Smith (2002) contend that using price limits leads to market inefficiency by prevents equity prices from following a random walk process. Chan, et al. (2005) found that employing price threshold increases the transaction costs and do not improve price discovery.

4.6 Rules of Trading Status

Securities exchanges use specified rules in certain circumstances that require ceasing the matching of one stock or securities group. Such a process usually anticipates a news announcement or corrects an order imbalance. Bhattacharya and Spiegel (1998) revealed that suspensions of trading occur when the company announces impending news or the market maker observes a severe order imbalance. Implementing trading status rules would increase the market efficiency by giving all investors equal opportunities to evaluate news and make either buying, selling or holding decisions which are based on the arrival of new information.

4.7 Rules of Short Selling

When an investor anticipates that the price of a certain stock will rise in the future, buying and holding the security could be the best strategy. Conversely, when an investor believes that the price of a certain stock will decrease in the future, selling the security could be considered as the best strategy. In this case if an investor does not hold the stock, he/she can sell in short, which means that he/she borrows an amount of stocks from the broker and sells it in the market hoping that the prices will go down. Then the investor can buy that amount from the exchange and give it back to the broker. Thus the difference between the sell price and buy price would be the investor profits or losses.

Since short sellers possess important information and their trades are important accomplishments affecting stock prices efficiency (Boehmer, et al., 2008). Securities exchanges implemented restricted rules regarding the short selling, in some exchanges short selling is not allowed, while it is permitted in others. Ko and Lim (2006) suggest that short selling does not disturb trading activity, but adequate to provides market liquidity.

4.8 Rules of Off-Market Trading

Off-market trading refers to the transaction stocks of listed companies which occur outside a formal securities exchange. Off-market transactions are conducted through negotiation rather than an auction system. The reason for using off-market trading is usually to transact big block of stock without affecting the stock prices. Booth, et al. (2002) found that off-market trading tend to have lower information content and lower price impacts than trading securities in formal exchange.

5. Conclusion

This paper determines the components of the market microstructure black-box. Market microstructure includes the trading mechanisms and regulations as the main components. Trading mechanisms determined by market type, price discovery, order forms and degree of transparency, whereas market regulations includes the rules of order priority, tick size and spread, listing, trading unit, price thresholds, trading status, short selling and off-market trading. Taking into account the components of market microstructure is important for conducting research in market microstructure and its related to other area of finance. More importantly as long as the research in market microstructure plays an important role in providing a necessary input to the issues of how to design and conduct the trading, therefore, taking into consideration the components of market microstructure is important for addressing such issues in future research and enhancing the design of markets as well as improving the trading strategies of individual investors.

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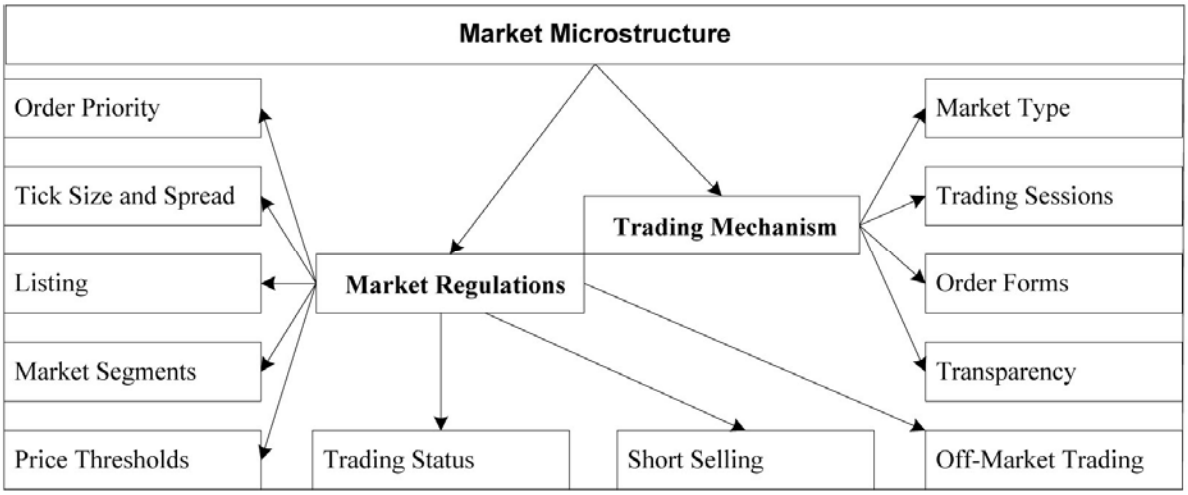

Figure 1. The components of the market microstructure black-box.

The Development Perspective of Finance and Microfinance Sector in China: How Far Is Microfinance Regulations?

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Abstract

The paper reviews the development process of bank and microfinance sector in China and presents their regulatory status. The financial sector is largely bank-based and dominated by the four state commercial banks in China. However, government liberal policy and special attention to financing underdeveloped regions and SMEs have gradually improved the scenario. The development of non-state banks, non-bank financial institutions and MFIs has extended financial services to the areas where state banks were previously not so active. Consequently, government banks, micro-credit companies along with some national and international MFIs and donor agencies have started their business a greater extent although the market freedom is still questionable. The benefit of microfinance services lies on favorable government policy formulation and allowing MFIs reasonable freedom toward smooth development. Thus, it is suggested that government authorities should take necessary steps for resolving the existing barriers of the promising microfinance sector in China.

Keywords: Finance, Microfinance, Microfinance regulation

1. Introduction

Financial access to all social groups particularly to the poor has become an important tool for reducing poverty and inequality for many developing countries in the world. China made unprecedented success in her economic and social aspects since reform and opening up started in 1978. It has made significant success in poverty reduction and rural development (ADB, 2008). For instance, official poverty fell from 15 percent in 1984 to 2 percent in 2007. However, the development of the financial sector is at a slower pace compared to other sectors in China's economy. China's financial sector is underdeveloped and inefficient in respect to market domination by four State Commercial Banks (SCBs), higher bank deposit and banks lending have misallocated (Aziz, 2002). In contrast, a substantial amount progress has been made in the reforming process. The important progress that has occurred are the restoration of a commercial banking system, development of non bank financing, rural financing, special priority to Small and Medium Enterprise (SMEs), micro-lending and the introduction of NGO-MFIs.

Microfinance is the financial provision to the poor who are traditionally not served by the conventional financial institutions. These institutes not only provide credits but also provide supplementary services i.e deposit, insurance, remittance, education, health, market information, training, awareness building, forestation, and so on. Accordingly, several microfinance models have been developed in diverse political and economic contexts. The microfinance models have been trying to apply in China's financial market with reasonable modification (Sun, 2002). In reality, microfinance is a young but promising sector in China introduced in 1993 (MIFA, 2009). However, the potentiality of micro-credit is enormous in China in respect to large rural populations, unemployed workers, SMEs, micro enterprises, low rural coverage, limited outreach and high loan/deposit ratio of formal financial institutions (He, 2008). So, the donors, government authorities, and NGOs come forward targeting poverty reduction through micro lending in the less developed regions of China (Aghion, 2002). However, the commercialization did not really emerge in China until recently (He, 2009). Within 15 years of microfinance experience, China has drawn some specific techniques and models, introducing a system suitable to the Chinese situation. But, the provision of supplementary services has not popularized among China's microfinance clients and providers. Even, the market freedom and favorable policy regulation is still lagged behind.

Therefore, this paper's ultimate goal is to provide a consistent conceptual interpretation and discussion of the development process of the financial sector, and more specifically, the development of microfinance sector and the

regulatory environment in China. However, the reviews have been limited to banking and microfinance sector rather to covering stock, bond and capital market in China.

2. Financial sector development

Finance is something which popular usage for covering medium to large scale funding either working capital or investment capital for enterprises or households to maintain its production process or businesses (Wijewardena, 2004). Discussion of the development of the financial sector covers two major parts, conventional banking system and microfinance sector. The development of conventional banking systems and microfinance sector both has been divided into three phases for further discussions-

2.1 Development Phase-I (1978-83)

Before 1978, China's financial system consisted of a single bank −the People's Bank of China (PBC), government owned and controlled by the Ministry of Finance, which served as a central and commercial bank. A significant change occurred in 1979 as government first removed the monopolistic position of PBC by establishing four specialized banks- the Agricultural Bank of China (ABC) has a mandate or rural financing, the People's Construction Bank of China (PCBC) has a mandate for investment and manufacturing financing, the Bank of China (BOC) for international financial transactions and finally the Industrial and Commercial Bank of China (ICBC) was formed in 1984, for working capital financing (Table-1). Finally, PBC has formally been established as China's central bank and a two-tier banking structure- PBC as central bank and state-owned specialized banks (SOBs) evolved. So, it is apparent that financial reforms have implemented in a gradual basis rather than revolutionary way like other sectors of the China's economy.

2.2 Development phase II: 1984–1993

This period can be treated as broadening the financial market by allowing Non-bank Financial Institutes (NBFIs) beside "Big Four" banks. NBFIs, such as Trust and Investment Companies (TICs), finance companies, leasing companies, management companies, postal saving banks, insurance companies and securities companies have been allowed to emerge and compete with the state-owned banks (having restrictions on both deposits and loans). Regional banks (partially owned by local governments) were formed in the Special Economic Zones in the coastal areas. In rural areas a network of Rural Credit Cooperatives (RCCs) has been set up under the supervision of ABC. The Urban Credit Cooperatives (UCCs) counterparts of the RCCs in the urban areas have also been shaped (Dyar, 2006.).

2.3 Development Phase III (1994 to date)

The third phase can be treated as liberalization and international orientation of financial market in China. It is noted that microfinance or micro-lending activities were incepted in this phase. The section is discussed separately in the following part. In the reforming process, three policy banks were created in 1994 to disburse government-directed loans. It is legalized that the state-owned specialized banks can be converted to commercial banks (Shirai, 2002). New commercial bank law was enacted in 1995, giving the central bank legal foundation to operate in a market environment under the leadership of the State Council. Hence, a greater autonomy has been given for lending decisions and encouraged to create privately-owned commercial banks. In addition, a unified inter-bank market auctions for treasury bills and strict asset-liability ratios have been accomplished for commercial banks. The reforms have connected between banks and non-bank financial institutions and tightened regulations on stock exchanges (World Bank, 1997). Consequently, the government controls over financial institutions have been relaxed which is considered as a prominent aspect of financial sector reform. PBC influence on financial institutions has become more indirect and the credit ceiling of financial institutions no longer in existence. Beginning in 1998, lending quotas for state-owned commercial banks have lifted. Banks have been authorized to adjust interest rates within a 20 percent band depending on the borrower's creditworthiness. In the process of reform, foreign banks have allowed in special economic zones at first, and then gradually expand their (foreign exchange) business throughout the country. However, foreign banks have been subjected to national treatment concerning Renminbi business since 1995 (Hofman, 2009). Geographical and customer restrictions on RMB business for foreign banks have been removed gradually after China's accession to the WTO in 2001 (Table 1). Moreover, non-prudential restrictions on foreign banks' operations in China have also been removed. Accordingly, the achievements in China's economic and financial development have been well recognized by the international community. More and more foreign banks are establishing themselves in the vast and fast growing Chinese market, or seeking extensive and mutually beneficial business cooperation and partnership with their local counterparts (CBRC, 2007).

These reforms took place in the banking sector amid sustained economic growth and without macroeconomic disturbance. But, the performance of the Chinese financial system is still questionable due to unclear regulatory environment, lack of market freedom, business restrictions (different banking services) and so on. Whatever the limitations and constraints of banking system in China- China's financial sector has proved its efficiency, potentiality and set an example to the world during two big financial crises in 1997 and 2008.

3. Microfinance development

China has experienced fifteen years of microfinance services after successful inception in October 1993 as part of a government scheme for poverty alleviation. The development process of microfinance sector is discussed by following three phases-

3.1 Development Phase I (1994-1998)

The phase can be regarded as an experimental phase; microfinance activities were limited with different development projects. Before 1994, some international foreign-aid projects in collaboration with other projects initiated credit plans for particular social groups (Table 2)- i.e. United Nations Women Development Fund (UNWDF) for creating employment opportunities of women, International Foundation for Agricultural Development (IFAD) for improving food supply and increasing the nutrition level of middle and low income households in rural areas, the "Women, Population and Development" project implemented by UNFPA for revolving capital, and Hong Kong Oxford for providing credit to rural households for livestock farming and veterinary services (Druschel, 2002).

The first experiment of microfinance on the successful Grameen Bank model was replicated by CASS in 1993 in China. The client was poor rural women in four project sites- Yixian County, Hebei; Nanzhao County, Henan; Yucheng County, Henan; and Danfeng County, Shaanxi. The initiation of this project is regarded as the real outset of microfinance activity in China (Saich, 2001). Hence, Funding the Poor Cooperatives (FPC) followed the Grameen Bank (GB) model, offering 8% interest rate (yearly), 5% of the loan is taken at the time of disbursement to serve as savings fund and 2 *yuan* (US$0.25) is also saved from weekly repayment (Du, 2001). Loan is disbursed for one-year terms, weekly repayments are made, monthly or bi-weekly center meetings are conducted, and a first loan size is 1000 *yuan* (about US$ 121). The loan size increases to 1500 *yuan* in the second year and 2000 *yuan* in the third year and it is capped at 2000 *yuan*.

3.1.1Brief introduction of Donor funded Microfinance program

In 1995, UNDP undertook a microfinance experiment project at Yilong County, Sichuan Province. The project has expanded to 48 counties of 17 provinces and became one of the largest microfinance projects assisted by an international organization in China. In 2008, UNDP has taken another collaborative project with CETICE for building an inclusive Chinese financial sector. The project is intended to build a draft national strategy for financial inclusiveness and will be submitted to the State Council at the end of 2011 (UNDP, 2008). In 1996, the United Nations Children's Fund (UNICEF) began microfinance activities as social development program for poor areas. Beside micro-lending activities, UNICEF provided training on maternal and child health care. The United Nations Population Fund (UNFPA) began microfinance activities in 1998. Accordingly, several international and national organizations have come forward to micro-lending in China among others- World Vision (WV) began microfinance services in 1997, The Canada-China Women's Income Generating Project (CC97) began in 1997, Oxfam Hong Kong in Yunnan province since 1992, the China Foundation for Poverty Alleviation (CFPA) a Chinese non-governmental organization was formed in 1997 and Rural Credit Foundations (RCFs).

Parallel with the above microfinance projects, the government has also been providing loans in rural areas through three leading financial institutions since the 1990s- the Agricultural Bank of China (ABC), for larger farming units such as seed companies and marketing co-operatives; the Agricultural Development Bank of China (ADBC), for storing crops, distributing, marketing, or processing agricultural products, or for large-scale agricultural development projects; while the Rural Credit Cooperatives (RCCs) for township and village enterprises (TVEs), and to middle-income male farmers (Du 2002; Zhu, *et al*. 1997). Hence, RCC is the first government bank providing micro loan to the farmers. RCCs have reached almost every township of rural China under the supervision of PBC. In 1996, the RCCs officially became independent entities (Watson 2002).

3.2 Development Phase II (1999-2004)

This phase has been labeled as the entire participation of formal financial institutions and the institutionalization of various projects. RCCs introduced micro-credit and group loan businesses for rural households in 1999. The experiment of RCCs have made success in some provinces like Shaanxi, Sichuan, Yunnan, Hebei, Guangxi, and Guizhou as they experienced faster microfinance growth (He, 2009). In the reforming process, the PBC has widely promoted micro-credit for rural households across the country. Thus, China has adopted micro-credit program from poverty alleviation project to rural financial sector. At present, RCCs is the largest microfinance practitioner in China as formal financial institutions.

Afterwards, in order to support the laid-off unemployed people for re-employed and meet the capital demand of that population, central government authorities (i.e. PBC, the Ministry of Finance (MOF), the State Economic and Trade Commission, and the Ministry of Labor and Social Security) encouraged local and provincial government to establish re-employment guarantee foundation since 2002. Consequently, laid-off unemployed are allowed start-up funds and working capital so as to uphold self-employment (Tang, 2009). This can be considered a holistic approach which satisfied laid-off unemployed through re-employment. The initiatives not only fulfilled the required funds but also expanded microfinance market from rural to urban areas in China.

3.3 Development Phase III (2005- to date)

The third phase can be treated as the normalization and institutionalization phase of microfinance. The phase begins with issuing a series of regulations by regulatory bodies in favor of microfinance development. In 2005, as China had experienced ten years of microfinance development, the PBC launched micro-loan companies (along with RCCs) in Sichuan, Guizhou, Shanxi, Shaanxi and Inner Mongolia provinces, pushing forward to popularization of

microfinance in China (Tang, 2009). Hence, legalization of micro-loan companies was a significant event in the course of microfinance development in China as well as rural financial reform.

In the course of microfinance development, China Association of Microfinance (CAM) was set up in 2005. CAM consists of domestic MFIs, relevant administrative departments, and domestic and international organizations as well as experts and scholars which care for and support the undertaking of microfinance. It is a collaborative, service-oriented, and self-disciplinary organization. The five main functions of the CAM include: policy coordination, self-regulation, technical assistance and training, information exchanges, and fundraising services (CAM 2010).

In the process of liberalization, China Banking Regulatory Commission (CBRC) permitted postal saving banks to gradually develop collateral-based micro-loan services since 2006. At the same time domestic commercial banks and rural cooperative banks have also been encouraged to set up fully-owned lending companies specializing in credit business (similar to the micro-loan companies promoted by the PBC). These are Village and Township Banks (VTBs), Lending Companies (LC) and Rural Mutual Credit Cooperatives (RMCCs). The business scopes of VTBs and RMCCs focus on towns and counties as well as villages and towns respectively (He, 2009). Hence, the establishment of lending companies approved by the CBRC indicates another progress in the normalization course of microfinance in China. Additionally, since 2007, the CBRC encouraged micro-loan companies and all banking financial institutions to offer micro-credit to traditional farming households, households in a variety of businesses, sole proprietors and rural micro and small enterprises (Table-2).

Furthermore, CBRC allowed individual, corporate legal entities and other social organizations investment towards the establishment of micro-loan (not allowed to collect public deposits) companies in 2008. At present, micro-loan companies are allowed to raise their funds from shareholders' capital, donated funds, and borrow from not more than two banking financial institutions (CBRC, 2009).

4. Microfinance structure and their services

Since the first microfinance seed was planted in China, a vast number of different types of microfinance operators have appeared within the Chinese market. The structure of microfinance system in China is shown in Figure 1. Generally, there are three broad categories of microfinance service providers. These include-

4.1 Micro-credit by financial institutes

This category mostly includes state own formal microfinance service providers i.e. ABC, ADBC, RCCs, Rural Commercial Bank, Rural Cooperative Bank, Postal Savings, China Development Bank (CDB), MCC, VTB, LC, and RMCCs. The microfinance market share is dominated by these providers.

4.2 Micro-credit by NGOs & international organizations

The service providers are- NGOs, international organizations and social organizations. The international organizations have been providing financial services as project based with the collaboration of government agencies. They also incorporate different services beside micro-credit i.e savings, training in project sites. NGO lending services have covered countrywide and large volume of business.

4.3 Micro-credit by Government agencies

This category provides micro-credit focusing on the government poverty reduction program. For instance, Urban Credit Bank (UCB) was established to support laid-off workers which ultimately expanded micro-credit services to urban areas.

The comparative features of different microfinance service providers are shown in Table 3. Among microfinance suppliers, only NGO-MFIs and MCCs are non-financial institutions and consequently not allowed to work with savings or receive funding from commercial banks –thus, preventing them from enjoying economies of scale (CAM, 2008). Even the lending companies are also not allowed to work with savings. In addition, the three newly created rural financial institutions (VTBs, LCs, and RMCCs) as well as MCCs are subjected to geographical restriction. The traditional collateral system for micro-financing still exists particularly for micro-lending companies, lending companies, postal saving banks, MCCs, and VTBs. Even RCCs and UCCs have followed a special kind of collateral to credit disbursement. RCCs required collateral for large loan amounts and UCCs required companies guarantee. On the other hand, the donor funded projects (UNDP, UNFPA, UNICEF, Heifer Project, World Vision, Oxfam Hong Kong and CIDA) are allowed to providing micro-credit services by collaboration with government departments or agencies having certain conditions.

5. Microfinance regulation

Microfinance development phase III, mostly covered the regulatory framework of China's microfinance. However, this section has tried to deal with some key issues of regulations. China Banking Regulatory Commission (CBRC) is the prime authorized institute to handle and maintain the rules and regulations of banking and MFIs sectors. Thus, CAM imitative to build a regulatory framework for the microfinance sector has been suspended due to the lack of authorization from government (Sun, 2008). In fact, CAM was trying to construct microfinance regulations with the technical assistance from citi-training center of China Academy of Social Sciences (CASS). Up to now, there is still a lack of complete regulation for the microfinance sector in China. Accordingly, slow and low quality development

of these NGO-MFIs has mainly been attributed to the limitations caused by an incomplete regulatory and supervisory system (Du, 2005). However, CBRC relaxation of interest rates and strong encouragement to micro-loan companies and village banks resulted in micro-lending coverage of 77 million household by the end of February 2008. With the approval of CBRC, commercial banks, NGOs and MFIs have started micro-lending services. At present, 91 village banks, 9 farmers' funding, 9 microcredit companies (7 domestic and 2 foreign) along with City Commercial Bank, ACLEDA, XAC Bank, and Grameen Bank have been providing financial services in China. According to CBRC report at the end of March 2009, 583 micro-finance companies have commenced their businesses in China which can be regarded as landmark for China's microfinance sector. CBRC has softened the requirements on SMEs loan applications procedures. Recently, government has planned to subsidize banks for the higher risk of lending to SMEs (World Bank, 2009, CBRC, 2009). So, emphasizing SMEs loan disbursement and government subsidization can be regarded as forward looking to expand the financial market in China. The most influential and favorable regulation for microfinance industries are-

5.1 Creating business opportunity to National and International NGO-MFIs

Gradually, opening up the market for financial intermediaries, i.e national and international companies, individuals, state own commercial banks, micro-loan companies, lending companies, VTBs, RMCCs, postal savings resulted in the continual development of the microfinance sector in China.

5.2 Interest rate guidelines

It is emphasized that the establishment of micro-loan companies does not mean loan-sharking and laissez-faire prices. The CBRC stressed that lending rates should not exceed the ceiling set by the central bank but the lower limit should be 0.9 times the benchmark rates. The floating ranges can be determined in accordance with market principles.

5.3 Guideline for loan services

Loan area: there are guidelines to distribute loans for all kind of agricultural services (production, processing, transportation, and circulation), all consumer areas (purchase of daily consumer products, high-end consumer durables, building or buying houses), medical treatment, children's tuitions, entrepreneurship, migrant workers, start-up businesses and vocational and technical training. *Loan size:* the guideline stipulates that the micro-credit loan size in developed regions and less developed regions can be increased to 100,000-300,000 RMB ($1470-$4412) and 10,000-50,000 RMB ($1470-$7353), respectively. Loan size can be decided on individual cases but within the above range for other regions. The group loan size can be increased to a moderate extent based on credit loan size, and the success rate of previous loan. *Loan procedure:* micro-credit providers are encouraged to simplify micro-loan procedures in rural areas including: applications procedures, loan processing time; using credit line cards, revolving lending within credit lines, and to improve the convenience level of borrowing.

Nevertheless, regulatory frameworks and policies governing microfinance in China remain vague and do not have a comprehensive framework. According to Prof. Muhammad Yunus, founder of Grameen Bank *"…there should be a separate regulatory authority for MFIs as distinguished in character from that for the commercial banks. The regulatory authority for MFIs should evolve guidelines keeping in view the objectives of socio-economic development of the poor.." ,* which is absent in China in the present context. UNDP China has also identified three interrelated deficits which hindering the development of micro-credit and other microfinance services in China. Among three difficulties the legal and regulatory arrangements is the first and foremost (UNDP, 2005).

6. Conclusion

From the above discussion, it appears that the banking and microfinance services have expanded and improved gradually. Hence, the banking sector is close to the maturity stage while the microfinance sector is still at learning stage. The government reforming initiative is quite good but still at an experimental level particularly for the microfinance sector. CBRC has been providing some favorable policy guidelines for the development of the banking and microfinance sectors within a controlled environment. For instance, creation of the four state owned banks from a mono bank system, introduction of private and commercial banks, creation of competitive environment, gradually opening the market for foreign banks from the special economic zones to all over the country, inter banks transactions, special attention to SMEs loan was the landmark achievement in the banking sector of China. In addition, market access of micro-credit service providers such as RCCs, RMCCs ADBC, micro-loan companies, VTBs, postal saving banks, NGO-MFIs have significantly contributed to mobilizing capital in rural areas. Even the introduction of UCC has created financial opportunities for the urban poor and laid-off workers. Last but not least, microfinance has enhanced the financial access to the poor who were excluded from the formal banking system in China like other countries in the world. In contrast, the collateral system of financing is still practiced by service providers including, micro-lending companies, lending companies, postal saving banks, MCCs, and VTBs. In addition, the business restrictions (NGO-MFIs, MCCs, Lending Companies are restricted to collect deposit) are still an obstacle for the smooth development of microfinance sector in China.

CBRC is the sole institute to deal with policy regulations for banks and microfinance service providers which may contradict to handle different goal oriented institutes (Banks and MFIs run their business in different perspectives). Therefore, it is recommended to the concerned authorities to have a balanced policy regulation for the microfinance

sector to enhance its sustainability. Furthermore, building a separate regulatory authority should be prioritized. The enormous prospect of the microfinance sector should not be bottlenecked only for the sake of a sound regulatory environment.

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Table 1. Chronological development of banking sector in China

Pre-reform period, prior to 1979	
Until 1979	▪ Monobank system. The People's Bank (PBC) functioned as central and commercial bank
Phase I: 1979–1983	
1979	▪ Established four State-owned specialized banks-
	▪ ABC for rural financing
	▪ PCBC for investment financing
	▪ BOA for international financial transactions
	▪ ICBC for working capital financing (established in 1984)
1981	▪ The first treasury bonds were issued and sold on a compulsory basis
1983	▪ Two-tier banking system created
	▪ Central bank created out of the PBC
	▪ Competition allowed among the state owned specialized banks
Phase II: 1984–1993	
1984	▪ Control over RCCs shifted from PBC to ABC
	▪ RCCs begin servicing TVEs and households independently
	▪ The selected new banks were permitted to operate alongside these four banks
1985	▪ Financing responsibilities shifted from government to banks
	▪ Foreign banks were permitted to set up branches
1986	▪ Provisional bankruptcy law passed for SOEs
	▪ Local interbank centers have emerged
1987	▪ Nonbank financial institutions were allowed for business
	▪ Competition among all banks and nonbank financial institutions were allowed
1991	▪ Separated commercial and policy-based lending
	▪ market interest rates were allowed
	▪ Encouraged banks to do better loan assessment and portfolio management
Phase III: 1993 to date	
1993	▪ Refinance facilities from PBC restricted
	▪ State-owned specialized banks converted into real commercial banks
	▪ Diversified financial market established
	▪ Restrictions on lending to non-priority sectors were eased
	▪ Comprehensive reforms introduced
1994	▪ Three policy banks established to provide policy loans
1995	▪ New commercial bank law was enacted
1996	▪ Established an interministerial coordination group for rural financial system reform
1998	▪ All specialized banks allowed financing all sectors in rural areas
	▪ Allowed foreign banks access to domestic inter-bank offering market
1999	▪ Relaxing the geographical and volume restrictions of RMB business for foreign banks
2001	▪ China's accession to WTO
	▪ Foreign banks were allowed to undertake foreign currency business
2003	▪ Foreign banks were permitted to undertake corporate RMB business
2004	▪ RMB business was opened to foreign banks in five cities
2005	▪ RMB business was opened to foreign banks in seven cities
2006	▪ Geographical and customer restrictions of RMB business on foreign banks were removed
	▪ The non-prudential restrictions on foreign banks' operations in China were removed

Sources: Compilation based on CBRC,(2007), Mehran(1996), Hofman, (2009) Shirai (2002),Meyer(2000), Laurenceson,(2003).

Table 2. Chronological development of Microfinance sector in China

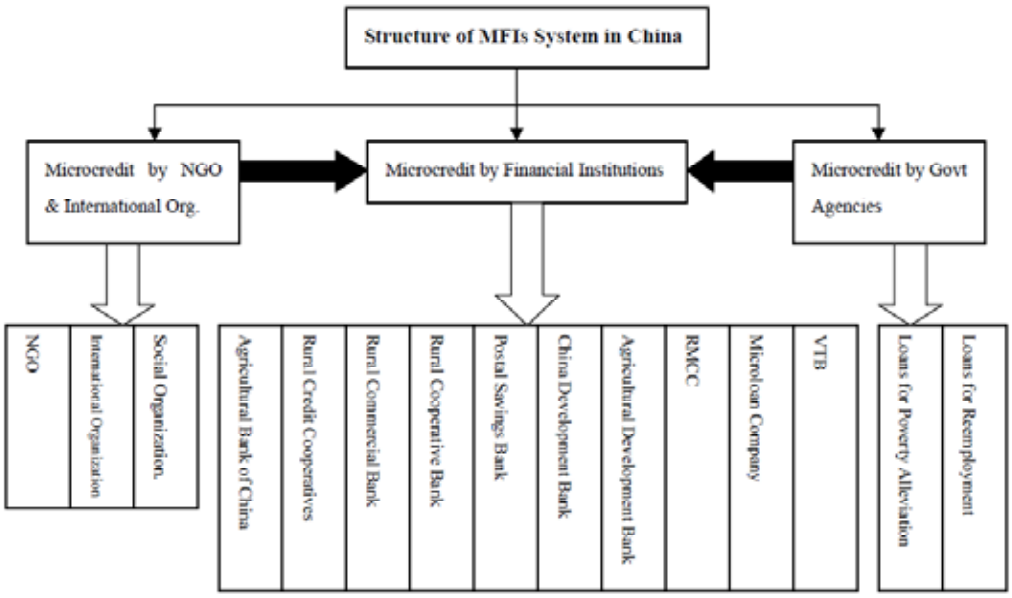
Before 1994	
Before 1994	▪ International foreign-aid projects with government collaboration- ▪ UNWDF for creating employment opportunities of women ▪ IFAD for improving food supply and increasing the nutrition level of middle and low income rural households ▪ UNFPA for revolving capital, and ▪ Hong Kong Oxford for livestock farming and veterinary services
Phase I: 1994–1999	
1994	▪ the first experiment of Grameen Bank model was implemented in China
1995	▪ UNDP undertook a microfinance experiment project
1996	▪ UNICEF started microfinance activities ▪ RCCs officially became independent entities
1997	▪ World Vision (WV) began offering microfinance services ▪ Established Rural Credit Foundations (RCFs) ▪ CIDA, Canada-China Women's Income Generating Project
1998	▪ UNFPA began microfinance activities
Phase II: 1999–2004	
1999	▪ RCCs introduced microcredit loan and group loan businesses
2001	▪ PBC promulgated the Guidance on Microcredit Loans Management of RCCs
2002	▪ PBC widely promoted microcredit loans for rural households across the country ▪ Established reemployment guarantee foundation
2003	▪ Tax-credit rating management methodologies" issued by State Administration of Taxation
2004	▪ Improvement in Granting Microfinance Loans and Serving the Rural Poor'
Phase III: 2005 onward	
2005	▪ PBC launched pilot credit-only for microloan companies ▪ Established China Association of Microfinance (CAM)
2006	▪ Pilot Management to Strengthen Postal Savings Bank management ▪ Eased Market Access for Banking Financial Institutions
2007	▪ CBRC promulgated the Guideline on How to Greatly Develop Rural Microloan Business
2008	▪ allowed individual, corporate legal entities and other social organizations investment

Source: Complication of He, (2009), MFIT (2008), CAM, (2008), Tang (2009), Sun, (2008), Druschel, (2002)

Table 3. A comparative features of micro-credit service providers

Type of institutions	**inception**	**Coverage**	**Beneficiaries**	**Collateral**	**Interest rate**	**Savings**	**Remittances**
NGO-MFI	1993	Country-wide	Mid-low income and poor clients	No	3-18	no	No
ABC	1997	Country-wide	Mid-low income and poor cliets	No	2-3	No	No
RCCs	2000	Country-wide	All farm households	No. but yes for large loans	0.9-2.3 times basic rate	Yes	Yes
UCB	2002	Urban areas	Laid off workers	Guarantee companies	Basic rate with subsides by government	Yes	Yes
MCCs	2005	5 provinces	Farmers and microenterprises	Yes	Around 20	No	No
VTBs	2006	6 provinces	Farmers and microenterprises	Yes	0.9-2.3 times basic rate	Yes	No
RMCCs	2006	6 provinces	Member farmers and micro enterprises	No	0.9-2.3 times basic rate	Yes	No
Lending companies	2006	6 provinces	Farmers and micro-enterprises	Yes	0.9-2.3 times basic rate	no	No
Poverty alleviation loans	2006	country-wide	Mid-low income and poor clients	No	Less than basic rate	Yes	Yes
Postal savings	2007	Country wide	All farm households	Yes	0.9-2.3 times basic rate	Yes	Yes
Commercial Bank	2005	More than 10 regions	Micro-enterprise and disadvantages people	No	Around 20	yes	Yes
Donor funded MFI projects and others							
UNDP	1995	17 provinces	Group lending	no	8	yes	-
UNFPA	1998	13 provinces	Farm households and groups, also training	no	8.77	no	-
UNICEF	1996	13 provinces	Women clients and training	no	9.6	yes	-
Heifer Project	1985	13 provinces	Farm households	no	6	no	
World Vision	1997	1 province	Farm households	no	4		
Oxfam Hong Kong		Country-wide	Village	no	Community decided	yes	-
CIDA	1997	1 province	Farm households	no	7-10	yes	-

Sources*: CAM, 2008, Druschel,(2002), Tang (2009)*



***Source**: He,Guangwen, (2009)*

Figure 1. Structure of MFIs system in China

The Link Between Purchase Delay and Resale Price Maintenance: Using The Real Options Approach

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Abstract

Why would a manufacturer want to impose resale price maintenance (RPM)? The traditional explanation of RPM is that it prevents retailers from free riding in providing services. In this paper, we show that the manufacturers still have incentives to impose RPM even their products do not need special services. When making a purchase decision, consumers choose from various alternatives, including options to delay the purchase, especially if they feel the price will be lower in the future. This paper connects frequent markdowns, purchase delay, and resale price maintenance (RPM) by using the real options analysis. The results indicate that the demand quantity under flexible pricing is lower than that under RPM, due to purchase delay. The profits of manufacturer will be lower without the use of RPM. This research also suggests that the manufacturer has more incentives to impose RPM on products with higher demand price elasticity. The results from real options analysis suggests that what we call consumers' purchase delay, which is caused by retailers' frequent markdowns makes RPM a desirable strategy for manufacturers.

Keywords: Resale price maintenance; Purchase delay; Real options approach

1. Introduction

Do retailers' frequent markdowns suppress or stimulate resale price maintenance (RPM)? This is an important issue in the current competitive environment characterized by substantial increases in intrabrand price competition and the use of RPM. Intrabrand price competition will lead to frequent markdowns among retailers. However, as a result of frequent markdowns, current demand may suffer if consumers are led to expect future prices to be lower. For example, it is widely thought that consumers delay automobile purchases in anticipation of future markdowns. When making a purchase decision, consumers choose from various alternatives, including the option of delaying the purchase. Consumers will delay their purchase if they feel the price will be lower in the future.

The key advantage and value of real options analysis is to integrate managerial flexibility into the valuation process. Real options analysis provides guidance that future decision possibilities and contingencies can affect manufacturers' decision significantly. This paper proposes the hypothesis that the uncertainty over retail price has negative effects on consumers' purchase decisions, which prompt the manufacturers to adopt appropriate marketing strategies. The relationship between frequent markdowns and RPM can be presented clearly under the real options framework. The standard "consumer free riding on special service theory" indicates that the motivation for manufacturers to impose RPM is to induce retailers to provide special services. However, as Klein and Murphy (1988, pp.265-266) and Mathewson and Winter (1998, p.68) note, RPM has been used for a much wider variety of products than the standard special-service theory would predict. The real options approach allows us to show that, even without the special service, the manufacturers still have strong incentives to impose RPM to reduce consumers' purchase delay.

This paper connects frequent markdowns, purchase delay, and resale price maintenance (RPM) by using the real options approach, thereby showing that the motivation behind RPM is to reduce the negative externality of frequent markdowns on consumers' purchase delay. In addition, the manufacturer has more incentives to adopt RPM if its product has higher demand elasticity.

2. Literature Review

There are several explanations for manufacturers choose to impose resale price maintenance (RPM) on their downstream retailers. Telser (1960) explains that RPM can exclude free riders from providing services. Mathewson and Winter (1983) show that manufacturers can use RPM to ensure the appropriate density of outlets, and consequently eliminate the problems of free riding and double marginalization. Mathewson and Winter (1984) specifically focus on examining the relationship between RPM and the spillover effect of advertising. When the exposure of advertising from one outlet spills into another outlet, retailers in outside areas may also benefit. Under these conditions, a manufacturer can ensure appropriate downstream behavior by using RPM.

Marvel and McCafferty (1984) stated that RPM will be adopted when a manufacturer wishes to purchase quality certification from reputable retailers. Deneckere et al. (1996, 1997) find that the use of RPM will be most attractive to manufacturers when demand uncertainty leads to the prospect of deep price-cutting in the event of slack demand. Their study uses Nintendo as an example, suggesting that Nintendo tried to protect retail prices in order to promote adequate inventory holding. Flath and Nariu (2000) state the desire of Nintendo to impose RPM may have been to preserve sales revenue in low-demand states. Implicit in their models is the assumption that demand uncertainty does not definitely encourage manufacturers to impose RPM. Using data from Japan, Chen (1997) shows that manufacturers are encouraged to impose RPM to stabilize retail prices. Chen (2004) demonstrates that RPM reduces intrabrand price competition by impacting the effects of advertising. Moreover, Chen and Chen (2006, 2007) apply options concepts into RPM from the manufacturers' perspective. Chen (1999, p.442) summarizes these arguments as follows: "Explicit or implicit in these arguments is the belief that resale price maintenance is used because from the point of view of the manufacturer, there would otherwise be too much price competition among retailers".

Intrabrand price competition will lead to frequent markdowns among retailers. However, as a result of frequent markdowns, current demand may suffer if consumers are led to expect future prices to be lower. For example, it is widely thought that consumers delay automobile purchases in anticipation of future markdowns. Assuncao and Meyer (1993) suggest that increasing expectations of a price reduction in the near future increase the likelihood of purchase delay. They argue that past prices affect expectations regarding future prices. They hypothesize that increasing expectations of a price reduction in the near future increase the likelihood of purchase delay. Kalyanaram and Winer (1995) reason that, over time, promotions erode purchase probabilities by lowering reference prices and thereby increasing price sensitivity. As a result, consumers might be more reluctant to pay regular prices or tolerate price increases. Such arguments are consistent with a lie-in–wait strategy, in which consumers are less likely to buy at high prices as they learn to buy when prices are especially low. Bell and Bucklin (1999) develop the model of category purchase incidence. In their model, increased promotional exposure on prior store visits increases the reference value for the product category on the current store visit. Consequently, the difference between the category value and the reference value diminishes, which results in a reduced likelihood of a category purchase incidence. Therefore, increased long-term exposure to promotions might lead to a lower category purchase incidence probability on subsequent purchase occasions. Mela et al. (1998) also show that frequent price promotions persuade consumers to "lie in wait" for a lower price in the future.

As mentioned above, intrabrand price competition will lead to frequent markdowns among retailers. However, as a result of frequent markdowns, current demand may suffer if consumers are led to expect future prices to be lower. For example, it is widely thought that consumers delay automobile purchases in anticipation of future markdowns. Jacobson and Obermiller (1990) note that when making a purchase decision, consumers choose from various alternatives, including the options of delaying the purchase. This would imply that frequent markdowns would lead to purchase delay. RPM is used because there would be too much price competition among retailers. Since intrabrand price competition leads to frequent markdowns, consumers' options become valuable, thus persuading them to delay a purchase since they expect that they can buy it at a lower retail price in the future. Under this circumstance, the demand curve shifts downward and manufacturers thus become the victim of intrabrand price competition. As a result, manufacturers will be encouraged to impose RPM, in order to stabilize retail prices and reduce the negative effect from purchase delay.

3. Real Options Approach and Its Analysis

In the discipline of finance, Black and Scholes (1973) and Merton (1973) showed how to value a financial option whose payoff is contingent on the value of the underlying asset. Brennan and Schwartz (1985) and McDonald and Siegel (1985) were the first to actually apply these insights to investment valuation, which is now known as real options analysis. In this article, this paper connects frequent markdowns, purchase delay, and RPM by using the real options approach under the frameworks of Dixit and Pindyck (1994), to show that the motivation behind RPM is to reduce the negative externality of frequent markdowns on consumers' purchase delay.

Retailers set the price to optimize for the products in the whole store. They have strong incentive to provide discounts on the product with high consumer salience in order to draw store traffic. The strategy is called "loss leading schemes", also called "variable price merchandising," constantly raise and lower the prices of different products, both up and down. This price movement on hundreds of products makes it more difficult for consumers to compare prices on the same products among stores, thus reducing the amount of information on the market. Thus retailers use "loss leading schemes" to deter new entrants and protect monopoly power. However, as retail price fluctuates, consumers may expect there will be a lower price in the future, and have incentives to wait for a longer time. Under this circumstance, the demand curve shifts downward, manufacturers are hurt by intrabrand price competition. Manufacturers will be encouraged to impose RPM, in order to stabilize retail prices and reduce the negative effects from purchase delay. From the consumers' perspective, the retail price fluctuates over time in a way that is at least in part random. Therefore we can view the process of retail price as a stochastic process.

Assume a manufacturer produce one product that the demand curve is:

$$P^* = MU / m = aQ^{-1/\varepsilon} \tag{1}$$

where P^* is the reservation price, which is the price just low enough to result in purchase. MU denotes the marginal utility that consumers get from the product, a is a positive constant, Q denotes the quantity demanded, $\varepsilon > 1$ denotes the price elasticity of demand, and m denotes marginal utility of money. The manufacturer decides how many quantities Q to produce. Once the quantity Q is determined, the manufacturer charges $(1-\lambda)aQ^{-1/\varepsilon} = (1-\lambda)P^*$ as wholesale price for every unit sold by retailers. The $\lambda aQ^{-1/\varepsilon} = \lambda P^*$ is the margin of per unit that the retailers can earn if they set the price at P^*. The positive constant λ is determined under the negotiation among the manufacturer and retailers.

The manufacturer can choose input like labor, denoted by v, to produce Q. Suppose the input price is a positive constant c, and production function of manufacturer is

$$Q = v^{\theta}, \qquad 0 < \theta < 1.$$

Then the profit function of the manufacturer can be written as:

$$\pi = \max_{v} \left[(1-\lambda)P^* Q - cv \right] \tag{2}$$

The instantaneous profit maximization gives the input demand function:

$$v = \left[\frac{c\varepsilon}{(\varepsilon-1)(1-\lambda)a\theta} \right]^{\frac{\theta}{\theta-1}} Q^{\frac{\theta}{\varepsilon(\theta-1)}} \tag{3}$$

and the supply function for output:

$$Q = \left[\frac{c\varepsilon}{(\varepsilon-1)(1-\lambda)a\theta} \right]^{\frac{\varepsilon\theta}{\varepsilon(\theta-1)-\theta}} \tag{4}$$

However the retail price, which is denoted by P, is not certainly set at $P^* = aQ^{-1/\varepsilon}$. As noted previously, retailers have incentives to use frequent price discounts to draw store traffic. The retail price that fluctuates over time can be described as a stochastic process. Without loss of generality, we assume the stochastic process of retail price, P, follows the geometric Brownian motion:

$$dP = \sigma P dW$$

where dW is the increment of a Wiener process, σ denotes the frequency of price discounts. In order to obtain MU, consumers need to pay retail price P.

Before purchasing, consumers have the option to delay purchase, which be denoted by $K(P)$, which gives consumers the right, not obligation, to choose when to pay P and in return receive MU. Consumers will delay their purchases in expectation a lower price, unless $MU > P + K(P)$. We can determine a unique threshold P^*; and a similar concept is the "reservation price," which is the price just low enough to result in purchase (Jacobson and Obermiller 1990). In addition, $P < P^*$ means $MU > P + K(P)$, indicating that consumers will make the purchase immediately. Using the Bellman equation and Ito's Lemma, $K(P)$ must satisfy the partial equation:

$$\frac{1}{2}K''(P)\sigma^2 P^2 - \rho K(P) = 0 \tag{5}$$

where $\rho > 0$ denotes the discount rate. Simple substitution shows that the equation has solutions in the form $K(P) = kP^{\beta}$, provided β is a root of the fundamental quadratic equation:

$$\frac{1}{2}\sigma^2\beta(\beta-1) - \rho = 0 \tag{6}$$

The roots of (6) are

$$\beta_1 = \frac{1}{2} + \sqrt{\frac{1}{4} + \frac{2\rho}{\sigma^2}} \; > 1$$

and

$$\beta_2 = \frac{1}{2} - \sqrt{\frac{1}{4} + \frac{2\rho}{\sigma^2}} \quad <0$$

Then the general solution to equation (5) can be written as

$$K(P) = k_1 P^{\beta_1} + k_2 P^{\beta_2}$$

When the retail price is far beyond the consumers' reservation price, the prospect of its falling to the purchase threshold is quite remote. Therefore the option should be almost worthless at this extreme. It makes sense to require $K(P) \to 0$, as $P \to \infty$. However, since $\beta_1 > 1$, that power of P goes to infinity as $P \to \infty$. To ensure that $K(P)$ goes to zero as P goes to infinity, we must set the coefficient of the positive power of P equal to zero, thus $k_1 = 0$, leaving

$$K(P) = k_2 P^{\beta_2} \tag{7}$$

In addition, $K(P)$ must satisfy the following boundary conditions:

$$K(P^*) = aQ^{-1/\varepsilon} - P^* \tag{8}$$

$$K'(P^*) = -1 \tag{9}$$

By substituting (7) into (8) and (9) and rearranging, the solution of purchase threshold is

$$P^* = aQ^{-1/\varepsilon} \frac{\beta_2}{\beta_2 - 1} \tag{10}$$

where

$$k_2 = -(aQ^{-1/\varepsilon})^{1-\beta_2} \beta_2^{-\beta_2} (\beta_2 - 1)^{\beta_2 - 1} \tag{11}$$

$$\beta_2 = \frac{1}{2} - \sqrt{\frac{1}{4} + \frac{2\rho}{\sigma^2}} \quad <0 \tag{12}$$

After imposing RPM, σ approaches zero since intrabrand price competition has been stabilized, the options for purchase delay become valueless. The $\beta_2 \to -\infty$ as $\sigma \to 0$, thus, P^* in (10) becomes:

$$P^* = aQ^{-1/\varepsilon} \tag{13}$$

The equation (13) is exactly the form of equation (1), which is presented in most microeconomics textbooks.

The P^* in (10) is lower than that in (13), indicating that frequent markdowns lead to a negative consequence by lowering consumers' reference prices (Jacobson and Obermiller 1990). Rearranging (10) and (13), respectively, yields demand curves under flexible pricing and RPM:

$$Q_{FL} = (P \frac{\beta_1 - 1}{a\beta_1})^{-\varepsilon} \tag{14}$$

$$Q_{RPM} = (P \frac{\delta}{a\rho})^{-\varepsilon} \tag{15}$$

Figure 1 shows the demand curves under RPM and flexible pricing separately. We denote that volatility of retail price under flexible pricing ($\sigma = 0.2$) is higher than that under RPM ($\sigma \to 0$). The demand quantity under flexible pricing at retail price P_0 is lower than that under RPM ($Q_0 < Q_1$), due to purchase delay caused by frequent markdowns. After imposing RPM, the demand curve under flexible pricing shifts upward to the demand curve under RPM, consequently, the manufacture can make up the damage ($Q_1 - Q_0$) caused by purchase delay.

Given $\sigma > 0$, the reservation price of consumers is equation (10), therefore the average revenue function faced by the manufacturer is:

$$(1-\lambda)P^* = (1-\lambda)aQ^{-1/\varepsilon} \tag{16}$$

Substituting the equation (16) into the equation (2), we can have the profit flow when the variable input is chosen optimally:

$$\pi = \Phi^{\frac{1}{\varepsilon(\theta-1)-\theta}} \left[\Delta^{\frac{\theta(\varepsilon-1)}{\varepsilon(\theta-1)-\theta}} - \Delta^{\frac{\varepsilon}{\varepsilon(\theta-1)-\theta}} \right] \tag{17}$$

where

$$\Phi = a^{-\varepsilon} c^{\theta(\varepsilon-1)}$$

$$\Delta = \frac{\varepsilon(\beta_2 - 1)}{(\varepsilon - 1)\beta_2(1-\lambda)\theta}$$

We next examine how π in (17) is affected by the change of intrabrand price competition. If the change of σ leads to a lower π, meaning that this change encourages manufacturers to impose RPM. In Figure 2, π decreases as σ becomes greater, representing the greater σ encourages manufacturers to adopt RPM. The implication is: as frequent markdowns are increased by intrabrand price competition, consumers may delay their purchase because a lower retail price may appear in the future. The frequent markdowns raise the value of options to purchase delay, so manufacturers will have more incentives to impose RPM, which is designed to decrease the value of consumers' options. Facing the frequent price promotions, consumers' wait options encourage them to delay the purchase unless they need the products urgently. This is one of the reasons why the luxury goods and durable goods usually find it more necessary to use RPM than do necessary goods. For most consumers, the luxury goods and durable goods are different from daily necessities since they are not for daily or urgent uses. As a result, consumers could wait for a substantial price discount if there is no RPM.

In general, RPM is prohibited in most developed OECD countries. Opponents claim RPM is used for maintain cartel prices and reduce competition among retailers. This paper suggests that in the real options model, RPM may be used to inhibit the mobility of a price rather than to maintain a sufficiently high price. This study does not suggest that all RPM cases should be *per se* legal. Instead it provides a different perspective for studying RPM, and suggests the factors of purchase delay should be considered as courts examining the RPM cases.

The effect of the elasticity change on RPM also provides marketing implications for practitioners. We denote $B = |\partial\pi / \partial\sigma|$ as the benefit of imposing RPM, if the change of one parameter leads to greater B, it represents that this change favors RPM.

Figure 3 shows the relationship between demand elasticity (ε) and the benefit of RPM (B). If demand elasticity becomes higher, the manufacturer has more incentives to adopt RPM. Because facing the same markdown frequency, price-sensitive consumers are more motivated to delay their purchases in expectation of greater discounts. Consumers have the options to purchase right now or to purchase at a later date. The consumers with less price-sensitive may choose not to wait further even they understand there is possibility that the retail price will be lower in the future. On the contrary, facing frequent price promotions, the price-sensitive consumers have more incentives to delay their purchase because they regard the price as an important factor in their purchase decisions. Thus, the manufacturers of the products with higher demand price elasticity will impose RPM to remedy the downward demand which is caused by frequent price promotions.

The results can be extended for the explanation on the link between RPM and advertising. RPM for advertised goods has already been widely implemented in Japan. Using data from Japan, Flath and Nariu (2000) state all the products for which RPM was specifically authorized in Japan are branded, advertised products. Chen (2004) found the manufacturers are encouraged to impose RPM on advertised goods in order to weaken the promotional pricing effect of advertising.

Advertising increases a brand's salience to consumers and increases the demand price elasticity (Albion, 1983). Consumers use well-known advertised brands as a benchmark to compare pricing among retailers. Retailers recognized this fact and discount these advertised brands to draw store traffic and achieve reputations for low prices. Although the lower margin caused by intrabrand price competition, the retailers still find it necessary to carry advertised brands because of the effect of advertised brands on store traffic. Individual stores alternate those promoted brands through daily and weekly specials. The arguments that RPM ensures the retailers have an acceptable margin and enable high levels of coverage obviously can not explain why RPM usually impose on the advertised products. Because the reason that the retailers are willing to carry advertised brands is advertised brands' ability to draw store traffic rather than the higher margin brought by RPM. With higher unit sales, an advertised brand can have a lower gross margin than an unadvertised brand and still maintain the same total contribution. Therefore, the main motivations behind RPM may not intend to maintain high levels of coverage. To answer this question, our model provides another explanation for the use of RPM on advertised good. As noted previously, advertising exposes more information to consumers, thus increasing the consumers' price elasticity. If RPM is absent, facing intrabrand price competition, consumers would delay their purchase due to rising price sensitivity caused by advertising. The manufacturer recognizes this fact, thus has more incentives to use RPM on advertised goods. The

imposition of RPM is designed to eliminate the negative effects that come from frequent markdowns, and to strengthen the effect of advertising.

5. Conclusions

When making a purchase decision, consumers choose from various alternatives, including the options of delaying the purchase. Consumers will delay their purchase if they feel the price will be lower in the future. We connect frequent markdowns, purchase delay, and RPM by using the real options analysis under the frameworks of Dixit and Pindyck (1994). This shows that the motivation behind RPM is to reduce the negative externality of frequent markdowns on consumers' purchase delay.

The results indicate that the demand quantity under flexible pricing is lower than that under RPM, due to purchase delay. After imposing RPM, the demand curve under flexible pricing shifts upward to that under RPM, so the manufacture can make up for the damage caused by purchase delay. This paper suggests that the motivation behind RPM is to reduce the negative externality of frequent markdowns on consumers' purchase delay. This paper also indicates that the higher price elasticity gives the manufacturer more incentives to use RPM. Taken together, the findings of this study suggest that what we call the purchase delay, which is caused by frequent markdowns, makes RPM a desirable strategy for manufacturers of certain types of products.

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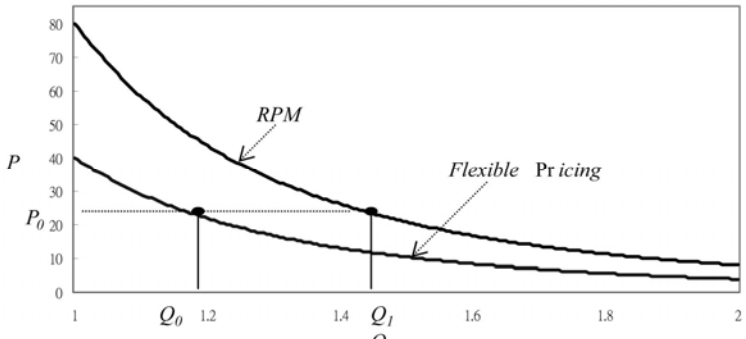

Figure1. Demand curves under RPM and flexible pricing

Parameter value: $\rho = 0.04$, $a = 80$, $\varepsilon = 0.3$, $\sigma = 0.2$

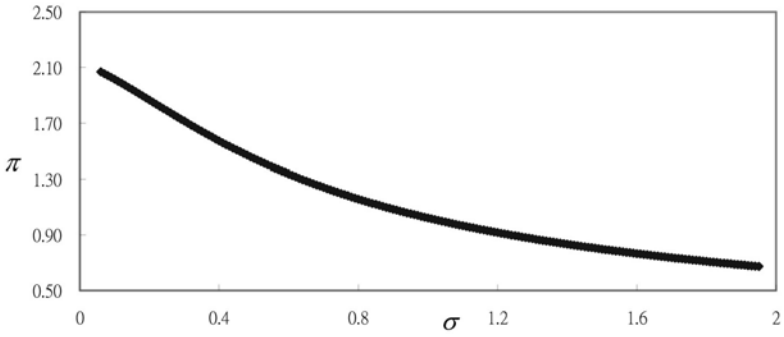

Figure2. The profit as a function of intrabrand price competition

Parameter value: $\rho = 0.04$, $a = 6$, $c = 12$, $\theta = 0.9$, $\lambda = 0.7$

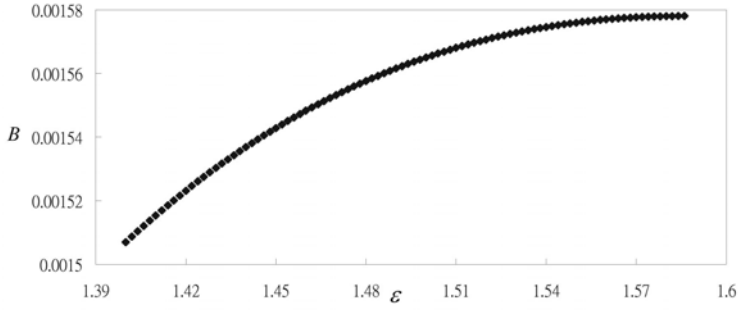

Figure3. The effect of an increase of demand elasticity on benefit of RPM

Parameter value: $\rho = 0.04$, $a = 6$, $c = 12$, $\theta = 0.9$ $\sigma = 0.15$, $\lambda = 0.7$

The Euphoria Effect of UEFA Champion League Final on Asian Stock Market

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Abstract

Football is the most popular sport in the world. It can make personal attachment to the supporters. One of the most wanted football events is UEFA Champion League Final. It can create euphoria in the supporters. The euphoria will affect the stock market behaviour. This research examines whether investor's performance affected by the football euphoria. This research is important in term of market efficiency, behavioural finance, and portfolio strategy.

This paper examines the UEFA Champion League Final affects on the World index, EAFE index, Pacific index, and 14 Asian stock markets. This paper wants to figure the seasonality of the euphoria during the UEFA Champion League Final.

This study conducts non parametric test such as: Holt Winters, Kruskal-Wallis, and Wilcoxon Signed test. The period of this study is from 1999 up to 2008.The results showed that there are euphoria effects of UEFA Champion League Final on the stock markets. Further, the results also showed that there is seasonality in stock markets caused by the euphoria of UEFA Champion League Final. Future research can employ the same issue in other regions. Another research should be conducted by finding the effect in shorter period or longer period.

Keywords: Investor Irrationality, Football Euphoria, Asian Stock Market Behavior, Behavioral Finance

1. Introduction

Generally, 1+1 does not always equal to 2 in the psychology perspectives. The cognitive in human logic thinking might be affected by human psychology. Finance theory assumes this behaviourism to be rational (Thaler, 1980). It can be seen on the foundation of expected utility theorem. This major stream proposes human will behave logical, rational, and probability calculation in their decision process (Tufan, 2004). However, as there are anomalies in market, finance scholars argue and reject this rational behaviour assumption. Kahneman and Tversky (1979) propose the role cognitive in economic decisions. The cognitive or intuition could replace the rational behaviour or logical way in place of calculating probability (Yazici, 2003). Further, Kahneman (2002) also address that intuitive judgement may be corresponding the perception operation and deliberate the reasoning operation. It means that mood, confidence, mental, emotion, temper can have significant influences on economic decision making.

Stock market anomalies are based on the investor psychology along with other factors (Turfan, 2003). Weather, Moon, Lunch Breaks, and human neuron are the affecting factor of human psychology. For instance, Saunders (1993) finds the relationship between the cloud cover level in New York and the equity returns in New York. In Saunders paper, it surmised when the level of cloud cover was 100%, the stock returns were significantly dispersed negative from the average, and when the clouds cover level was 0-20%, the stock returns were significantly dispersed positive from the average. Gao (2009) investigates the lunar phase effect on two major Chinese stock market return. Gao showed the returns are relatively lower and higher in new moon and full moon, respectively. Azarmi (2002) has investigated if the lunch break on Chinese stock market affects the market returns. Azarmi favour the lunch break has effects on market volatility. Meanwhile, this study wants to investigate the role of football euphoria in stock market of the world.

Football is one big industry in the world nowadays. It is also the most populist sport in all around the world (Note 1). Deloitte Football Money League in 2007 surmised that European Football industry has generated about 3.35 billion Euros revenues annually. Large number of Institution and retail investors are mainly supporters in certain European clubs (Benkraiem, Louhichi, and Marques, 2009) such as AC Milan, Manchester United, Barcelona, Real Madrid, Chelsea, Arsenal, and others club. This emotional attachment may bring those investors to out of their bounded rationality.

The emotion attachment can be seen in many ways in term of financial perspective. Recently, Manchester United, the biggest football club in world, has financial distress problem. The Manchester United Supporter Association, called Red Knight, did fund rising to tackle this problem (Note 2) Before, Newcastle United, Aston Villa, and Liverpool supports also planned to do the same thing.

The emotion attachment also can be seen in the IPO process. Tottenham Hotspur, the first football team went IPO, raised £3.3 million or equivalent to £100million today because the involvement of football supporters (Gannon, Evans, and Goddard, 2006). It also happened to Milwall in 1989 and Manchester United 1991. Another emotion attachment can be seen in emotion sentiment in Listed Football Club price volatility. Brooks et al (2009) conducted research to examine the influence of match result on clubs stock prices. By panel regression of 19 clubs, Brooks et al

found there is significant influence between match result and club stock prices. The sentiment of supporters can also be seen in the noise trading behaviour of betting market (Avery and Chevalier, 1999).

The emotional attachment in decision making can be explained by abnormal psychology. Kreb and Blackman (1990) states that where people tend to have full of energy but easily to distract by talking incessantly, loudly, rapidly and changing from topic to topic in midstream. This is what they called as Mood Mania. Further, Kreb and Blackman state that Mood mania can drive individual to be overconfident.

Mood mania also can motivate individual to act moodily. Early study of this is Showers and Cantor (1985) paper. They address that mood is the determinant of motivation. Positive mood has increased motivation, vice versa. Other study is Raglin et al (1990) paper. It assessed 84 female rowers to examine the relationship between mood and self motivation. They conclude that mood state has significant influence on self motivation in a seasoned competition. Moreover, Bless (2001) states that the mood also affect the motivation process. Mood will decrease individual processing motivation as individual has negative state of mood.

Based on the literature of abnormal psychology, this study also proposes that the euphoria in Final of UEFA champion league can trigger the mood mania. Then, the mood mania will disorder the irrationality in decision making and creating seasonality in the market.

The purpose of this research is to investigate the UEFA champion league final euphoria on 16 Asian stock markets. It is important to examine this phenomenon in regard to portfolio and investing strategy. Further, this research also wants to examine the role of emotion on stock market behaviour. This research is different from other research in 4 ways. First, this research investigated the effect of UEFA Champion League final in 11 years. Previous study by Turfan (2003) only investigated the effect of one World Cup Final. Secondly, this research did conduct more robust analysis by not only using Mann U Whitney as previous research did but also Holt Winters and Wilcoxon Signed Test. Further, we did not employ plain Mann U Whitney, but generalized Mann U Whitney called by Kruskal Wallis. Thirdly, this research examined the effect of three periods, which are 7 days effect, 15 Days effect, and 20 days effect. Lastly, this research did not only examine in one market but 14 stock markets all around the Asia plus 3 world benchmarks which are: MSCI Pacific Index, Europe Australasia and Far East Index, and MSCI World Index. This research contributes to theoretical perspective in term of portfolio strategy, investing strategy, and behavioural finance. It enriches those fields by adding emotion sentiment and euphoria of football match.

This is research is important in 3 ways. In term of market efficiency theory, if there is seasonality found during the UEFA Champion league final, this study can propose the new market anomaly. Secondly, in term of behavioural finance, If there is euphoria effect, this study can propose the football euphoria as the new variable that can affect the investor performance. Lastly, in term of portfolio strategy, if there is seasonality, an active trading strategy can be based on this anomaly and can be beaten market.

This study is organized as follows: section 1 will introduce briefly the stock returns, psychology, and football effects. Literature review is also including in this section. Section 2 will address the data and methodology. This is followed by section 3 and 4 which will present empirical results and conclusion respectively.

2. Data and Methodology

2.1 Sample

This research will take the entire Asian stock markets. The samples are: 5 East Asia (China, Hong Kong, Japan, Taiwan, and South Korean), 4 South Asia (Bangladesh, India, Pakistan, and Sri Lanka), 5 South East Asia (Indonesia, Malaysia, Philippines, and Thailand), and 1 Oceania (Australia). To make a robust comparison, this study added MSCI Pacific Index, Europe Australasia, and Far East Index, and also MSCI World Index. The time period is start from 1999 up to 2009. The UEFA Champion League finals are distributed into 10 finals. All of the finals are held on the month of May each year.

2.2 Research Design

This research conducted 5 tests to examine the effect of UEFA Champion League Final euphoria on world stock market. The tests are probability distribution, correlation, Holt Winters, Kruskal-Wallis, and Wilcoxon W. There are also 3 types of lags that will be included in the model, which are 7 days lag, 15 days lag, and 20 days lag. This lag is conducted to reveal the length of the effect of the euphoria on the world market stock markets. This study chooses the 20 days effect as the edge because UEFA Champion league final usually holds 21 days after the last semifinal.

The data of market returns is retrieved from Thomson Datastream and recalculate by using straight forward return calculation by lognormal approach as $r_{t} = \log\left[{P_t}/{P_{t-1}}\right]$ where Pt and Pt-1 are the closing prices of market on day t and t-1, respectively.

3. Results

3.1 Descriptive Result

Panel 1, 2, and 3 depict the probability distribution of the markets. Panel 1 addresses the descriptive result of Asian stock market behaviour 7 days before-and-after UEFA Champion League final. Meanwhile, Panel 2 and Panel 3 address the Asian stock market behaviour 15 days before-and-after the final and 20 days before-and-after the final,

respectively.

According to Panel 1, 2, and 3, the daily mean returns of the entire Asian stock market have inclining and declining trends. For instance, Australian stock market has – 0.009% daily mean returns in 20 days before Final. Then, in the panel data of 15 days before the final, the daily mean returns were inclining to -0.08%. It was inclining again to – 0.05% daily mean returns in 7 days before the final panel data. These inclining and declining trends of daily mean returns are also found in other stock markets as shown by Panel 1, 2, and 3.

Therefore, we can surmise that there is a declining or inclining trends of the Asian stock markets returns from D-7 to D-15 to D-15. This declining and inclining indicates that there is an effect of football euphoria in the stock markets. Based on this table, we can hypothesize that there is a positive influence between the euphoria of UEFA Champion League Final and the behaviour of the entire Asian Stock Markets. This means that there is still room to investigate further the relationship between euphoria of football and stock market.

3.2 Correlation Results

Correlation indicates the same sharing information among the variables. If the correlation is above 0.7, it means the variables are sharing the similar contained information (Liu, 2000, Brahmana and Hooy, 2009). As addressed by table 2, the correlation between one market to another market is very low. None among of Asian stock market has correlation that higher than .70. It indicates one market is not correlated to other market in term of the information. This result addresses that each market has follow the result of UEFA Champion League Final by their own rationality. The result also addresses that there is a seasonality probability as the markets do not share similar information each other. It is the evidence of irrationality behaviour of the market.

3.3 Holt Winters Result

The Holt-Winters method is a robust, easy-to-use projection procedure which has been around for over 20 years and generally works quite well in practice (Chatfield and Yar, 1988). It can capture the predicted variation of time series seasonal.

The Holt Winters in this study is predicted value to estimate the seasonal in market during 7 days before and after UEFA Champion League Final. As depicted in table 1, this study addresses three important measurements which are the alpha coefficient, beta coefficient, and the Root Mean Square Error (RMSE). The alpha coefficients address that the seasonal can be estimated if it is lower than 0.3. Based on table 1, the entire market alpha coefficient is lower than 0.3 except for EAFE. It means there is a probability of the seasonal existence in the entire market except EAFE. It also indicates the seasonal is fixed during the period of 7 days before and after the UEFA Champion League Final.

In term of beta coefficient, if the beta coefficient is smaller than 0.3, the trend and seasonal component are fixed and not changing. According to table 1 results, the entire market has beta value smaller than 0.3. It means all the market has seasonality during the period of 7 days before and after the UEFA Champion League Final. It indicates there is a euphoria effect of 7 days before and after UEFA Champion league Final in Asian Stock Market.

Lastly, table 1 depicts the RMSE of the entire markets. RMSE Holt Winters is the measurement to show the predicted value has good measure of precision on the cyclic variation such as seasonality. Based on table 1, all of the RMSE Holt Winter of the markets is very close to zero. It means the seasonality is predicted and exits.

As a conclusion, the Holt-Winters no-seasonal results indicate 3 important findings. First, alpha coefficient indicates there is a probability of the seasonal existence in the entire market except EAFE. Secondly, the beta coefficient is smaller than 0.3, meaning the averaging of seasonality in the 7 days before and after UEFA Champion League Final is exits. Lastly, based on the RMSE, it depicts the precision of the seasonality is very close to zero. It means that there is a variability trend and seasonality in 7 days before the UEFA Champion league final. The UEFA Champion League Final euphoria is the driver of this seasonality, meaning there is an effect of UEFA Champion League euphoria in the Asian stock markets.

The Euphoria of UEFA Champion Final is occurred as there is emotional attachment between the investor to the delight and sorrow to their supporting team. The feel of happiness and sorrow brings an irrational behaviour to investor in investing decision. This is in line with the abnormal psychology science. It states the mood disorder can be occurred as the human being has euphoria (Krebs and Blackman, 1990). This mood disorder euphoria brings to the irrational decision making (Isen et al, 1968; Tvede, 2000).

3.4 Kruskal-Wallis (Generalized Mann Whitney)

This research is based on non-parametric test as the sample cannot employ in panel regression and consider small sample. One of the non-parametric tests that conducted in this research is Kruskal-Wallis or the generalized Mann Whitney. This method is robust as it ranks the series from smallest value to largest in generalization series.

Table 3 addresses the result of Kruskal-Wallis. The null hypothesis is there is the difference between 7 days before the Final of UEFA Champion League and 7 days after the Final of UEFA Champion League. The difference between 7 days before and 7 days after is important to reveal the seasonality in the population. If there is difference between the pint-point periods, the Euphoria of UEFA champion league is real exists, vice versa. Hypothetically, the Euphoria should only occur before the event.

Based on the result in Table 3, MSCI world, MSCI EAFE, MSCI Pacific, and most Asian stock market cannot reject the hypothesis in 10% significance level. It means there is significant difference between 7days before and 7days after the Final of UEFA Champion League. It means there is difference between 7 days before and 7 days after UEFA Champion League Final. Therefore, the euphoria of UEFA Champion League Final has significant effect on market behaviour.

It also indicates there is seasonality in the 7days before and 7 days after UEFA Champion League Final. The seasonality affects the investor decision making by its euphoria of Football. The euphoria of football drives the mood mania of investor; and this mood mania affect the investor behaviour in investing decision. This is how the Euphoria of football affects the market behaviour.

3.5 Wilcoxon Signed Test

Another robust non-parametric that employed in this research is Wilcoxon Signed test. Table 4 depicts the result of wilcoxon signed test of this study. The results of wilcoxon signed test are similar to the results of Kruskal-Wallis. The table addresses there is difference before the Final of UEFA champion league and after the Final of UEFA Champion League. This study surmised it as the entire market cannot reject the hypothesis in 10% significance level. It indicates the differences.

These depicted results indicate the seasonality in the market during the UEFA Champion League Final. It indicates also the euphoria effect on the market behaviour. In the end, we can conclude that there is a euphoria effect of UEFA Champion League Final on the World, EAFE, Pacific, and Asian markets. Indeed, this result strengthens the previous result of the Kruskal-Wallis.

4. Conclusion

Football is recognized as the most popular sport in the world. One of the most wanted football event is UEFA Champion League Final. The euphoria of football can affect the behaviour of investor which depicted in market returns behaviour.

After conducting the descriptive statistics, this study found a declining or inclining trends of the Asian stock markets returns from D-7 to D-15 to D-15. This declining and inclining indicates that there is an effect of football euphoria in the stock markets.

Correlation indicates the same sharing information among the variables. None among of Asian stock market has correlation that higher than .70. It indicates that there is a seasonality probability as the markets do not share similar information each other. It means each market has followed the result of UEFA Champion League Final by their rationality.

In term of Holt Winter, the results indicate The UEFA Champion League Final euphoria is the driver of this seasonality, meaning there is an effect of UEFA Champion League euphoria in the Asian stock markets.

The Kruskall-Wallis test also show MSCI world, MSCI EAFE, MSCI Pacific, and most Asian stock market cannot reject the hypothesis in 10% significance level. It means there is significant difference between 7days before and 7days after the Final of UEFA Champion League.

Lastly, this research employed Wilcoxon signed test. The Wilcoxon test also indicates the seasonality in the market during the UEFA Champion League Final. It indicates also the euphoria effect on the market behaviour.

This study surmises that there is a relationship between 7 days before and after euphoria in UEFA Champion league on market behaviour. This result can be explained by the mood mania of abnormal psychology. Krebs and Blackman (1999) define mood mania as a state where people tend to have full of energy but easily to distract. This mood mania is believed as the trigger for overconfident situation in the market (Huberman, 2000). Euphoria is also another form of mood mania. The happiness or sadness in facing UEFA Champion League final can affect investor behaviour. The irrationality of investor behaviour will drive the market to seasonality. This research result shows that there is seasonality 7 days before and after the UEFA Champion League Final. It means the Euphoria in football can affect the market behaviour.

This finding indicates that this study can propose the new anomaly. The new anomaly is the Football anomaly. Investor can rely on this anomaly as active strategy to beat the markets.

Future research can employ the same issue in other markets such as North America region, South America Region, Africa, and Europe. Another research should be conducted by finding the effect in shorter period or longer period. As the robustness check, the winsorized data can be used to used to avoid the effect of outliers.

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Notes

Note 1. http://www.sportingo.com/football/a9387_why-football-beautiful-game-most-popular-sport-world,http://www.fifa.com/mm/document/fifafacts/ffprojects/ip-401_06e_tv_2658.pdf

Note 2. http://www.dailymail.co.uk/sport/football/article-1218910/Former-Manchester-United-chairman-Martin-Edwards-reveals-debt-fear-club.html

Panel 1 Descriptive 7 days before and after the final

		Australia	Bangladesh	China	HongKong	India	Indonesia	Japan	Malaysia
D-7 Days periods	Mean	-9.33E-05	0.001278	0.000806	-0.00011	0.000307	0.000404	-0.0008	-3.73E-05
	Median	-0.00034	0	0.000188	-0.00028	0.001403	0.000209	-0.00111	0.000191
	Max	0.009396	0.012716	0.019858	0.0153	0.034125	0.01925	0.010831	0.013135
	Min	-0.00944	-0.006917	-0.01994	-0.01506	-0.05184	-0.03388	-0.01402	-0.01519
	Stdev	0.003538	0.003643	0.007719	0.005742	0.009058	0.007949	0.005664	0.004218
	Skew.	-0.06017	0.678349	0.056469	-0.09116	-2.01733	-1.41239	0.075251	-0.12444
	Kurtosis	2.970659	4.257727	3.975342	3.152948	17.99438	8.283561	2.489683	5.245109
D+7 Days periods	Mean	0.00025	0.000373	-0.000409	0.000384	0.000221	-0.00097	0.00087	-0.00016
	Median	0.000583	0	0.000213	0.000122	0.001417	-6.80E-05	0.001047	-0.00048
	Max	0.009396	0.009737	0.016131	0.021881	0.067273	0.019413	0.012952	0.010995
	Min	-0.00825	-0.011112	-0.029095	-0.01374	-0.03105	-0.02699	-0.01074	-0.00878
	Stdev	0.003415	0.002584	0.006998	0.005716	0.011781	0.007708	0.005152	0.003736
	Skew.	0.019086	-0.322113	-0.797801	0.470854	2.104767	-0.33087	-0.17855	0.454082
	Kurtosis	2.928443	8.648333	5.619117	4.771092	15.37285	4.669422	2.673845	3.524339

		Pakistan	Philippines	Korea	SriLanka	Taiwan	Thailand	WORLD	EAFE	Pacific
D-7 Days periods	Mean	-0.00084	-0.00079	0.000138	0.000148	0.000236	6.94E-06	-0.00011	-5.85E-05	-0.00022
	Median	-0.00019	-0.00017	0.000224	0	7.00E-05	1.30E-05	5.40E-05	5.10E-05	-0.00012
	Max	0.032552	0.020421	0.020554	0.013306	0.023047	0.023565	0.01392	0.011428	0.015918
	Min	-0.03172	-0.02001	-0.02387	-0.01285	-0.02271	-0.0205	-0.00912	-0.009777	-0.01325
	Stdev	0.009139	0.005711	0.008408	0.004574	0.007498	0.006944	0.00451	0.004027	0.005292
	Skew.	0.165925	-0.33322	-0.32771	0.028643	-0.00066	-0.00786	-0.03982	-0.108824	0.137051
	Kurtosis	6.473286	5.952095	3.502463	4.208419	4.830646	4.587673	3.320883	3.655897	3.827902
D+7 Days periods	Mean	-0.00192	0.000931	0.001122	0.000899	0.000113	0.000771	0.001079	0.000853	0.000572
	Median	8.10E-05	0.000361	0.001203	0	0.000652	0.00055	0.000832	0.000753	0.001003
	Max	0.036946	0.016603	0.024798	0.027185	0.012871	0.021295	0.01392	0.013679	0.011225
	Min	-0.03362	-0.0176	-0.02747	-0.00967	-0.01644	-0.01725	-0.00906	-0.007937	-0.00973
	Stdev	0.012334	0.006061	0.008578	0.005139	0.005664	0.006853	0.004419	0.003804	0.00453
	Skew.	-0.00921	0.168493	-0.22056	2.603531	-0.49641	0.031987	0.209007	0.50985	-0.24241
	Kurtosis	4.416424	4.176257	4.315857	13.78404	3.49984	3.663581	3.640387	3.901654	2.892185

Panel 2. Descriptive of 15 days before and after the Final

		Australia	Bangladesh	China	HongKong	India	Indonesia	Japan	Malaysia
D-15 Days periods	Mean	-8.91E-05	0.001089	0.000478	-0.0003	0.000704	0.000458	-0.00068	0.000186
	Median	-2.90E-05	0	0	0	0.001124	0.000108	-0.00027	0.000191
	Max	0.009396	0.016984	0.019858	0.018164	0.067273	0.019413	0.019318	0.019276
	Min	-0.01521	-0.013224	-0.01994	-0.01873	-0.05184	-0.03388	-0.02157	-0.02178
	Stdev	0.00371	0.003704	0.006581	0.005859	0.010191	0.007137	0.005902	0.004641
	Skew.	-0.33756	0.614853	-0.08742	-0.13351	0.715359	-1.037	-0.13884	-0.47401
	Kurtosis	4.068522	6.860291	4.500091	3.8646	17.83634	7.577631	4.585849	8.20523
D+15 Days periods	Mean	-1.78E-05	0.000389	-6.20E-05	0.000213	-0.00052	0.000136	0.000426	6.17E-05
	Median	0.000352	0	0.000189	7.60E-05	0.00081	0.000177	0.000543	6.40E-05
	Max	0.009767	0.015981	0.034315	0.021881	0.019975	0.046502	0.012952	0.014075
	Min	-0.01218	-0.012639	-0.03744	-0.01867	-0.03105	-0.02699	-0.01288	-0.01037
	Stdev	0.003589	0.00348	0.008523	0.005694	0.007823	0.007551	0.005073	0.003983
	Skew.	-0.48063	0.060539	-0.67017	0.320665	-0.46369	1.069036	-0.16507	0.25768
	Kurtosis	4.007026	7.209934	7.940908	5.050708	3.939477	11.61818	2.924951	3.851162

		Pakistan	Philippines	Korea	Sri Lanka	Taiwan	Thailand	WORLD	EAFE	Pacific
D-15 Days periods	Mean	-0.00015	-3.99E-05	-0.00069	0.000509	-7.61E-05	-0.00025	-5.89E-05	-0.00018	-0.00033
	Median	-1.00E-06	0	0	0	0.000277	0	0.00016	0.000171	-0.0002
	Max	0.032552	0.020421	0.021624	0.031695	0.023047	0.023565	0.01392	0.011428	0.017654
	Min	-0.02194	-0.02001	-0.02563	-0.01833	-0.02409	-0.0218	-0.01298	-0.01697	-0.02506
	Stdev	0.007202	0.005597	0.007772	0.005825	0.006947	0.006809	0.00468	0.004037	0.005613
	Skew.	0.424257	-0.03522	-0.4436	1.475687	-0.32368	-0.53501	-0.21315	-0.54594	-0.3225
	Kurtosis	6.236771	4.87223	4.254179	11.21639	4.841711	4.921332	3.476519	4.48866	5.589742
D+15 Days periods	Mean	-0.00076	0.000514	0.000707	0.000526	-0.00029	0.000856	-1.83E-05	-7.66E-05	0.000114
	Median	0.000658	4.50E-05	0.000701	0	0.000147	0.000521	0.000153	-7.30E-05	0.000593
	Max	0.036946	0.020744	0.02754	0.010891	0.015714	0.021295	0.015248	0.013679	0.015317
	Min	-0.03362	-0.0176	-0.02747	-0.00967	-0.01644	-0.01725	-0.01523	-0.01288	-0.0142
	Stdev	0.010199	0.006325	0.008727	0.003686	0.005899	0.006473	0.004528	0.003971	0.004956
	Skew.	-0.1756	-0.02829	-0.01035	0.397177	-0.36601	0.211646	-0.04936	0.057011	-0.20025
	Kurtosis	4.968435	3.930102	4.311819	3.752931	3.437985	3.41013	4.169805	4.060995	3.28977

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Panel 3. Descriptive of 20 days before and after the Final

		Aus	Bang	Chn	HK	Ind	Ina	Jpn	Mal
D-20 Days periods	Mean	-4.02E-05	0.000557	0.000829	0.000294	0.000694	0.001046	-0.00023	0.000465
	Median	-7.75E-05	0	0	0	0.00104	0.000493	0	0.000264
	Max	0.012872	0.025668	0.038603	0.023422	0.067273	0.023999	0.019318	0.019555
	Min	-0.01521	-0.04324	-0.01994	-0.01873	-0.05184	-0.03388	-0.02157	-0.02178
	Stdev	0.003589	0.005094	0.006785	0.005914	0.009897	0.007218	0.005778	0.004599
	Skew.	-0.00597	-2.36018	0.781434	0.200304	0.517021	-0.55307	0.002903	-0.03068
	Kurtosis	4.684689	30.21335	7.938413	4.539987	15.98328	6.871835	4.782546	8.301878
D+20 Days periods	Mean	-0.00027	0.000569	-0.00014	-0.00026	-6.46E-05	0.000215	-0.00037	-0.00054
	Median	0.000565	0	-5.70E-05	-0.0002	0.000252	0.000292	0.000471	-0.00034
	Max	0.006653	0.015371	0.022177	0.018576	0.024658	0.01806	0.011672	0.011898
	Min	-0.01366	-0.01264	-0.02934	-0.01272	-0.02328	-1.62E-02	-0.01837	-0.01326
	Stdev	0.003884	0.003759	0.008516	0.005791	0.008133	0.006475	0.00593	0.003918
	Skew.	-1.34776	0.380765	-0.21336	0.306884	-0.31207	-0.053	-0.57311	-0.43239
	Kurtosis	5.089481	7.094496	4.869913	3.430968	3.781123	3.673647	3.315159	4.898425

		Pak	Phi	Kor	SLK	TAI	THAI	WORLD	EAFE	Pacific
D-20 Days periods	Mean	-0.00029	1.99E-05	-0.00039	0.000377	-2.06E-05	0.000247	0.000142	0.000139	9.85E-05
	Median	0	0	0	0	0	0	0.000176	0.000335	1.05E-05
	Max	0.032552	0.020421	0.021624	0.031695	0.028336	0.041792	0.01392	0.011428	0.017654
	Min	-0.02194	-0.02001	-0.02563	-0.01833	-0.02409	-0.0218	-0.01298	-0.016974	-0.02506
	Stdev	0.006784	0.005553	0.007687	0.005292	0.007268	0.007116	0.004639	0.003979	0.005386
	Skew.	0.288101	0.040903	-0.33638	1.499991	0.050176	0.690755	-0.08134	-0.399465	-0.2009
	Kurtosis	6.391644	4.692716	4.314048	12.59443	5.345814	9.495951	3.590944	4.385499	5.734775
D+20 Days periods	Mean	-0.00065	-0.00054	-0.00026	0.001833	-6.75E-05	-0.00015	-0.00059	-0.000794	0.000572
	Median	3.70E-05	-7.50E-05	0.00052	0.00017	-0.00033	-0.00046	5.80E-05	0.000374	0.001003
	Max	0.025052	0.020744	0.016881	0.022663	0.013297	0.016064	0.010103	0.008144	0.011225
	Min	-2.63E-02	-0.01672	-0.0264	-0.00806	-0.01885	-0.01564	-0.01434	-0.016062	-0.00973
	Stdev	0.008506	0.006339	0.007721	0.005232	0.006273	0.006672	0.004428	0.004373	0.00453
	Skew.	-0.35236	0.127308	-0.62508	1.602254	-0.22606	0.193351	-0.77211	-0.942185	-0.24241
	Kurtosis	4.070174	4.069138	4.229771	6.358516	3.279968	2.74431	4.055432	4.610878	2.892185

Panel 4. Correlation Among Indices

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
WORLD (1)	1																
EAFE (2)	0.81	1															
PACIFIC (3)	0.13	0.56	1														
AUSTRALIA (4)	0.16	0.13	-0.05	1													
CHINA (5)	0.04	0.07	0.2	-0.04	1												
HONGKONG (6)	0.02	0.03	-0.01	0.56	-0.01	1											
JAPAN (7)	0.03	0.03	0.07	0.68	-0.03	0.61	1										
KOREA (8)	0.2	0.39	0.53	-0.04	0.14	-0.04	0.02	1									
TAIWAN (9)	-0.01	0.02	0.07	0.39	0.06	0.48	0.53	0.09	1								
BANGLADESH (10)	0.24	0.14	-0.23	-0.04	-0.03	-0.04	-0.12	-0.2	0	1							
INDIA (11)	0.14	0.17	0.17	0.33	-0.02	0.47	0.47	0.07	0.44	0.15	1						
PAKISTAN (12)	-0.05	0.03	0.12	-0.06	0.19	0.09	0.03	-0.01	0.19	0.08	0.07	1					
SRILANKA (13)	0.02	0.09	-0.01	0.16	-0.07	0.16	0.19	0.05	0.22	0.08	0.06	0.12	1				
INDONESIA (14)	-0.1	0.04	0.12	0.24	0.03	0.38	0.36	-0.01	0.46	0.05	0.62	0.45	0.14	1			
MALAYSIA (15)	0.04	-0.07	-0.12	0.19	-0.06	0.33	0.26	0.03	0.39	0.06	0.28	-0.06	0.03	0.12	1		
PHILIPPINE (16)	0.19	0.25	0.11	0.42	-0.21	0.35	0.35	0.02	0.36	0	0.28	0.16	0.04	0.32	0.05	1	
THAILAND (17)	0.05	0.01	-0.08	0.4	0.05	0.51	0.49	0.06	0.63	0.12	0.43	-0.1	0.2	0.34	0.41	0.29	1

Table 2. Holt Winter result

Date: 03/10/10 Time: 15:49

Sample: 1999 2009

Included observations: 154 (each market)

Method: Holt-Winters (No Seasonal)

	Parameter		Sum of Squared	Root Mean Square	End period levels	
	Alpha	Beta	Residual	Error	Mean	Trends
World	0	0	0.001347	0.004182	-0.00074	-4.58E-05
EAFE	0.52	0.26	5.34E-37	5.69E-20	-0.00477	-4.58E-05
Pacific	0.04	0.1	0.001677	0.004666	-0.00083	-7.22E-05
Australia	0.2	0.01	0.0025	0.003893	0.001388	5.13E-05
China	0.02	0.06	0.008632	0.007233	-0.00204	-4.02E-05
Hongkong	0.12	0	0.006798	0.006419	0.003896	0.000106
Japan	0.14	0.02	0.005166	0.005595	0.001559	2.15E-05
South Korea	0.09	0	0.006162	0.008946	-0.00154	-0.00011
Taiwan	0.02	0.03	0.007243	0.006626	0.000496	2.56E-05
Bangladesh	0.05	0	0.002066	0.003539	0.001665	1.94E-05
India	0.08	0	0.017981	0.010439	0.008372	0.000117
Pakistan	0.02	0.08	0.019201	0.010787	0.001386	0.000143
Sri Lanka	0.03	0.02	0.004111	0.004992	0.001409	2.10E-05
Indonesia	0.01	0.03	0.010312	0.007905	3.29E-05	1.22E-05
Malaysia	0.03	0.01	0.002703	0.004047	0.000308	7.82E-06
Philippine	0.1	0.01	0.006298	0.006178	0.003258	6.50E-05
Thailand	0.12	0.01	0.00825	0.007071	0.003134	1.52E-05

Table 3. Kruskal - Wallis Results in Asian Stock Market

	Kruskal-Wallis	
	Value	Probability
World	1.895475	0.0686
EAFE	1.312159	0.052
Pacific	1.567742	0.0105
Australia	0.366351	0.0545
China	0.364167	0.0546
Hongkong	0.202398	0.0528
Japan	3.857156	0.0495
South Korea	0.423071	0.0515
Taiwan	0.031995	0.0580
Bangladesh	1.880579	0.0703
India	0.21227	0.0450
Pakistan	0.016456	0.0979
Sri Lanka	0.236218	0.0627
Indonesia	2.977247	0.0844
Malaysia	0.299705	0.0584
Philippine	1.567742	0.0105
Thailand	0.556812	0.0455

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Table 4. Wilcoxon Signed Result

	Wilcoxon Signed	
	Value	Probability
World	1.374956	0.0691
EAFE	1.143689	0.0528
Pacific	1.250288	0.0112
Australia	0.603463	0.0462
China	0.601656	0.0474
Hongkong	0.44808	0.0541
Japan	1.962158	0.0497
South Korea	0.648632	0.0516
Taiwan	0.177064	0.0595
Bangladesh	1.369535	0.0708
India	0.458921	0.0463
Pakistan	0.126474	0.0994
Sri Lanka	0.484216	0.0282
Indonesia	1.723663	0.0848
Malaysia	0.545646	0.0853
Philippine	1.250288	0.0112
Thailand	0.744391	0.0566

The Demand for Money in Cote d'Ivoire: Evidence from the Cointegration Test

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Abstract

This paper demonstrates that there is a long run equilibrium relationship between money supply (M_1) and its main determinants, real income (GDP) and interest rate in Cote d'Ivoire. In order to investigate long-term relationship among these variables, we use Juselius and Johansen cointegration test with time series data covering the period of 1980-2007. The results show that there is long-term relationship among these variables as well as the linkage between them. Base from this result we found that only real money balances (M_1) has significant long -run economic impact of variations in monetary policy in Cote d'Ivoire. However, the study also revealed that the effect of aggregate (M_2) is not so stable linking with it determinants.

Keywords: Cointegration test, Money demand (M_1).

1. Introduction

The research about long-run relationship among broad money and its determinants and the macroeconomic stability have always been a key point of the monetary policy and it has reached exchange rate due to financial innovations, and shift increased financial integration sector. After Friedman's work on the demand for money (Friedman, 1956), many researchers and policy makers are agree that a stable money demand fonction is very important for the central bank's monetary policy to reach it preferable objectives. In an other words , money supply will have a predicable effect on real variables only if when demand for money is stable. The study of long -run relationship between broad money and its determinants and the stability of the demand for money have always been the main points of the monetary policy makers. Knowing that monetary policy depends ceteris paribus, on it short and long- run stability, economist researchers analyze deeply and estimate money demand function at least for two reasons. i) Money demand function's income elasticity tells us the long-term consistent rate of monetary expansion and; ii) Knowing the interest elasticity of money demand allows economists to calculate the welfare cost of long-term inflation see (Baharumshah, 2009) More recently, numerous studies have investigated whether there is a stable relationship money supply and its determinants such as interest rate ,real income(GDP) using a variety of theoretical , empirical and econometric techniques in emerging countries including sub-Saharan African countries. Economist such us (Hafer, 1991) and (Jansen, 1991) , (Miller, 1991), (Hoffman, 1995) and (Rasche, 1992.) investigate the stability of the demand for money in the United States by using either the Engle-Granger two-step cointegration method (Engel -G. , 1987) or the (Johansen S. , 1988) and (Juselius ,. K., 1988) multivariate cointegration method see (Hwan, 2002). In addition, numerous studies have attracted many researchers related to issues in money demand function in Sub Saharan African developing countries has in fact been limited; the exceptions include (Nachega, 2001), (Pedroni, 2004), (Rother P. , 1999), (Jenkins, 1999) and (Shigeyuki, 1988).

The evidence in the studies mentioned above finds that there is strong long-term relationship between income and real balances (Chen, 1997) and (Arize M. a., 2000). Hence it also indicates that the definition of broad money gives better measure to implement policy hence, there is cointegration vector between real income with interest rate while the definition of M_1does not produce any meaningful impact (case of developed countries). However, the empirical studies on the stability of the money demand function in the Sub-Saharan African region confirmed the cointegrating relationship of money demand by the authorities (central banks) promises to play an important role in stabilizing the price levels in this region (Shigeyuki, 1988) and (Loomis, 2006). The studies revealed that both monetary aggregate M_1 and M_2 are reliable variables. In other words, there is a close relationship between the money supply and the real economy over the long-term. Concerning this study we forecast to one important Sub-Saharan African countries which is Cote d'Ivoire .Why Cote d'Ivoire? One of the wealthiest members of French West African country, Cote d'Ivoire enjoyed a high economic growth rate from its independence through the 1970s. Economic productivity and exports subsequently grew with the introduction of a market economy and International Monetary Fund sponsored reforms, but since the late 1990s ethnic and political unrest have hurt the

economy. This seriously disrupted the administration and the economic system. Despite the political crisis that has been ongoing since 2002, Côte d'Ivoire's economy nonetheless registered growth estimated at 1.2 per cent in 2006, following a 1.8 per cent increase in 2005 see (African Economic Outlook 2007). We think that the economic growth and macroeconomic stability attempting was not possible without appropriate monetary policy targeting inflation in order to stabilize the economy. The purpose of this paper is to examine the performance of money supply or in another words to determine whether M_1 or M_2 monetary aggregates have any long-run relationships in Cote d'Ivoire using Johansen and juseluis (1990) cointegration approach with its determinants. More specifically, our objective is to examine whether there is a long-run stationary relationship between money demand (M_1or M_2) and its determinants (interest rate, real income GDP) for the period covering 1980-2007. After the monetary adjustment in 1994(devaluation) following by the harmonization of financial instrument in UEMOA (Union Economique et Monetaire Ouest-Africain) market, the central bank BCEAO (Banque Centrale des Etats de l'Afrique de l'Ouest) authorities have token more responsibility to play role with appropriate monetary policy.

With more than forty years of the literature on monetary areas to consider, the remains part of our study is organize as follows. The next sections involve the empirical foundation of the money demand function. Then, we briefly highlight the econometric methodology and the selected sources in section 3. The section 4 deals with interpretation and discussion of the econometric results of money demand function and the last section is a concluding part that presents recommendations and formulates policies which could help state government and authorities to reach optimal stabilization.

2. The money demand function

In the seminal paper of (Friedman M. , 1959) which has been published in the Journal of Political Economy in 1959, was one of the first theoretical and empirical studies of money demand function. Following this literature there are various theories on the money demand function. For example, (Laidler E. D., 1993) (Kimbrough, (1986b); (Mankiw, November 1986) and (Faig, 1988) set up forth the following demand function by taking account the transaction costs as follow:

$$\frac{M_t}{P_t} = L(Y_t, R_t) \;\; L_y > 0; R_r < 0 \tag{1}$$

Through the above formula M_t denotes nominal money supply for period t; P_t represents the price index for period t ; Y_t is the real output for period t ; and R_t represents the nominal interest rate for period *t*. Increases in output yield increases in money demand, and increases in interest rates lead to decreases in money demand. We will however follow the standard method of using national income as the scale variable of choice. As illustrated above, the model estimates elasticity then, we incorporate natural logarithm which produces a more responsive measure of money demand function in Cote d'Ivoire. Hence, we can rewrite the equation as follow:

$$\left(\frac{\mathrm{M}}{\mathrm{P}}\right)^{\mathrm{d}} = f(y, r) \tag{2}$$

M/*P* denotes the real money stock, *y* is represented by real income (GDP/CPI), and *r* indicates the nominal interest rate. Taking natural logarithm (Ln) both sides excepted interest rate, we obtain the following equation:

$$Ln(M - P)t = \theta_0 + \theta_1 Ln(Y) + \theta_2 r + \mu_t \tag{3}$$

The model's parameters θ evaluates the sensitivity of the variables to money demand and μ_t represents a stochastic error term thus, according the equation (3) mentioned above, we expected to have $\theta_1 > 0, \theta_2 < 0$ .Because we want to examine whether real money balances measured by M_1 or M_2 which is more preferable in considering the long-run economic impacts of changes in monetary policy, we use and estimate two models with either scale variable and determine which of the two variables produces a more responsive measure of the money demand function with respect to Cote d'Ivoire.

$$\text{Model 1: } Ln(M_1 - P)t = \theta_0 + \theta_1 Ln(Y_t) + \theta_2 r + \mu_t \tag{4}$$

$$\text{Model 2: } Ln(M_2 - P)t = \theta_0 + \theta_1 Ln(Y_t) + \theta_2 r + \mu_t \tag{5}$$

The key point here is that if there really genuine long-run relationship between these three variables equation (3) then, although the variables will rise over time (because they are trended), there will be a common trend that link them together. For an equilibrium, or long run relationship to exist, what we require, the residual term needs to be stationary $\hat{\mu}_t \sim I(0)$. Modern time series analysis has established that regression with non-stationary variables may lead to nonsense regression results (Hendry, 1983) and (Juselius K. , 2000).These regression results might indicate the existence of extremely high correlation between variables; therefore there is no ready causal explanation. The recent development of unit root in econometrics has facilitated addressing the problem in a more constructive way; furthermore details will be given in the coming section.

3. Data and econometric framework.

Data used for the study was obtained from the International Monetary Fund's Financial Statistics (IMF-FS-CDROM) for Cote d'Ivoire (IMF 2008) and all series are seasonally unadjusted. The data for each variable is annual time series data from 1980 to 2007 spanning 28 years and providing a fairly ideal sample size. As explained earlier we

have obtained real money balances by divided $M_1$and M_2 to consumer price index (CPI) respectively reflecting demand for real money balance (Laidler E. D., 1993).The real income level (GDP/CPI) is obtained directly in World Development Indicators(WDI) data base for the period covering 1980-2007 published by the World Bank . The interest rate we utilize is the market discount rate instead of nominal interest rate because it's only the rate available in IMF data base.

Prior to testing for cointegration, the time series properties of the variables need to be examines. Non-stationary time series data has often been regarded as a problem in empirical analysis. Working with non-stationary variables leads to spurious regression results from which further inference is meaningless when these variables are estimates in their levels. In order to overcome this problem there is a need for testing the stationarity of these micro-economic variables. The unit root and cointegration test on relevant economic variables are in order to determine time series characteristics. This test is important as it shows the number of times the variable has to be differenced to arrive at a stationary value. In general, economic variables which are stationary are called I (0) series and those which are to be differenced once in order to achieve a stationary value are called I (1) series. In testing for stationarity, the standard augmented Dickey-Fuller test (Dickey F. , 1979), (Fuller, 1979) and (Phillips–Perron, 1988) are performed to test the existence of unit root in order to establish the properties of individual series. The regression is estimated by equation (5) as follow:

$$\Delta Y_{t-1} = \alpha + \beta Y_{t-1} \sum_{j=1}^{k} \gamma i \, \Delta Y_{t-k} + \varepsilon_t \quad (5)$$

Where Δ is the difference operator, Y the series to being tested, k is the number of lagged differencies, and ε an error term. Beyond testing for the unit root, there is a need to establish whether the non-stationary variables are cointegrated so we follow method developed by (Johansen S. , 1988) and (Juselius K. , 1990) to test for the presence of equilibrium relationship between economic variables. The concept of cointegration implies that, if there is a long run relationship between two or more non-stationary variables. Cointegration test is conducted after conducting a unit root test first on individual series and if the variables are integrated of order one; that is, I (1), the static model is estimated for cointegration regression. Secondly, the order of integration is evaluated, that is on the residual generated from static model. The t-statistics of the coefficient of the regression usingADF test determines whether we should accept cointegration or not. With this cointegration test still error correction is better than and being adopted. Following this procedure, the Error Correction Model $(ECM)$is very crucial in the cointegration literature as it drives from the fact that, if macro variables are integrated in order one and are cointegrated, they can be modeled as having been generated by Error Correction Model. The error correction model produces better short run forecasts that hold together in economic meaningful ways. Thus, we suggest the reparametrization of the initial vector auto regression (VAR) in the familiar vector error- correction $(VECM)$formulated in equation (6). The general $VAR(p)$ model can be written as:

$$\Delta Y_t = \prod Y_{t-p} + \sum_{i=1}^{p-1} \prod i \, \Delta_{t-1} + \emptyset B_t + v_t \quad (6)$$

Where Y_t is and $NX1$ vector of the time series of interest, v_t ~$IN(0, \sum)$, and B_t contains the conditioning variable set. The order of VAR p is assume finite and the parameters$\prod_i$, $\prod$ and $\emptyset$ are assume constant. The long-run response matrix is $\prod$and, if the case $\prod$ can be express as the product of two Nr matrixes φ and $\omega's$: $\prod$=$\varphi\omega$ where ω contains the r cointegrating vectors and φ is the loading matrix which contains the coefficients with which the cointegrating relationships enter the equations ΔY_t .As we mentioned earlier Johansen and Juselius methodology target is to test the existence of the long-run equilibrium relationship among the variables therefore the test is base on the maximum eigenvalue noted by (λ_{max}) including the trace statistic (λ_{trace}) or the likelihood ratio $(L.R)$.The general overparameterized model is estimated with maximum n lags denoted p. An error correction term is introduced in the model. Hence equation (7) is re-specified to include error-correction term (ECT) in this form:

$$\Delta Ln(M-P)t = \sum_{k=1}^{n} \mu' \, \Delta Ln(M-P) + \varphi[Ln(M-P)t - 1 - \omega' F_{t-1}] + \sum_{p=0}^{n} \Upsilon' \, \Delta F_{t-k} + \mu_t \quad (7)$$

Where $F = [Y_t, r]'$ is the vector of fundamentals and μ_t is independently an identically distributed (i.i.d) mean-zero stationary random variable. The formula $[Ln(M-P)_{t-1} - \omega' F_{t-1}]$ measure the adjustment speed between the short-run and long-run disequilibrium and is vector error correction term (ECT) as independent variable in the estimation process will cover all the long-run information that was lost in the original estimation process.

4. Empirical results and interpretation.

4.1. Empirical results.

In this section, we first perform the augmented Dickey-Fuller (DF) and Phillips–Perron (1995) test, which tests the series's stationarity. In all cases, the test concerns whether $\gamma = 0$ equation (5).The ADF statistic is the t statistic for the lagged dependant variable. If the ADF statistical value is smaller than the critical value then we reject the null hypothesis of a unit roots and conclude that Y_t is a stationary process. However the result is presented in table 1. the standard augmented Dickey-Fuller test (Dickey F. , 1979), (Fuller, 1979) and (Phillips–Perron, 1988) which test the stationarity of the individual variables shows that we fail to reject the stationary null hypothesis base on ADF and PP tests at level. In another words the tests indicate that all variables contains a unit root at level while

they are all first difference stationary equation (5).Thus, according the empirical foundation, we found that all variables follow the $I(1)$ process.

The second test conducted is the cointegration tests following the famous method of (Johansen S. , 1988) and (Juselius K., 1990). As we illustrate earlier this method is based on the statistics values such us maximum eigenvalue (λ_{max}) the trace statistics (λ_{trace}) or the likelihood ratio (LR).We use these two statistics value to find the number of cointegration vectors between money supply and it determinants. It necessary for us to determine the appropriate lag length (k) before the cointegration tests is conducted. We use the criteria developed by using the Akaike Information criterion (AIC) and Schwarz Bayesian Criterion (SBC) in this form:

$$AIC(p) = Ln\left(\frac{SSR(p)}{p}\right) + (p+1)\frac{2}{T} \tag{8}$$

$$BIC(p) = Ln\left(\frac{SSR(p)}{T}\right) + (p+1)\frac{LnT}{T} \tag{9}$$

Where $SSR(p)$ is the sum of square residuals of the estimated $AR(p)$ the BIC estimator of $\widehat{p}$,p is the value that minimizes $BIC(p)$ among the possible choices $p = 0,1 \dots, p_{max}$ is the largest value of p value considered. Because the regression decreases when add lag. In contrast, the second term increases when you add a lag. The BIC trades off these two forces so that the number of lag that minimizes the BIC is a constant estimator of the true lag length (Waston, 1994).The difference between the AIC and the BIC is that the term "LnT" in the BIC is replace by "2" in the AIC, so the second in the AIC is smaller then T represent the simple. The result shows that the optimal lag length is $k = 6$ respectively for model 1 and model 2.

Thirdly, we determined the number of cointegrating vectors for different combinations of variables. For that, we forecast on the degree of adjusted version of the λ-max and trace statistics since the Johansen procedure tends to overestimate the number of vectors with small samples and or too many variables (Cheung and Lai, 1993) the result is shown in table 2 and 3 bellow. And finally, after obtaining the long-run cointegration relationships using Johansen method, the short-run dynamics of the long-run money demand model is explored by estimating an error correction model with maximum six (6) lag assuming the unrestricted intercepts procedure with no trend in the VAR model as follow:

$$\Delta Y_t = \gamma_1 Y_{t-1} + \cdots + \gamma_k \Delta Y_{t-k+1} + ECM_{t-1} + \Phi D_t + \epsilon_t \tag{10}$$

Where ECM_{t-1} is one lag of error-correction term and D_t incorporates dummies and intercept. Following the literature, we can get the cointegrating relationship which is normalized against real money balance. The error-correction term (ECT) coefficient term is estimate of back adjustment speed to the long-run equilibrium relationship. The ECT should have a negative sign and significantly different from zero. The negative sign of ECT means that the deviation event between actual and long-run equilibrium level would be adjusted back to the long-run relationship in the current periods to clear this discrepancy. Since all the variables in the above model follow $I(1)$ process, statistical inference base on standard t and $F-tests$ is valid. Thus we can find the preferred model by removing all parsimonious insignificant regressors and test whether this diminution is supported by$F-test$. In our present case, because we want to examine whether real money balances measured by M_1 are preferable to those measured by M_2 in considering the long-run economic impacts of changes in monetary policy, we estimate separately ECM for model 1 equation (4) and model 2 equation (5) are presented in table 4 and 5. (We don't display these 2 tables in our work because space problem but available by the author upon the request). Hence, by using the AIC and the BIC criterion we find that the maximum lag length for both models is $k = 6$. Finally, the resultant model can be checked by performing diagnostic tests on the residuals.

In the same order we examine the presence of autocorrelation in the error terms of a regression models. (Engel F. R., 1982) introduced a new concept allowing the autocorrelation to occur in the variance of the error, rather than in the error themselves. To capture this autocorrelation Engel developed the Autoregressive Conditional Heteroskedasticity $(ARCH)$ model, the key idea behind which is that the variance of μ_t depend on the size of square error them lagged one period that is μ_{t-1}^2 . Table 6 shows the parsimonious equation and diagnostic test results with M_1 and M_2 .The diagnostic tests refer to the first and fourth autoregressive conditional heteroskedasticity test $(ARCH)$,the general heteroskedasticity test (White) and the Lagrange multiplier test (LM) developed by (Breusch, 1979) and (Godfrey, 1979) .

4.2. Interpretation of empirical results.

We first examine the money demand function with for both models 1and 2. For this analysis, we conducted the standard augmented Dickey-Fuller test (Dickey F. , 1979), (Fuller, 1979) and (Phillips–Perron, 1988) for all variables simultaneously (M_1, M_2, Y and r) to test whether each variable taking individually was stationary or not. The result shown in table 1 fail to reject the null hypothesis at level based on the tests mentioned above. But the overall tests shows that all the variables are stationary at first difference and treated as $I(1)$ process according the literature.

The second stage was to perform the cointegration test using the popular method developed by (Johansen S. , 1988) and (Juselius K. , 1990). We found in the preliminary analysis that real money($M_1 - P$) real income(Y) and interest rate r are cointegrated at the 5% level of significance. Both the LR tests identify a unique statistically significance vector with ($\lambda_{max} = 0.681539, \lambda_{trace} = 38.80344$) see table 2. However, we reject the null hypothesis that long-term relationship exist between aggregate M_1 and it determinants (model 1) when the nominal interest rate is employed as the opportunity cost of holding money. Meanwhile, the L. R statistics for real money demand ($M_1 - P$), real income, are not all statistically significant at conventional significance levels even at 10% compare to the model 2 which real income and the nominal interest rate is significant at 10% level. The estimated cointegrating vectors are giving economic meaning by the normalized equation on money balances. Normalization is only conducted if nonzero vector or vectors are confirmed by the cointegration test. Table 2 shows the results of the normalized cointegrating vector tests for Model 1and 2. The normalized equation with $(M_1 - P)$indicates more meaningful result with real income elasticity (5.311675) significantly greater than the zero and negative sign of nominal interest rate elasticity (0.191327). As is evident from Table 2, the normalized equation with $(M_2 - P)$ model 2 shows less meaningful result and the real income elasticity (1.438495) is greater than zero but positive sign of nominal interest rate elasticity (0.045515).Thus, as we mentioned earlier, if we utilize the nominal interest rate, regarding aggregate M_1or M_2 we fail to reject the null hypothesis of single cointegration at 5% significance level. This mean that the money demands function in Cote d'Ivoire is stable. Therefore, the long-run nominal interest rate used for our study seems to be acceptable in specifying the money demand function. As suggested Jansen ,Thornton and (Dickey, 1991), the vector that makes economic sense is that the estimated coefficients are close to and have the same signs as those predicted by economic theory. However, according to Jansen, Thornton and Dickey (1991), cointegration analysis does not give estimates with structural interpretation regarding the magnitude of the parameters of the cointegrating vectors. Because cointegrating vectors merely imply long run, stable relationships among jointly endogenous variables, they generally cannot be interpreted as structural equations. All that can be said is that there are a number of linear combinations for which the variance is closed. In this way we cannot decide whether real money balances measures by M_1or M_2 produces a plausible response for money demand function in Cote d'Ivoire.

Third, after computing the long-run cointegration relationships using the Johansen method, the short-run dynamics of the long-run money demand function is analyzed by computing an error-correction model(ECM). The selection of the number of lags($k = 6$) for model 1 and 2 included in the estimated model was based on the famous general methodology. The results are summarized in tables (4 and 5). We found that only money demand function running by model 1 equation (4) displays a correct sign (negative) and relatively small $ECT1_{t-1}$ coefficient (0.0044). This implies that the adjustment process to an exogenous shock is rather slow. The $ECT1_{t-1}$ coefficient (-0.0044) means that it would take 0.44 of the year of real money balances M_1 to come to equilibrium if an econometric shock of money aggregate M_1 occurred in the exogenous on the right hand side. However, (Deng and Liu, 1999) reported a value of -0.12 for the error-correction term for M_2using data from 1980:1 to 1994:4. Therefore, cointegration among M_1 and its determinants can also be confirmed by the significance of the lagged error–correction term. Furthermore, the test indicates that the nominal interest rate seems not to be an important component for long-run cointegration estimation vector but has a significant short-run impact on money demand.

Fourth, we continued our study by testing the model 1 and 2 utilizing a battery of diagnostic tests. For that we conducted the autoregressive conditional heteroscedasticity test (ARCH), the general heteroscedasticity test (White) and the Lagrange multiplier test (LM) developed by (Breusch, 1979) and (Godfrey, 1979) .Table 6 shows the parsimonious equations and diagnostic test results with both models 1 and 2 .The computed Breusch–Godfrey Lagrange multiplier (LM) statistic shows no evidence of serial correlation up to the fourth order in the VAR residuals with aggregate M_1 then aggregate M_2 see table 6 respectively panel A and B. The Ramsey's RESET (Ramsey, 1969) statistics revealed no serious misspecification of variables. Both models also passed the (Jarque-Bera, 1987) test for normality without any serious pain. The coefficient of the error-correction term is positive and statistically insignificant for aggregate M_2, this is theoretically implausible because it means that the demand for money is not so stable when M_2 is utilized as monetary aggregate. In contrary, the diagnostic statistics test with aggregate M_1 are satisfactory and pass the standard tests with negative error-correction term coefficient. The small magnitude of the coefficient suggests that the speed of adjusting to long-run changes is slow therefore acceptable as we explained earlier. This means that the money demand with aggregate M_1 is more stable. In order to verify the stability of our models coefficients, we performed the $CUSUM$ and $CUSUMQ$ square (Brown and Durbin, 1975) to test the parameters stability of the money demand function. Figure 2 and 3 display the cumulative sum of residuals plot. We found that only the money demand functions with aggregate M_1 (model 1) appears more stable at 5 percent level of significance than model 2 using aggregateM_2. Therefore following the literature, we partially conclude that the real money balances measured by M_1 are preferable to those measured by M_2 in considering the long-run economic impacts of changes in monetary policy in Cote d'Ivoire.

5. Conclusion

The main objective of this paper was to analyze the money demand function in Cote d'Ivoire using the recently advanced method cointegration test utlizing time series data covering the period of 1980-2007. The software Eviews 3.1 was utilized for our econometric analysis. Unit root test was conducted to test the stationarity of data and

cointegration test was performed to test for the existence of the long-run relationships of the variables. In the same way, the models 1 and 2 were generated from overparameterized models, based on statiscall rather economic considerations. We also run a battery of diagnostic tests such as $ARCH$, White, LM and Ramset RESET. Finally, according the importance of the stability in the regression analysis of the model, we run the stability test to check whether our models were stable at the conventional significance level. Basing on theoretical and related empirical literature from Sub-Saharan Africa and other related studies, a number of hypotheses were tested. Following the leaving out of insignificant variables in the general model without losing valuable information, the models 1 and 2 pass the misspecification and serial correlation test and reports significant $F - statistcs$ implying that there is an improvement in the overall significance of the models.The empirical analysis results revealed that there exists a cointegration relation between money demand and it determinants in Cote d'Ivoire for the period covering 1980-2007, whatever M_1 or M_2 is used as the money supply measure. The econometric results shows that money supply using aggregate $M_1$is more reliable and gives plausible response in term of policy variables in order to target inflation and the opportunity cost of holding money this according our empirical evidence.

The results also highlight the evidence of some important policy implications. Our empirical results suggest that monetary policy or money supply (M_1) is a reliable policy variable aimed at stabilizing the domestic economy by targeting inflation at the same time promoting economic growth. As expected, national income positively influences the level of money demanded in the economy whereas nominal rates negatively impact money demand. This confirms our empirical finding. Thus, due to the existence of an equilibrium relationship between real money balances, real income, and price level, in attempting to control the price level or output, the reliability of money supply as a target variable holds (Shigeyuki, 1988) and (Loomis, 2006). Therefore, the results of this study could be useful for Cote d'Ivoire policy makers and monetary authorities in making appropriate fiscal and monetary policies.

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Table 1. Univariate unit root tests.

	ADF statistics		Phillips-Perron Statistics	
Test/variables	No trend	Trend	No trend	Trend
Level				
Ln(M1-P)	0.614323	-2.15013	0.915187	-2.38644
Ln(M2-P)	0.231298	-1.7547	0.260894	-1.95193
LnY	0.506304	-2.075838	0.491382	-1.78201
r	-1.8308***	-2.81233	-1.12197	-3.1031
First difference				
ΔLn(M1-P)	-3.903757*	-3.78718*	-4.26774*	-4.11359*
ΔLn(M2-P)	-4.043563*	-4.1018**	-5.6289*	-5.72846*
ΔLn(Y)	-2.59947**	-2.598441	-3.1731**	-3.0951*
Δr	-3.89932*	-4.2932*	-5.19810*	-5.4145*

Source: Own computation by Eviews 3.1

The table shows univariate unit root tests. The notation $(M1-P),(M2-P),Y$ and r indicate respectively the real money supply, national real income and nominal interest rate. The Δ denotes first-difference derivation. The asterisks *, **, and *** denote statistical significance at 1%, 5%, and 10% levels, respectively. McKinnon (1980) critical values are used for rejection of the null unit root.

Table 2. Johansen tests for cointegration with monetary Aggregate M_1.Series: $Ln(M_1-P)$,LnY, r

λ_{max} Eigenvalue	Likelihood Ratio L.R	5 % CV	1% CV	Hypothesized No. of CE(s)
0.681539	38.80344	29.68	35.65	None **
0.416396	12.48554	15.41	20.04	At most 1
0.004308	0.099297	3.76	6.65	At most 2

This table displays Johansen tests for cointegration. The asterisks *, **, denote statistical significance at 1%, 5%, level, respectively. The λ-max and λ-trace (LR) are Johansen's maximum eigenvalue and trace eigenvalue statistics for testing cointegration. Critical values (*C.V.*) L.R. test indicates 1 cointegrating equation(s) at 5% significance level

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)

Ln(M1-P)	*LnY*	*r*	*C*
1	5.311675	0.191327	-25.29941
	-6.16372	-0.24307	
Log likelihood	58.92131		

Table 3. Johansen tests for cointegration with monetary Aggregate M_2.Variables Ln (M_2-P), LnY, r

λ_{max} Eigenvalue	Likelihood Ratio L.R	5% C.V	1% C.V	Hypothesized No. of CE(s)
0.732478	53.92407	29.68	35.65	None **
0.416883	23.59734	15.41	20.04	At most 1 **
0.38529	11.19189	3.76	6.65	At most 2 **

This table displays Johansen tests for cointegration. The asterisks *, and**, denote statistical significance at 1%, and5% level, respectively. The λ-max and λ-trace(L.R) are Johansen's maximum eigenvalue and trace eigenvalue statistics for testing cointegration. Critical values (*C.V.*) *(**) denotes rejection of the hypothesis at 5%(1%) significance level, L.R. test indicates 3 cointegrating equation(s) at 5% significance level

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)

Ln(M2-P)	*LnY*	*r*	*C*
1	-1.438495	-0.045515	3.974909
	-0.078	-0.00438	
Log likelihood	44.58638		

Table 4. Error -Correction Regression

Panel A Aggregate: M_1

$$\Delta DLnM1_{t-1} = -0.2780 + 0.4912DLnY_{t-1} - 1.2057DLnY_{t-2} + 09485LnDY_{t-3} - 0.6591\mathrm{DLnY}_{t-4} - 0.1049\mathrm{DLnY}_{t-5} + 0.0320\mathrm{DLnY}_{t-6} + 0.0151Dr_{t-1} - 0.0036\mathrm{Dr}_{t-2} - 0.02\mathrm{Dr}_{t-3} + 0.0311\mathrm{Dr}_{t-4} - 0.0013\mathrm{Dr}_{t-5} + 0.0128\mathrm{Dr}_{t-6} - 0.0044\mathrm{ECM}_{t-1}$$

LM(1):	1.6951	ARCH(1):	0.2146	R^2:	0.6008	D.W.:	2.1616
LM(2):	1.478	ARCH(2):	0.1733	$\bar{R}$:	0.1405	WHITE:	2.0477(0.1210)**
LM(3):	0.7927	ARCH(3):	0.0468	SE:	0.0763	Jarque-Bera	1.0549(0.5901)**
LM(4):	1.2844	ARCH(4):	0.0503	F-statistic:	0.81043(0.64769)**	Reset:	1.1795(0.4645)**

Notice: Numbers in parentheses are $t-values$. R^2 Is the $R-square$, Adjusted $\bar{R}$ is the adjusted coefficient of determination. DW is the Durbin-Watson statistic, which tests the autocorrelation. LM (p) is the Lagrange multiplier test statistic for up to the fourth-order autocorrelation. ARCH (p) is a test statistic for up to the fourth-order autoregressive conditional heteroskedasticity. WHITE indicates White's (1980). The asterisks (**) denotes the corresponding probability's value.

Panel B Aggregate: M_2

$$DLnM2 = 0.2472 + 2.8164DlnY_{t-1} - 2.9214DlnY_{t-2} + 3.1466DLnY_{t-3} - 1.9998DLnY_{t-4} + 1.8254DLnY_{t-5} - 0.7257DLnY_{t-6} + 0.0563Dr_{t-1} + 0.0373Dr_{t-2} + 0.0064Dr_{t-3} + 0.0813Dr_{t-4} - 0.0379Dr_{t-5} + 0.0784Dr_{t-6} + 0.00302ECM_{t-1}$$

LM(1):	2.4443	ARCH(1):	0.5696	R^2:	0.5026	D.W.	2.8215
LM(2):	2.1776	ARCH(2):	0.0952	$\bar{R}$:	0.4213	WHITE	0.8314(0.5190)**
LM(3):	2.2119	ARCH(3):	0.1879	SE:	0.1854	Jarque-Bera	2.0222(0.3638)**
LM(4):	1.8623	ARCH(4):	1.3075	F-statistic:	0.544(0.8371)**	Reset	0.6991(0.6418)**

Notice: Numbers in parentheses are $t-values$. R^2 Is the $R-square$, Adjusted$\bar{R}$: is the adjusted coefficient of determination. DW is the Durbin-Watson statistic, which tests the autocorrelation. LM (p) is the Lagrange multiplier test statistic for up to the fourth-order autocorrelation. ARCH (p) is a test statistic for up to the fourth-order autoregressive conditional heteroskedasticity. WHITE indicates White's (1980). The asterisks (**) denote the corresponding probability's value.

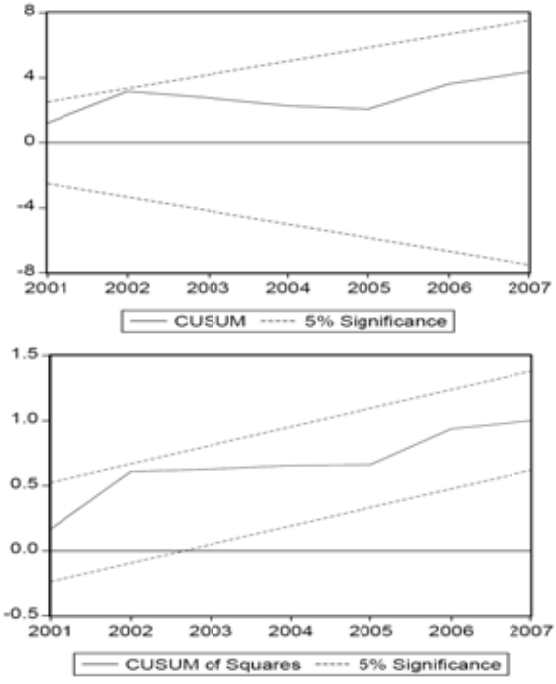

Figure 1. Plot of Cumulative Sum of Squares of Recursive Residuals for Aggregate M1

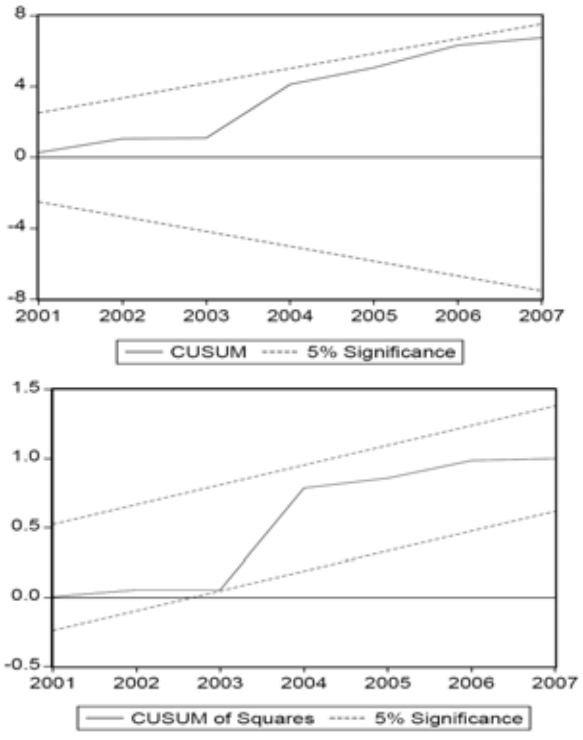

Figure 2. Plot of Cumulative Sum of Squares of Recursive Residuals for Aggregate M2

Why Women are Self-Employed? Empirical Evidence from Pakistan

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Abstract

In developing economies like Pakistan, the rising trend of women's labor participation has become the core indicator of growth and development. In this respect, the MDGs (Millennium Development Goals) relates to efficiency and equity, especially elimination of gender disparities in education, improvement of maternal health, lessening mortality rate among children and women empowerment are desirable goals. But still the representation of women in wage as well as in the self-employment sector is very low. The present study investigates the factors which influence women's participation in self-employment. Primary source of data is used for empirical analysis. Logistic regression technique is employed to estimate the women self-employment model. The findings indicate that age and experience positively affects women's self-employment. Further, it is concluded that education, location and number of dependents significantly reduce the women's work participation as self-employed worker. It is suggested that the government provide technical and vocational education to the women, and also give old age benefits just to minimize the dependency burden.

Keywords: Women Self-employment, Experience, Logistic regression, Dependency burden, Higher Education, Per Capita Income.

1. Introduction

The population of Pakistan indicates a double faced phenomenon. On the one side, population of the country is considered as an asset and performs an integral role in the growth and development process of the country. On the other hand, the high growth rate of population is a great hindrance in way of economic prosperity and development of the country. For examining the role of human capital in economic development, it is imperative to study both the qualitative and quantitative aspects of the population. At the time of independence in 1947, the total population of Pakistan was 32.5 million. By the year 2006-07, the population reached 156.77 million. The population of Pakistan has grown at an average rate of 2.6 percent per year. The changes in the labor force and employment level are affected by the population growth rate and its composition. This high growth rate of population shows that Pakistan will become the eighth most populous country in the world by the year 2010 (Govt. of Pakistan Economic Survey 2006-07).

Employment generation, poverty reduction and human resource development are the main features of Pakistan development policy. The employment led growth rate captures a central place in attaining the sustained development. Table 1 highlights the labor force participation (LFPR) among the region and gender based on crude activity rates in the years 1996-97 to 2005-06.

The labor force of Pakistan was estimated at 50.05 million on the basis of participation rate of 32.2 percent during the year 2005-06. During the two years, this rate has increased from 45.23 million to the present level by adding 4.82 million, both men and women. The present situation nevertheless is the information about a high dependency ratio. From the table 1, it is clear that the LFPRs though low, is increasing gradually over the years. The rural – urban participation rates show also a gradual increase both for men and women for the last ten years. An increase of 3 percent female labor force participation in the urban areas is dominated by males i.e. (4.4 percent for males versus 2.0 percent for females). On the other hand, almost an increase of 4 percent in the rural areas is dominated by females i.e. 5.5 percent of females vs. 2.7 percent of males. Such satisfactory rise in labor force participation in rural areas, particularly for females and of males in urban areas represents the positive step for development of Pakistan's economy. This all has happened due to expansion of educational facilities and health facilities in rural areas for females and further providing employment opportunities in social as well as in economic sectors, both in rural and urban areas.

Although, facts indicate a rising trend in female labor force participation over the period but still it is low as compared with other developing and developed nation. The issue of female's employment and labor market participation has given top priority in the developing nations generally and especially in Pakistan. The present analysis is arranged as follows. The first section provides a brief introduction and importance of study. Section 2 reviews the relevant literature, section 3, discusses the data source and presents the methodology. Section four provides the results and discusses the findings. The final section concludes the whole discussion.

2. Review of the literature

There is an immense literature available on the issue of women participation in economic activities at the national and international level. Women represent a sizeable portion of the population and require a lot of attention. They are considered as a supporting factor in the economic development of the country and put a significant effect on overall business and economic activities. Hill (1983) concluded that husbands' wages were inversely related to women participating in the formal labor market but directly to women working for family business. Sheehan and Standing (1978) showed that age is less important by women participating in the labor market while education, social and environmental factors have significant impact on participation. Similar study made by Behrman and Wolfe (1984). They investigated that number of children had no larger effect on participation but schooling, experience and nutrition level had a significant impact on labor supply and wages.

Amin et al (1995) analyzed the different factors which directly or indirectly affect women's work participation. The results of the analysis showed that the income, purdah and patriarchal system had an inverse effect on female labor force participation and education, age and marital status had positive influence on female labor force participation. Irfan (1983) discussed the factors which determine the female labor supply. Using ordinary least square (OLS) and Logit estimation techniques, he found that higher level of education significantly influences the female LFPR, but only if they work as an employee. The study also shows that household per capita income is correlated with wage employment but self-employed women remained unaffected. Hafeez and Ahmad (2002) explored various factors which affect the decision of educated married women in participating in the labor market. Naqvi and Shahnaz (2002) made an attempt to explore the factors which influence women's decision regarding work participation and concluded that age and education were positively related to decision making and participation in economic activities but married women were less likely to participate.

Faridi et al. (2009) estimated the factors which influence the women's decision to join the labor market. They concluded that education significantly affects women's work participation. Rees and Shah, 1986; Georgellis and Wall, 2004; Do Trang, 2008; Blau David, 1985; Le Anht, 2000; and Blanchflower and Oswald, 1988 provided very informative studies on the issue of the self-employment. They concluded that education, health, experience family background, marital status turned out to be very significant factors.

Most of the studies reviewed focus on the factors which determine female labor force participation. But the aim of the present study is to identify different socio-economic factors which determine why women are self-employed. The importance of the study becomes more powerful and rational that women's participation as self-employed worker reduces public sector burden and expands the private sector, business sector by attracting more investment. Ultimately, this thing raises the process of economic development.

3. Data Sources and Methodology

3.1. Data Sources

In order to observe the factors which influence the women's decision to be self-employed, we have chosen district Bahawalpur as study area. Pakistan consists of 4 provinces and FATA (Federally administrated area). Punjab is the largest and densely populated province of Pakistan. It consists on 9 divisions and 34 districts. Bahawalpur district is one of them and is situated in the southern part of the Punjab. Bahawalpur is the largest district of Punjab, covering of an area of round about 24830 square km. Total population of the district was 2.433 million or 243309 in 1998. Almost 72.7 percent of the total population is living in rural areas while the urban population is 665304 or 27.3 percent. Total females' participation in self – employment is 29 percent, out of which 38.2 percent are rural self – employed and 18.6 percent are urban self – employed (Note 1). Primary source of data is used for analysis. Simple random sampling and stratified sampling techniques are employed to collect the data both from formal and informal sectors. A total of 164 women in the age cohort of 15-64 years are interviewed randomly both from urban and rural areas according to the population distribution. Our study includes human as well as non human capital related factors to see why women are self-employed.

The study is based on an empirical analysis. Women's decision regarding self-employment is analyzed at two stages. At the first stage, we present a preliminary analysis considering mean, standard deviation, skewness, and kurtosis of the selected variables and also pair wise correlation is constructed to examine the existence of multicollinearity. In the second stage of the analysis, the study report multivariate estimates of the self-employment model. The multivariate analysis of self-employment is structured in the framework of the conventional theory of utility maximization (Becker 1965), by using the maximum likelihood Logit model.

3.2. The self-employment model

There are numerous macro and micro-economic variables that decide whether women who desire to participate in economic activities being salaried employed or own account or self-employed worker (Note 2). Decision regarding labor supply is influenced by some of these factors and others require decision. We start with general function.

$$Y_i = f(X_1, X_2, \ldots\ldots, X_n) \quad (1)$$

Where Y_i indicates the women's decision in the labor market as self-employed worker. Y_i is equal to "1", if women participate in economic activities as self-employed worker and equal to zero if the women prefer to wage/ salary employment.

Following Blundell (1987) an index function, WSE_i may be defined as that it depends on a vector of explanatory variables Z_i. These factors make decision whether a woman should participate in self-employment activities or not. Hence the general model for self-employment is;

$$\overset{*}{WSE}_i = \beta Z_i + \varepsilon_i \quad (2)$$

Where $\overset{*}{WSE}$ is a latent variable that apprehends the propensity of women "i" to be self-employed, Z_i is a vector of remarked or noted factors held to affect the propensity of women "i" to be self-employed, β is a vector of estimated coefficients and ε_i is a random/ disturbance error term.

$$\text{If} \qquad \overset{*}{WSE}_i = \beta Z_i + \varepsilon_i > 0 \quad (3)$$

The woman would obtain self-employment where as if:

$$\overset{*}{WSE}_i = \beta Z_i + \varepsilon_i \leq 0 \quad (4)$$

The woman would be wage/ salaried employed. The vector Z pertains variables for age, experience, education, financial capital (Assets), marital status, number of dependents, number of children, husband salaried, location and family setup.

Where as, $\overset{*}{WSE}_i$ is a latent variable which is not directly observable, only dichotomous variable WSE is remarked which is defined as;

$WSE = 1$ if $\overset{*}{WSE}_i > 0$

$WSE = 0$ Otherwise.

The probability of finding the women self-employment is;

$$\Pr ob(WSE_i = 1) \quad \Pr ob(\varepsilon_i > \beta Z_i)$$
$$= 1 - F(-\beta Z_i)$$

Where F is the cumulative distribution function for ε_i. It is assumed that ε_i is normally distributed with mean zero and constant variance [i.e. $IN(0, \sigma^2)$].

In our analysis, the explained variable is binary or indicator variable WSE. The inadequacy of linear probability model suggests that non-linear specification may be more appropriate. Therefore, a Logit or Probit econometric model is more useful and we use Logit model technique in our study. The Logit model hypothesizes the following cumulative probability density function.

$$WSE = \frac{1}{1 + e^{-\beta Z_i}} \quad (5)$$

Where WSE is the probability that a women participates in economic analysis as self-employed, "e" is the exponential value. β is the row vector of parameters and Z_i is the column of the explanatory variables.

With the Logit model the natural log of the odds ratio of self-employment to wage/ salary employment, $\ln(\frac{WSE}{1-WSE})$ is expressed as a linear function of explanatory variables, such as;

$$\ln(\frac{WSE}{1-WSE}) = \beta Z_i \quad (6)$$

Therefore, the estimated parameters are the Logit model register the effect on the log odds of a little change in the independent variables. Partial effects of independent variables on the probability of being self-employed are described by;

$$\frac{\partial WSE}{\partial Zk} = WSE(1 - WSE)\hat{\beta}k \qquad (7)$$

Where Z_k is the k^{th} independent variable and βk is its related estimated parameter. Conventionally, the marginal effects are evaluated at the sample mean self-employment rate (See Greene, 1993).

3.3 Variables description

The self-employment model which is specified above is general model, can be utilized as a guiding paradigm. Considering the theoretical rationale, the operational model depends upon the factors which are provided by the data. Generally, we have found in the past studies in the self-employment literature (e.g., Rees and Shah, 1986, Borjas, 1987, Evans, 1989, de Wit, 1993, Bernhardt, 1994, Kidd, 1993) that self-employment is determined by both human capital and non-human capital variables which are discussed below. The justification for including these variables in the women self-employment model and their expected relationships are interpreted below.

3.3.1 Education

Education is considered a vital factor in determining self-employment activities. In the literature of self-employment, it is observed that educational attainment is pleaded to apprehend a range of effects. On the one side, educational attainment may be pondered as a source of workers' managerial capability and hence workers are more likely to be self-employed. On the other side, it is expected that educated workers are more inclined to salary or wage employment as the attainment of higher level of education rises and higher level of education reduces the likelihood of self-employment. Therefore, we can not determine the effect of educational attainment in advance. So, it is not surprising that various studies have concluded mixed effects of educational attainment on self-employment. Kidd (1993) has concluded that tendency to be self-employed is not significantly influenced by the educational attainment. Further, according to Evans' (1989) study, it is found that self-employment is inversely and significantly influenced by the level of education among immigrants. In the present discussion, we have traced out the impact of education on self-employment in two ways. First, completed years of education are considered as continuous variable and secondly we have used various level of educational attainment as dummy variable in the self-employment model.

3.3.2 Age/ Experience

Age and experience are highly correlated. Experience and age move in same direction. The present study discusses the impact of both variables separately. There are two ways (approaches) to interpret the labor market experience. These are stock(Note 3) and flow (Note 4) approaches. According to stock approach, aggregation of work-related skills of an individual or worker is an indicator of labor market experience. It is assumed that there is positive relationship between experience and labor markets participation as self – employed worker. Experience and stock of managerial capability which is attained on the job trainings are directly related (Note 5) Hence it is expected that there is positive correlation between self-employment and labor market experience (Note 6). According to the flow approach, labor market experience that is related with the age of worker can be contemplated as the rate at which the aggregated stock of knowledge is attained. In this respect, as worker becomes aged, his learning ability reduces because it would be tougher for the worker to have complete command over the new technology. As a result, the knowledge increases at decreasing rate. So the expected sign of experience – squared (EXP^2) is negative and indicates non-linear relationship.

3.3.3 Marital Status

In the literature of economics, it is assumed that marriage represents stability. Thus it gives an appropriate background for risky self-employment. It is observed that married couples are interested to start their own business with joint finances just to maximize family profit. Therefore, a positive relationship is expected between marital status and self-employment.

3.3.4 Household Assets

Presence of household assets influences the self-employment positively. The study incorporates all types of assets (e.g. Land holdings, Live-Stocks, Shops, Rented Homes, Personal homes, Bank deposits, Gold, Foreign currency account etc) to find out their impacts on self-employment. It is expected that presence of household's assets and self-employment are positively related.

3.3.5 Family Setup

In the light of previous studies, it is observed that family setup has mixed effect on women work participation as self-employed worker. Here, the family setup means whether a joint family system or a nuclear family system. Nuclear family system is defined as such system which includes only husband and wife with or without children while joint family system considers other members of the family such as mother, father, brothers, sisters, grand father, grand mother, uncle and aunts. The major characteristics of the joint family system is that people living in combined family having common expenditure especially kitchen.

3.3.6 Per Capita Income

Households' per Capita Income is an important economic indicator which measures the welfare and well-being of the family. Theoretically, it is expected that women are less likely to participate in the labor market being self-employed worker, as per capita income of the family is high or rising.

3.3.7 Number of Dependents

Theoretically, it is expected that number of dependents and women's self-employment is inversely related. The rationale behind this hypothesis may be that women's inside home activities may increase.

3.3.8 Husband Salaried and Number of children

From the review of the various studies regarding women's participation in the labor market, it is noted that women whose husbands are working and salaried employed and have more children are expected to be self-employed.

3.3.9 Location

Self-employment is also affected by the region of residence or location. The location is classified as rural and urban area. Therefore, it is expected that women belong to rural area are more likely to be involved in own business activities like working on farm, rearing live stock etc.

3.4. Operational Model

The operational model for estimating the women self-employment status is outlined in the following equation. In order to analyze the influence of different variables on self-employment, two specifications are chosen for estimation. The first specified model for women self-employment is given below:

$$WSE = \alpha_0 + \alpha_1 AGE + \alpha_2 EDC + \alpha_3 PCI + \alpha_4 PHA + \alpha_5 MAR + \alpha_6 HSL + \alpha_7 FSP + \alpha_8 NDT + \alpha_9 LCN + \alpha_{10} NCH + \mu_i \quad \text{..... (A)}$$

In the equation of women self-employment model, the independent variables are Age, Completed years of education, Per Capita income, Presence of household Assets, Marital Status, Husband Salaried, Family Setup, number of dependents, location and number of children.

In order to observe the influence of experience on women's self-employment, the study includes a continuous variable experience in the self-employment model. Experience is obtained by subtracting completed years of education and age of the women at the time of entry into the school from the completed age of the women. i.e. EXP = AGE – Education – 5. Further, we have introduced different levels of education as binary variables to analyze the contribution of education at each level in the women self-employment model. AGE and Completed years of education are omitted from the second equation just to remove the effect of multicollinearity.

$$WSE = \beta_0 + \beta_1 EXP + \beta_2 EXP^2 + \beta_3 PED + \beta_4 SED + \beta_5 HED + \beta_6 PCI + \beta_7 PHA + \beta_8 MAR + \beta_9 HSL + \beta_{10} FSP + \beta_{11} NDT + \beta_{12} LCN + \beta_{13} NCH + \omega_i \quad \text{.....(B)}$$

The list of the variables for Logistic estimates of the determinants of women self-employment is given in the table 2.

4. Results and Discussions

4.1 Preliminary Analysis

We have presented the preliminary analysis of data by providing the brief discussion on the profile of respondents and interpreting descriptive statistics of the some selected variables. Correlations among explanatory variables are also presented.

4.1.1 Respondents' characteristics

Overall 164 women are interviewed at random from formal as well as informal sectors. Out of which 106 or 64.63 percent women belongs to rural area and 58 or 35.37 percent women are living in urban area. Total percentage of women's participation in self – employment is 21.82 percent in the present study. Further, it is concluded that 15.79 percent self – employed women belong to urban locality while 25.0 percent self – employed women live in rural area.

4.1.2 Descriptive Statistics

Table 3 describes the basic statistics of some selected variables. The average age of self-employed women is 38.11 years with variability about mean is 13.26. On the average, self-employed women's education in completed years is 10.62 years. The average per capita income of the family is 2387.70 rupees per month. The study indicates that the number of children is 3.18 on the average. In addition, the descriptive analysis reports that 0.49 or 49 percent women have education up to primary level (5 years of education) on the average and 0.17 or 17 percent respondents (women) have education up to secondary level (10 years of education). Similarly on the average, 0.34 or 34 percent respondents have higher degree in education (M.A/ M.Sc, professional, M.Phil, Ph.D).

4.1.3 Correlation analysis

We have presented the correlations matrix of different explanatory variables in the table 4 as preliminary investigations of the relationships. This correlation matrix is used to examine the multicollinearity among the

variables. The explanatory variables, whose pair wise correlation is greater or equal to 0.83, show the existence of multicollinearity. We have dropped those variables in the remaining analysis. From the table, it is obvious that age and experience are multicollinear. So we have used age and experience in separate equations to have perfect estimation.

4.2 Multivariate Estimates

Tables 5 and 6 present the Logit estimates of the determinants of women self-employment model. Each table consists of four columns. First column in each table describes the nature of the explanatory variables while others remaining three columns discuss the estimated parameters, their asymptotic Z-statistic and marginal effects respectively in each table. The marginal effects show the change in probability of being self-employment due to unit change in a given explanatory variable after holding all other variables as constant at their mean.

The present study uses two tailed test of significance or Z-statistic for determining the acceptance or rejection of null hypothesis to examine the reliability of the point estimates. For this purpose, we have used 1 percent, 5 percent or 10 percent level of significance. The intercept terms in the both equations of self-employment turns out to be negative and statistically highly significant. This significant result indicates that women's participation being self-employment may be influenced by omitted factors from the study. The values of McFadden R^2 in both the equations are very low (i.e. 0.27 and 0.39 increases positively). Low level of R^2 is a typical phenomenon in cross sectional studies. However, the quality of our estimates should not be gauged by this low R^2. Overall performance of the self-employment model is judged by the highly significant LR-statistic.

Women's work participation being self-employed is influenced by age. We have found that probability of self-employment rises with age. The coefficient of age is positive and significant. In the second equation, we have used years of experience as a explanatory variable instead of age in years. The coefficient of experience (EXP) is positive and significant at 10 percent level of significance. The probability of women's work participation in the labor market as self-employed workers increases by 6 percentage points due to additional years of experience. The reason may be that self-employment or self-business requires more experience, courage, skill and management qualities. The negative coefficient of EXP^2 indicates the non-linearity relationship.

Education plays a pivotal role in determining the self-employment activities. We have introduced both the completed years of education and different levels of education as explanatory variables in our self-employment model. In the first equation of self-employment model, we have observed that the coefficient of completed years of education (EDC) is positive and highly significant. The probability of women's self-employment increases by 1.2 percentage points as a result of an increase of one year of education. The reason may be that self-employment activities need managerial skill, efficiency, decision making ability and risk facing activities of the worker, which are acquired through more years of education.

In the second equation of self-employment model, the coefficients of PED and SED are positive and statistically significant at one percent level of significance. The reason may be that the low educated women are inclined to start up a business because low level of education is not sufficient in securing permanent salaried jobs. Our results are in line with the findings of verheul et. al (2006). In addition, we have noted in our study that the higher education (HED) has a strong negative and significant impact on women's decision to be self-employed. The probability of women's self-employment diminishes by about 34 percentage points due to an increase of one unit in higher education. The highly educated women's prefer to be salaried employed in Government and Semi-Government sectors because salaried employment is a secured, risk less and permanent source of income. Our study also supports verheul et. al (2006)'s findings.

Households' per Capita income is another important factor which influences women's participation in the labor market as an own account worker. The women are less likely to be self-employed by 1.2 percentage points because of an increase of one rupee in monthly per capita income. The presence of household assets has positive and significant impact on self-employment. The results of the study has pointed out that married women are less likely to be self-employed. The married women's probability of being self-employed workers drops by 2.9 and 3.5 percentage points in both equations respectively. But married status has insignificant impact. The reason may be that a large number of women have started their own business like embroidery, sewing, teaching the kids or tuition centre at home, and beauty parlor both in urban and rural areas. The coefficient of the husband salaried is positive and has significant impact on women's work participation. The interpretation may be that the women whose husbands are regular salaried workers are more inclined to start their own business especially at home like sewing clothes, embroidery or even rearing few animals etc, just optimal utilization of time simultaneously both in own business activities and at home activities like preparing meals.

We have observed that family setup (FSP) positively influences self-employment. Women belonging to joint family setup are more likely to be self-employed. The study revealed that the number of dependents has strong negative impact on women's work participation being self-employed. The probability of self-employment falls by about 5 percentage points in both equations due to an addition of one dependent in the family. The significant result indicates that women responsibilities at home increased because of high dependency burden. The coefficient of

location (LCN) is negative and statistically significant. It means that rural women are more likely to be self-employed. The study has showed that the number of children raises the probability of self-employed.

5. Conclusion and Policy Recommendations

The role of women's participation in economic activities is considered a vital factor for growth and development. The women's labor market participation has become an important issue due to rising trend in women's population growth and labor force. The present study is conducted to examine the various socio-economic factors which determine why women are self-employed. The findings of the study reveal that the age and experience have positive and significant influence on women's work participation being self-employed. It is explored from the study that women's participation in self-employment activities is enhanced because of more years of education. When we consider various levels of education, the findings are very interesting. The low level of education motivates the women to start their own business but highly educated women are not inclined to be self employed. Presence of household assets, number of children and husband salaried positively and significantly influence the women's self-employment. In addition, the study concludes that Per Capita income, number of dependents and location reduce the women's work participation as self-employed worker. Our results are consistent with the previous studies as discussed in the literature.

The research has concluded that there is short of formal jobs for women in study area especially and generally in Pakistan. Lack of education at higher level and inconvenience in attaining higher education for women is main cause of women's self employment. The joint family system and larger size of family (more number of children) is another cause of women's inclination toward self – employed activities (in case of under developed countries in Pakistan). Further, study explores that high per capita income of the family reduces the women's participation in self – employment activities. But, low per capita is general phenomenon in poor countries generally and especially in Pakistan. Considering the study's conclusion, it is suggested that Government create formal jobs for women and also provide facilities in attaining higher education by establishing more educational institution especially health related and vocational training centers. There is a need to create awareness among the people to have a small size of family and independent family structure (nuclear family system).

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Notes

Note 1. This information is taken from population census report of district Bahawalpur (1999).

Note 2. In the present study, self – employment is defined as the situation in which the workers (women) have started their own business both in rural and urban areas and also engaged in self made activities like working on farm and rearing livestock in rural areas and also engaged in embroidery, sewing clothes, teaching the kids at home or tuition centers and having beauty parlor or garments and cosmetics shops.

Note 3.See Evans' (1989)

Note 4.See Kidd (1993)

Note 5. See A. T. Le (2000)

Note 6.See Lucas (1978)

Table 1. Crude Labor Force Participation Rates * by Region and Gender (in percentage)

Year	Total			Urban			Rural		
	Both	Male	Female	Both	Male	Female	Both	Male	Female
1996-97	28.7	47.0	9.0	27.2	46.6	5.9	29.4	47.2	10.5
1997-98	29.4	48.0	9.4	27.0	47.1	5.3	30.6	48.4	11.5
1999-00	29.0	47.6	9.3	27.1	46.5	6.3	29.8	48.2	10.7
2001-02	29.6	48.0	9.9	29.1	48.9	7.3	29.9	47.6	11.1
2003-04	30.4	48.7	11.2	29.2	49.8	7.0	31.0	48.2	13.2
2005-06	32.2	50.3	13.3	30.2	51.0	7.9	33.2	49.9	16.0

Source: Labor Force Surveys (various issues).

*Labor force participation is estimated on the basis of crude activity rate (CAR) and refined activities rate (RAR) in Pakistan. The CAR is the percentage of labor force in total population where as refined labor force participation is the ratio of labor force 10 years and above to the total population. The labor force participation rates in table 1 are estimated on the basis of crude activity rate

Table 2. List of the Variables used in the self-employment equations

Variables	Description of variables
Dependent variable	
WSE	=1 if woman is participating in economic activities as self-employment worker =0 otherwise
Explanatory variables	
AGE	Age of the woman (in years).
EDC	A continuous variable defined as the completed years of education.
EXP	A continuous variable defined as: Experience = Age – Education – 5
EXP^2	Square of Experience.
PED	= 1 if the woman education level is up to Primary level = 0 otherwise
SED	= 1 if the woman education level is up to Secondary level =0 otherwise
HED	=1 if the woman education level is up to Higher level =0 otherwise
PCI	A continuous variable defined as Per Capita income of the family in Pak. Rupees which is attained by dividing total monthly family income by the total number of family.
PHA	=1 if the women have assets in any form =0 otherwise
MAR	=1 if the women are married =0 otherwise
HSL	=1 if the woman's husband is salaried person =0 otherwise
FSP	=1 if females belong to joint family system =0 otherwise
NDT	Total number of dependents in the family
LCN	=1 if the women are living in urban area =0 otherwise
NCH	Total number of children in the family

Table 3. Descriptive Statistics of some selected variables

Variables	Mean	Standard Deviation	Skewness	Kurtosis
AGE	38.11	13.25	0.11	2.23
EXP	110.50	13.50	0.16	2.25
EXP2	687.2	667.24	1.14	3.62
EDC	10.62	3.82	-0.50	3.02
PED	0.49	0.50	0.02	1.00
SED	0.17	0.38	1.75	4.06
HED	0.34	0.46	0.85	1.72
PCI	2387.70	2724.29	1.79	6.25
PHA	0.54	0.50	-0.17	1.03
MAR	0.78	0.42	-1.36	2.84
HSL	0.51	0.50	-0.05	1.00
FSP	0.60	0.49	-0.42	1.18
NDP	4.70	1.95	0.27	2.25
LCN	0.35	0.48	0.51	1.38
NCH	3.18	2.14	-0.16	2.13

Table 4. Correlation among explanatory variables

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	AGE	1.00														
2	EXP	0.96	1.00													
3	EXP2	0.91	0.95	1.00												
4	EDC	0.08	-0.21	-0.21	1.00											
5	PED	-0.06	0.07	0.12	-0.46	1.00										
6	SED	0.03	-0.13	-0.16	0.58	-0.65	1.00									
7	HED	0.05	0.04	0.02	0.03	-0.45	-0.30	1.00								
8	PCI	0.17	0.19	0.18	-0.08	0.05	-0.11	0.03	1.00							
9	PHA	-0.11	-0.09	-0.08	-0.05	0.10	-0.22	0.12	0.37	1.00						
10	MAR	0.60	0.57	0.46	0.05	-0.07	0.00	0.04	0.47	0.05	1.00					
11	HSL	0.25	0.23	0.13	0.04	-0.13	-0.02	0.15	0.57	0.35	0.54	1.00				
12	FSP	-0.32	-0.33	-0.29	0.04	-0.05	0.02	0.07	-0.52	-0.14	-0.43	-0.34	1.00			
13	NDT	0.36	0.33	0.28	0.10	-0.07	0.03	0.07	-0.34	-0.20	0.35	0.04	0.25	1.00		
14	LCN	-0.12	-0.15	-0.19	0.12	-0.02	0.06	0.00	-0.11	-0.06	-0.01	0.06	-0.05	0.00	1.00	
15	NCH	0.60	0.57	0.47	0.08	-0.05	0.02	0.04	0.05	-0.05	0.79	0.35	-0.31	0.67	0.02	1.00

Table 5. Logistic Regression Estimates

Variables	Coefficients	Z-statistic	Marginal Effects
C	-3.55***	-2.48	---
AGE	0.031*	1.78	0.00039
EDC	0.098**	1.95	0.012
PCI	-0.084*	-1.84	-0.011
PHA	0.667***	2.86	0.083
MAR	-0.234	-1.05	-0.029
HSL	1.10*	1.75	0.137
FSP	0.249	1.30	0.031
NDT	-0.366*	-1.69	-0.046
LCN	-1.013*	-1.71	-0.127
NCH	0.443**	1.93	0.055
Log Likelihood	-52.57247	Sample Size	164
LR-Statistic (10 df)	38.40478	McFadden R^2	0.267
Probability (LR)	0.0003		

*** Significant at 1% level of significance ** Significant at 5% level of significance * Significant at 10% level of significance

Table 6. Logistic Regression Estimates

Variables	Coefficients	Z-statistic	Marginal Effects
C	-4.66***	-2.91	---
EXP	0.48*	1.68	0.06
EXP^2	-0.008	-1.03	-0.00009
PED	3.15***	2.71	0.394
SED	3.08***	3.10	0.385
HED	-2.71**	-2.12	-0.339
PCI	-0.095**	-2.20	-0.012
PHA	0.265***	2.36	0.033
MAR	-0.283	1.27	-0.035
HSL	1.05*	1.69	0.131
FSP	0.521	0.98	0.065
NDT	-0.404*	-1.76	-0.051
LCN	-1.18*	-1.82	-0.147
NCH	0.528*	1.81	0.066
Log Likelihood	-39.23781	Sample Size	164
LR-Statistic (13 df)	58.42158	McFadden R^2	0.387
Probability (LR)	0.000002		

*** Significant at 1% level of significance ** Significant at 5% level of significance * Significant at 10% level of significance
Non formal education is considered as base category

Assessing the Elasticities of Electricity Consumption for Rural and Urban Areas in Malaysia: A Non-linear Approach

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Abstract

This paper investigates and estimates the price and income elasticity of electricity consumption and then compares the level of sensitivity of demand for electricity in the rural and urban areas in Malaysia. The non linear model was employed to estimate the elasticity of electricity consumption. The electricity demand has been estimated as a function of tariff, real GDP, gas price and population in the rural and urban population. The gas price has been used as a proxy to measure the level of sensitivity goods by using the annual data covering the 1980-2009 period. The results showed that the income elasticity (E_y) was less than unity which indicated electricity as a necessity good to the people in Malaysia. The reaction of electricity consumption was found to be greater in the urban area compared to the rural area. The higher sensitivity of electricity consumption in the urban population was due to higher exposure to electricity appliances and facilities.

Keywords: Elasticities, Electricity consumption, Rural and urban, Unit root test, Co-integration.

1. Introduction:

Since the past three decades, the topic of elasticities has been researched by many researchers (such as Huang, 1993; Hondroyiannis, 2004; Holtedahl, 2004; Bose, 1999; Filippini, 2007; Narayan, 2007). However, the focus of their studies is not similar in term of the location (countries) of the studies, time period and the proxy they employed for endogenous variables. For the above reasons, the outcomes of these studies are predicted to be different especially for a country with different economic background.

The term "elasticities" is most commonly referred to sensitivity or responsiveness. Generally, it was used to quantify the response in one variable when another variable changes (Case and Fair, 2009; Perloff, 2009). Specifically, these elasticities were divided into three sub-criteria namely; price elasticity(E_p), cross elasticity (E_c) and income elasticity(E_y). The price elasticity (E_p) refers to percentage change in one variable, due to the changes in its own price. The cross elasticity (E_c) refers to percentage change in one variable due to the changes in the price of substitute product. Finally, the income elasticity refers to percentage change in one variable due to the change in income (GDP). These elasticities estimates have particular relevance for designing pricing policies (Bose and Shukla, 1999). The effects of any price revisions on consumption will depend on the price elasticity (Filippini, et al, 2004). On the other hand, the information regarding income elasticity is also important especially in the case of a rapidly developing country where one can expect to see large increases in income of households in the next decades (Filippini, et. al, 2004).

The termination of electricity rebate (for consumers having a bill of RM20 and less) on December 31, 2009 serves as a "wake up call" to a researcher to estimate how the electricity consumption changes in response to the changes in electricity tariff. Does the change in electricity tariff give a big impact on the quantity of electricity usage (elastic) or does it give any impact at all (inelastic)? Or is there any variable that could give a greater impact to the quantity of electricity consumption? By knowing how sensitive or responsive electricity consumption is to the electricity tariff changes, we can predict a suitable tariff to be imposed on particular consumers in Malaysia and to suggest a suitable strategy to the policy makers in order to increase the revenues.

In view of the above, an attempt has been made in this paper to estimate the elasticity of electricity consumption in Malaysia and then to compare the level of sensitivity of electricity consumption towards the changes in urban and rural population. This study was focused in these areas to compare their consumption elasticity as it was assumed that electricity consumption in rural and urban area is totally different in terms of the level of exposure to electricity appliances, the distances from power station, population densities, poverty levels and skill availability (Haanyika, 2008). At the same time, this interest is mainly due to the fact that electricity consumption elasticities of population in rural and urban areas are important for assessing the proposal to revise electricity rates and for predicting the

needs for electricity consumption in future period. An accurate estimation enables the policy makers to promote the efficient use of electricity (Narayan, et al., 2007) and increases the welfare of society.

In order to accomplish the above objectives, we apply the non linear model to estimate the elasticity of electricity consumption. The electricity consumption was a function of electricity tariff, gas price, GDP, urban and rural population. The rest of the paper is structured as follows: Section 2 presents the background of electricity sector in Malaysia. Section 3 discusses literature review. Section 4 defines the data and variables. Section 5 discusses the methodology. Section 6 analyzes the results. Section 7 discusses the policy implication and finally section 8 includes some conclusion and suggestion for further study.

2. Overview of electricity sector in Malaysia:

Since the past three decades, the role of electricity sectors is characterized as a vital concern in accelerating Malaysia economics namely as a growth and income redistribution instrument. In the Eight Malaysia Plan, a total of RM463.6 million was spent for the implementation of the rural electrification program, which benefited an additional 101,530 rural households in Malaysia. Of this amount, 30% benefited the rural household in Sabah, 50% benefited rural household in Sarawak and the remainder benefited rural household in Peninsular Malaysia. The increase in rural electricity coverage might accelerate the economic development in the rural area and create more job opportunities to the respective communities. Moreover, this development will raise the standard of living in the rural and urban areas and alleviate poverty. Also, the Ninth Malaysia Plan carried the government mission to reduce the disparity of income levels especially between rural and urban areas as well as between rich and poor people. In finalizing the Malaysia 10th plan, the government still emphasizes on eliminating unequal socioeconomics by reducing poverty. Other strategy that links with the previous mission is by imposing a rebate to the consumers having a bill of RM20 and less. By imposing rebate, the respective communities are able to increase their disposable income and allocate more of their income for other purposes such as education and health or it may even increase their standard of living.

Other than income redistribution instrument, electricity sector could also be seen as a growth instrument. Several studies found a positive connection between electricity consumption and economic growth (Yoo, 2006; Tang, 2008; and Chandran, 2010). These studies found that there is a causal flow from electricity consumption to economic growth. Figure 1 shows the growth rate of the electricity consumption and GDP in Malaysia. The total electricity consumption recorded a growth rate of 9.2% for the period of 1980-2009. There was kWh 9.363 billion of consumption in 1980, increasing to kWh 22.35 billion in 1990, and in 2008 the electricity consumption continuously increased to kWh 102.657 billion. On the other hand, the GDP was recorded at RM100.29 million in 1980, an increase by 6.2% per year for the 1980-2008 period. The main reason for the growth of electricity demand was the development of transport sectors such as the railway system, particularly the light rail transit in Klang Valley and inter-city commuter train service and tremendous development of Information Communication Technology (ICT) (National Energy Balance, 2007).

The strong growth in manufacturing activity, supported by increases in export and strong domestic demand, higher tourism activity and the opening of new retail outlet also contributed to growth in electricity consumption (National Energy Balance, 2007). Electricity consumption in Malaysia stands as the second highest among ASEAN members (Tang, 2008). From our visual observation, we found that the electricity consumption and population in rural and urban areas were moving upward over the period of 1980-2009. The growth rate of the total population was reported at 2.5%. [See figure 2]

In order to meet the demands of electricity from various sectors, the government invested huge amounts of money in a mega project such as Bakun Hydroelectric Project. The government invested RM41.1 billion in electricity supply industry (8th Malaysia Plan) and this investment was demand-driven with more than one half of it accounted for generation activity [see figure 1]. In order to secure and strengthen the grid system, a total of RM17.6 billion was spent on upgrading and constructing transmission lines as well as improving the distribution network (8th Malaysia Plan).

3. Past literature review:

Several studies have been conducted to address various aspects of electricity consumption and factors influencing it. Most of the studies show the existence of relationship between electricity consumption and electricity price (tariff), GDP and population of countries. Al-Ghandoor et al., (2009) studied the fuel and electricity consumption in Jordan. They found that population income and fuel price are the significant factors of electricity consumption and population is a significant factor of fuel consumption. Bianco et al., (2009) investigate and forecast the long run consumption in Italy. They observed that the electricity consumption responds to GDP and GDP per capita changes. Also, the increase in the total electricity consumption is driven by both domestic and non domestic consumptions. Pao (2004) analyzed and forecast Taiwan's electricity consumption by using linear and non linear model. He found that population and national income affect Taiwan's electricity consumption the most, followed by CPI and GDP. The results also showed that non linear model is more appropriate to be applied in Taiwan.

The overall findings show that the factors affecting electricity consumption may vary from one region to another. The predictor for one region may not be appropriate for another region. Therefore, a different model should be developed in different regions for efficient planning.

Besides studies on factors influencing electricity consumption, the analysis on price and income elasticity of electricity consumption is also a vital concern in the past decade. Previous studies (Hondroyiannis, 2004; Holtedahl, 2004; Bose, 1999; Filippini, 2007; Narayan, 2007) analyzed the roles of elasticities of demand for electricity. The elasticity of electricity consumption makes up for the general impact of electricity price change (or other factors) on electricity consumption (Bose et al., 1999). It measures the percentage change in electricity consumption resulting from the percentage change in factor influencing demand [GDP (income), price of electricity (tariff) and price of substitute or complementary goods]. The previous researches show that the oil, LPG, kerosene is substitute to electricity. These elasticities estimate have been used by numerous researchers around the world to understand demand behavior and also to undertake other activities like forecasting, demand management and policy analysis (Bose, et al., 1999). These analyses are significantly relevant for designing pricing policies of economies.

Huang (1993) examined the electricity–economic growth nexus for China for the 1950–1980 period. He did not test for any causal relationships, but rather examined the correlation among the variables, and found income elasticity of electricity consumption to be greater than unity. A similar study was conducted by Holtedahl and Joutz (2004) for case of Taiwan for the 1955–1996 period. They found the income elasticity of electricity demand to be unity in the long run, while the relative price of electricity (to petroleum products) elasticity was inelastic. Hondroyiannis (2004) examined the demand for residential electricity for Greece for the 1960–1998 period. He found the income elasticity to be greater than unity, while the price response was inelastic in the long run.

Yamaguchi (2007) made a comparison between the periods of 1986-1993 and 1993-2004, and found that income elasticities increased from 1.076 to 1.679. It showed that the level of sensitivity towards income was increased after 1993, and the price elasticities were below unity before and after 1993. Zachariadis (2007) used annual data for the 1960-2004 period to examine electricity consumption in the residential and service sectors. However, the results showed that long run elasticities of electricity consumption were greater than unity for income and was measured at -0.3 to -0.4 for prices. There were some researchers who found that income elasticity is greater than unity which means that the electricity consumptions in their researched countries were not sensitive to the change in income (Huang, 1993; Holtedahl, 2004; Hondroyiannis, 2004; Yamaguchi, 2007; and Zachariadis, 2007). Meanwhile other group of researchers found that income elasticity was less than unity (See table 1).

Silk and Joutz (1997) examined the short run and long run elasticities in the US residential electricity demand for the 1949-1993 period. They found that in the long run, income and price elasticities were equal to 0.5 and the price elasticities were in the opposite direction. Meanwhile in the short run, the income elasticity was one half of the long run elasticities. The change in electricity consumption due to a change in oil price is equal to 0.059. It shows that the electricity consumption is not sensitive to the change in its own price, income, as well as price of substitute. Halicioglo (2007) studied the elasticity of electricity demand in Turkey for the 1968-2005 period and found that the income and price elasticity in the long run are greater than income and price elasticity in the short run. It showed that the level of sensitivity has increased in the long run due to population's ability to respond to the policy changes and the changes can be seen in the long run. Generally, it was in line with the theory of elasticity where the short run elasticities are expected to be lower than the long run elasticities.

Kamerschen (2004) studied the demand for residential, industrial and total electricity for the 1973-1998 period in the US, and he estimated that residential price elasticity is between -0.85 to -0.94, whereas the industrial estimates range between -0.34 to -0.55. These results showed that demand from residential sector is more sensitive compared to demand from industrial sector. Wasantha (2009) investigated the short run and long run relationship between electricity consumption and factor influencing demand in Sri Langka for the 1960-2007 period. The long run demand elasticities of income, own price and price of substitute (kerosene oil) were estimated to be 0.78, -0.62 and 0.14 respectively. The short run elasticities for the same variables were estimated to be 0.32, -0.16 and 0.10 respectively. The results show that increase of income in the long run is likely to significantly increase the demand for electricity while the increase in price of electricity does not effectively reduce electricity consumption.

Lijesen (2007) also examined the price elasticities in the Netherland. Unfortunately, he found that the price elasticity was equal to -0.0043 which is very low compared to the long run and short run price elasticities conducted by other researchers. Nesbakken (1999) studied the price sensitivity of residential energy consumption by using cross section data from the Norwegian consumer expenditure survey for the 1993 – 1995 period. In Norway, 70% of energy consumption is electricity use. The results show that the energy price sensitivity in residential energy consumption varies from year to year but it is higher for the higher income households than for low income households. In the short run, the income elasticity was 0.01 and 0.15 – 0.28 in the long run. In table 1, we are summarizing the empirical findings of the elasticities for a number of countries around the globe.

Although several studies on elasticity have been conducted in China, Taiwan, US, etc, the findings were not consistent from one country to another. For this reason, there is a real need to understand the elasticities of electricity consumption in Malaysia. In this paper, we attempt to study the elasticities of electricity consumption in Malaysia by exploring the behavior of consumer in urban and rural areas.

4. Research data and variables:

Annual time series data for the 1980-2009 period were utilized in this study. The annual data of electricity consumption (EC) was collected from Energy Information Administration-EIA (www.eia.doe.gov) and Malaysia Energy Centre (MEC). The electricity consumption was measured in billion kilowatts. The annual data for population (Pop) was collected from Department of Statistics Malaysia (DSOM) and were categorized in terms of population in the rural (R) and urban (U) areas, while the data for GDP (Y) were collected from International Monetary Fund (IMF) after they are compared with DSOM. The data of real GDP was from year 2000 and was used as the base year and it was measured in national currency (RM). It was used as a proxy of income.

Data on gas price (Pg) and electricity tariff (Pe) were also collected from DSOM. Since the actual price of electricity and gas were unavailable (same reported by Chandran, et.al, 2010), we used the price index (base year: 2005) as a proxy. There are a number of studies that have used index as a proxy such as Asafu-Adjaye (2000), Masih and Masih (1998) and Hondroyiannis (2002).

The original data are transformed into natural logarithms, which have economics meaning and they are approximated to view growth rate and elasticities. So, the variables $EC, Pe, Pg,\ Y, R$ and U, were transformed to lec, $lpe, lpg, ly, lr\ and\ lu$ respectively.

5. Methodology:

The electricity consumption (EC) can be expressed in general as a function of GDP, electricity tariff, gas price and population in the rural and urban areas. The electricity consumption is the dependent variable and the rest are the independent variables which are expected to influence the level of electricity consumption. The function of electricity consumption can be expressed in Equation [1].

$$EC_t = f(Y_t, Pe_t, Pg_t, R_t, U_t) \quad [1]$$

where $EC, Y, Pe, Pg, R\ and\ U$ represent electricity consumption, GDP, electricity price (tariff), gas price, population in rural areas and population in urban areas respectively. We can represent this function in a mathematical model as shown in Equation [2].

$$EC_t = Y_t^{\beta 1}\ Pe_t^{-\beta 2}\ Pg_t^{\beta 3}\ R_t^{\beta 4}\ U_t^{\beta 5} \quad [2]$$

To apply this model, we transformed it to be linear as shown in Equation [3].

$$lec_t = \beta_0 + \beta_1 ly_t - \beta_2 lpe_t + \beta_3 lpg_t + \beta_4 lu_t + \beta_5 lr_t + \ e_t \quad [3]$$

where, β_0 is a constant coefficient and $\beta_1, \beta_2, \beta_3, \beta_4\ and\ \beta_5$ are the coefficients estimate. The coefficient β_1 represents income elasticity, $-\beta_2$ represents price elasticity, β_3 represents cross elasticity and β_4 and β_5 represents population growth in the rural and urban areas respectively. The Equation [3] provides the information on long run elasticities.

Economics theory suggests that electricity consumption will have an inverse relationship with the price or tariff. Also, there is a direct relationship between electricity consumption and price of substitute product. This relationship can be expressed through the positive and negative coefficient of β_1 and β_2. In this paper we employed gas price as a substitute to electricity.

Analyzing elasticities will involve the process of examining the stationarity of the time series and verifying the order of co-integration by using the Engle-Granger test. In order to conduct the Engle-Granger test, the series of variables is required to be stationary. This is done by testing for unit root test by using ADF and P.P tests at level $I(0)$. If we failed to reject the null hypothesis $[H_0: Y_t \sim I(0)]$, we have to proceed with stationarity test at first difference $I(1)$. If once again we failed to reject null hypothesis $[H_0: Y_t \sim I(1)]$, we will proceed to test stationarity at second difference. Usually, the macroeconomics data will achieve stationarity at first or second difference. So, the function of stationarity is to avoid spurious regression results.

The co-integration can be captured by analyzing the stationarity of the residual which is estimated by OLS method. If the residual is stationary, this indicates that there is long run equilibrium among variables (Vogelvang, 2005) and all the variables are accepted by macroeconomics theory to analyze the elasticity of electricity consumption. If the variables are not co-integrated at level [failed to reject null hypothesis $H_0: e_t \sim I(1)$] we must test for co integration at first and then second difference until they are co integrated. The decision whether to reject or not is depended on the value of ADF statistic for residual. If this value is smaller than the critical value of ADF value (Vogelvang, 2005), we have to reject the null hypothesis which means that there is no co-integration. This procedure is crucial because the elasticities are valid only if the variables have the same order of integration. ADF or P.P tests for co-integration will be used to investigate the degree of integration.

If the variables are co-integrated $[(e_t \sim I(1)]$, we will estimate the short run elasticities by using the Vector Error Correction model (VECM). The VECM will be estimated according to step 2 in Engle and Granger (1987) as shown in Equation [4].

$$\Delta lec_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta lec_{t-1} + \sum_{i=1}^{p} \propto_2 \Delta lPe_{t-1} + \sum_{i=1}^{p} \propto_3 \Delta lPg_{t-1} + \sum_{i=1}^{p} \propto_4 \Delta lY_{t-1} + \sum_{i=1}^{p} \propto_5 \Delta lu_{t-1} + \sum_{i=1}^{p} \propto_6 \Delta lr_{t-1} + \propto_7 ect_{t-1} + \varepsilon_t \quad [4]$$

In equation [4], the lagged residual variable ect_{t-1} stems from the long run Equation [3], which is the error correction term in equation [4]. $\propto_1, \propto_2, \ldots\ldots \propto_6$ are the coefficients to indicate the short run elasticities and Δ denotes a difference operator. The $\propto_7$ can be interpreted as the speed of adjustment (Bekhet & Nora, 2009). It shows the adjustment of dependent variables (in this case, electricity consumption is the dependent variable) in order to achieve long run equilibrium.

6. Result analysis:

We use time series model to estimate the electricity consumption elasticity in Malaysia. The analysis involves three steps: First, we have to make sure that all variables followed normal distribution, then all variables must be stationary and finally variables ought to be integrated at the same level (co-integration). Based on the normality analysis, it was found that all variables were nearly following the normal distribution.

6.1 Stationarity

The properties of time series data for the 1980-2009 period were analyzed by using ADF and PP tests. A summary of these tests statistics are presented in Table 2. It is crucial to be sure that the time series variables are stationary before analyzed regression analysis to avoid spurious regression result (Studenmund, 2006). In this test, we include intercept because it was more appropriate with economic practice (Vogelvang, 2005). Based on the analysis, we found that all variables are not stationary at level I(0). In order to make them stationary, they were differenced once, and the results showed that electricity consumption, GDP, electricity tariff and gas price are stationary at the first level difference I(1) and significant at 5% and 10% level. For the remainder variables (rural and urban population), they are stationary at second difference at 5% and 10% significance level. These results are consistent with the notion that most of the macroeconomics variables are non-stationary at level I(0), but they will become stationary after the first or second difference (Nelson & Plosser, 1982; Tang, 2008).

6.2 Co-integration

To examine the properties of the regression residual, first of all we estimated the coefficient of the variables above by applying the OLS method and make the residual term. Then, we analyzed the unit root test for residual by using ADF test. This two-step procedure is called the Engle-Granger Augmented Dickey-Fuller test for co-integration or EG-ADF test (Stock & Watson, 2007). Engle and Granger (1987) have shown that if a long run equilibrium exists among series or variables, a linear combination of the non stationary can be stationary in which they are co-integrated (Ho & Sin, 2007). The result showed that the value of ADF statistic is smaller than ADF critical value at 10% significant level (-4.2982 < -4.14). These results indicated that all variables are co-integrated as shown in equation [5]. Furthermore, the results show that there is a long run equilibrium relationship between the variables above. This indicated that all the variables are accepted by macroeconomics theory to analyze the elasticity of electricity consumption. Since all variables are co-integrated, the elasticities can be explained by computing the coefficients of the Equation [5]. These coefficients will be discussed at the next section.

6.3 Short run and long run elasticities

The coefficients in Equation [5] denoted the long run elasticities. The results show that income elasticity for electricity (E_y) is less than unity and consistent with the study by Tang (2009) and Chandran et. al. (2010). These results indicate that electricity consumption is not responsive to the change in income due to the role of electricity as a necessity good to the community. The growth of electricity consumption due to the growth in urban population was found to be greater than unity while the growth of electricity consumption due to the growth in rural population was found to be less than unity. These results indicated that electricity consumption is sensitive to the changes of urban population. These results are consistent with Tang (2009), where he found that electricity consumption was sensitive to the changes in population (but he did not split the population into urban and rural population). However, the reaction towards the changes in rural population was found to be less than unity and was not significant. The greater response from urban population was due to higher exposure to electricity appliances, commuter, habit and other facilities compared to people in the rural area. The result of the price elasticity was found to be insignificant and consistent with earlier result obtained by Chandran (2010). Since the cross elasticity by using gas index as a proxy (from the best of our knowledge) is the first time study in Malaysia, we cannot make a comparison with the previous study and it is also found to be insignificant.

$lec_t =$	-15.17	$+0.84lY_t$	$+0.59lPe_t$	$-0.11lPg_t$	$+0.20lR_t$	$+1.08lU_t$	[5]
		(0.0001)	(0.3834)	(0.3376)	(0.4631)	(0.0006)	
	t =	4.5948	0.8880	-0.9786	0.7456	3.9358	
	$R^2 =$	0.998	$DW = 1.54$	$F\ test = 33805.51$		(0.0000)	

Since there is an evidence of co-integration [$(e_t \sim I(1)$], the short run elasticities is performed using the VECM. The results are presented in Equation [6]. The results showed the existence of long run relationship between electricity consumption and all exogenous variables [See Equation 6]. In addition, we can see that the coefficient for 'ect' is -0.66 and is statistically significant at 5%. In other words, the electricity consumption system had corrected its previous period's disequilibrium for the long term. However, if the changes of electricity consumption were driven directly by this long run equilibrium error, then it was responding to this feedback by 66% of speed adjustment.

However the short run elasticities (E_p, E_y and E_c) were found to be insignificant because the t-statistic for each variable is greater than 10% critical value. For the income elasticity, the result was consistent with Chandran (2010).

In order to reduce the number of insignificant endogenous variables, we tried to take off the variables with the highest insignificant level and kept the variables with higher significant level. The results were presented in Equation [7]. It showed that the short run income elasticity was equal to 0.41 and it was significant at 10% level. This result was consistent with the study by Tang (2009) but not consistent with Bekhet & Nora (2009). The inconsistency was due to different types of energy used as a dependent variable. In this study, we concentrated on electricity while Bekhet & Nora, (2009) took energy in general.

$$\Delta lec_t = \underset{\substack{(0.1000)\\ t=\ (1.7245)}}{-0.01} \underset{\substack{(0.2755)\\ (-1.1210)}}{+0.31\Delta lEC_{t-1}} \underset{\substack{(0.6624)\\ (-0.4432)}}{-0.42\Delta lPe_{t-1}} \underset{\substack{(0.2969)\\ (1.0710)}}{-0.07\Delta lPg_{t-1}} \underset{\substack{(0.5690)\\ (0.5791)}}{+0.25\Delta lY_{t-1}} \underset{\substack{(0.2709)\\ (1.1323)}}{+0.62lR_{t-1}} \underset{\substack{(0.0105)\\ (-2.8245)}}{+1.47lU_{t-1}} -0.66ect_{t-1}$$

$R^2 =$ 0.64 DW=2.09 F- test=5.06 (0.0020) [6]

$$\Delta lnEC_t = \underset{\substack{(0.7219)\\ t=\ (0.3603)}}{0.01} \underset{\substack{(0.0973)\\ (1.7284)}}{+0.41\Delta ly_{t-1}} \underset{\substack{(0.1301)\\ (1.5699)}}{+1.08\Delta lu_{t-1}} \underset{\substack{(0.3096)\\ (1.0389)}}{+0.19\Delta lec_{t-1}} \underset{\substack{(0.0340)\\ (-2.2539)}}{-0.48ect_{t-1}} \quad [7]$$

$R^2 =$ 0.4979 DW=2.0111 F test=5.7 (0.0024)

7. Policy implication:

This paper provides the results of electricity consumption elasticities in rural and urban areas. The non linear model was used to determine the responsiveness of electricity consumption to its own price (tariff), GDP and price of substitute product. This study employed the gas price index as a proxy of substitute product. The results showed that the coefficient of E_y was found to be less than unity. This indicated that electricity consumption does not drastically reflect the changes in income and proves that electricity is a necessity to the people in Malaysia. They are willing to pay no matter at what cost. In other words electricity has been identified as something they cannot live without. This means that everyday activities need electricity to make things done well. This result is consistent with the results found by other studies (Filipini and Pachauri, 2004; Chandran, 2010; and Tang, 2008).

As a consequence, the strategy to increase or decrease the tariff would not reflect the changes in electricity consumption. In other words, if the policy makers want to aim for energy saving or reduction of electricity consumption, tariff is not an effective tool. But the strategy to increase tariff may put people into depression due to the reduction in their purchasing power. One the other hand, such policy may increase crime and corruption in community. At the same time it would resist Malaysia's objective to move to higher income based economy (BERNAMA, 2009).

On the other hand, government can manipulate this situation in order to increase government revenue. Economics theory showed that the revenue can be increased by increasing the price of goods with inelastic demand. With this strategy government can take advantage from community insensitivity. There would be a conflict between gaining higher revenue and to sustain healthy community development in a country. Also, there would be an opportunity cost between one to another. So at this point, we cannot determine which one is better than other. This study only serves us with an idea about consumer sensitivity towards tariff, income and price of substitute goods. We have to employ other techniques as a complimentary to this study in drafting an effective pricing strategy.

8. Conclusion and suggestion for further study:

In this study, we econometrically estimate the electricity consumption elasticities. These elasticities were divided into three sub-criteria namely; electricity price elasticity, cross elasticity and income elasticity. The electricity demand function has been estimated for tariff, GDP per capita, population and gas price. The gas price has been used as a proxy to measure the level of sensitivity goods by using the annual data covering the 1980-2009 period. Income elasticity was found to be less than unity which means people are not sensitive to income change. This result was consistent with Tang (2009) and Chandran (2010). This indicates the role of electricity as a necessity good to the Malaysians. The result for population growth showed that electricity consumption is sensitive to the changes of urban population but not rural population. The results for changes of electricity consumption by the growth of rural population and price elasticity were found to be insignificant. However if we use data in a longer period of time, the results could slightly change and this becomes our study limitation.

This paper provides an idea regarding consumer behavior towards electricity consumption by estimating their reaction or responsiveness to the changes in tariff, income and price of substitute goods. In the Malaysian scenario, we found that electricity consumption is not responsive to the income change. However, this information cannot be categorized as a final source in determining a new pricing strategy. This paper should be extended by exploring the factor driven to higher electricity consumption (such as number of electricity appliances, climatic condition and foreign direct investment as suggested by other researchers) and causal relationship between electricity with other

macroeconomics variables. With the extended analysis, we believe that it would provide more evidence support to the policy makers in drafting a suitable energy policy in Malaysia's economy.

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Table 1. Estimates of the price and income elasticity of electricity consumption.

Country	Empirical work	Type of model	Type of data	Elasticities	
				Long Term	Short term
Greece	Hondroyiannis, G (2004)	Double log model	1986 - 1999	$E_Y > unity$ (1.56) $E_p < unity$ (-0.41)	$E_Y = inelastic$
Taiwan	Holtedahl, P et al (2004)	Household production theory	1955 – 1996	$E_y = unity$ $E_c < unity$ (to petroleum product)	$E_p < unity$ (inelastic)
India	Bose, R.K et al (1999)	Double log model	1985/6 – 1993/4 (pooling data)	$E_y > unity$ (for commercial and large industrial sectors) $E_y < unity$ (for residential and SMI)	$E_p > unity\ (-1.35)$ (for agriculture sectors) $E_p > unity$ (for residential, large industries, commercial and SMI)
India	Filipini, M et al (2007)	Double log model	1993/1994 cross section data		$E_p < unity$ $E_y < unity$ $E_c < 0$ (to LPG)
G7(Canada, France, Germany, Italy, Japan, UK and US)	Narayan, P.K et al (2007)	Multivariate Regression	1978 - 2003	$E_p > unity$ $E_y < unity$ $E_c > unity$ (to natural gas)	
China	Huang (1993)		1950 - 1980	$E_y > unity$	
USA	Silk and Joutz (1997)	Econometric and ECM	1949 - 1993	$E_y = 0.5$ $E_p = 0.5$	$E_y = 0.25$ $E_c = 0.059$ (to a change in oil price)
Japan	Yamaguachi (2007)	Co-integration model	1986 – 2004 (structural changed in 1993)	$E_y > unity$	
Turkey	Halicioglo (2007)	Semi log model	1968 - 2005	$E_y(in\ long\ term) > E_y\ (in\ short\ term)$ $E_p(in\ long\ term) > E_p\ (in\ short\ term)$	
Cyprus	Zachariadis, T et. Al (2007)	VECM	1960 - 2004	$E_y > unity$ $E_p < unity$	
USA	Kamerschen et al (2004)	Flow adjustment model	1973 - 1998	$E_p = -0.85\ to - 0.94$ (residential sectors) $E_p = -0.34\ to - 0.55$ (industrial sectors)	
Sri Langka	Wasantha et al (2009)	ECM	1960 - 2007	$E_y < unity\ (0.78)$ $E_p < unity$(-0.62) $E_c < unity$(0.14) (to kerosene oil)	$E_y = 0.32$ $E_p = -0.16$ $E_c = 0.10$ (to kerosene oil)
Netherland	Lijesen (2007)	Log linear method	2003 (electricity demand on hour and hour basis)		$E_p = -0.0043$
Norway	Nesbakken (1999)	Econometrics model	1993 - 1995 Cross section data	$E_y = 0.15\ to\ 0.28$	$E_y = 0.01$
Malaysia	Chandran (2010)	Energy demand function	1971 – 2003 (ARDL)	$E_y = 0.15\ to\ 0.28$	
Italy	Bianco et al (2009)	Linear log model	1970 - 2007	$E_p = -0.09\ to - 0.24$	$E_p = -0.06$

$* Note: E_p = price\ elasticity\ ;\ E_y = income\ elasticity\ and\ E_c = cross\ elasticity$ $* LPG = liquid\ petroleum\ gas$

$* SMI = Small\ Medium\ Industries$

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Table 2. The results of the unit root test.

Variables	At First difference		At second difference	
	ADF	PP	ADF	PP
$lnEC_t$	$-4.1827^{*\,**}$	$-4.1909^{*\,**}$	$-5.9621^{*\,**}$	$-15.5750^{*\,**}$
lnY_t	$-3.6030^{*\,**}$	$-3.6315^{*\,**}$	$-5.9110^{*\,**}$	$-10.9631^{*\,**}$
$lnPe_t$	$-8.4860^{*\,**}$	$-8.7389^{*\,**}$	$-7.7940^{*\,**}$	$-22.0757^{*\,**}$
$lnPg_t$	$-5.6482^{*\,**}$	$-5.5166^{*\,**}$	$-6.8952^{*\,**}$	$-13.4046^{*\,**}$
lnR_t	-1.6173	-1.6817	$-4.8041^{*\,**}$	$-4.8041^{*\,**}$
lnU_t	-1.4844	-1.5719	$-4.7916^{*\,**}$	$-4.7916^{*\,**}$

Notes: * and ** *represent the rejection of the null hypothesis of nonstationarity at* 5% *and* 10% *level of significance, respectively.*

Source: Output EViews 6.0.

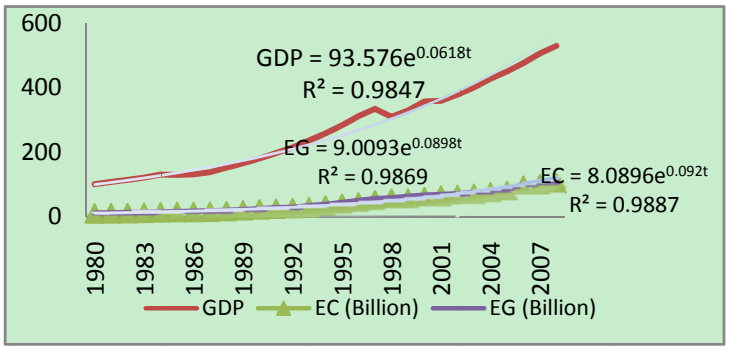

Figure 1. Electricity consumption, electricity generation and GDP of Malaysia (1980-2009)

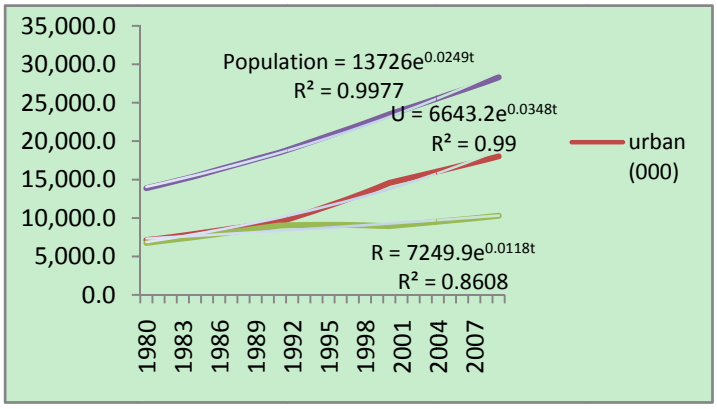

Figure 2. Population of Malaysia

Stock-Options and the Performance of CAC40 Listed Companies

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Abstract

This paper analyses two main issues: the determinants of the top-executives compensation of the CAC40s' listed firms and the impact of the equity-based compensation on the firm market and accounting performance. Our results show that stock-options grant for CAC40s' top-executives are uncorrelated with its determinants and have no impact on the firm performance over the period of analysis. These results support the theoretical approach of the managerial power and entrenchment.

Keywords: Stock-options, Executive compensation, Incentives, Firm performance

JEL Classification: J33, M52.

1. Introduction

The relationship between firm performance and executive pay has been one of the widely studied issues in the executive compensation literature (Note 1).

A substantial theoretical literature develops optimal executive compensation contracts that link pay to firm performance variations as a mean of aligning the incentives of managers (the agents) with the interests of shareholders (the principals). From an empirical view, prior research used a wide variety of methodologies. It provides mixed evidence on the relation between equity-based compensation and firm performance.

The stated objectives of almost company stock-options plans are to help the company attract, retain and motivate its executives and other employees. Options help companies attract executives who are higher skilled and relatively less risk-adverse. Options provide retention incentives through a combination of vesting provisions and long option terms. Also, options motivate executives by providing a direct link between company performance and executive wealth, thereby providing incentives for executives to take actions that increase share prices and avoid actions that decrease share prices. Finally, in addition to these stated objectives, conveying compensation in the form of stock-options rather than cash allows companies to conserve cash while reducing reported accounting expense (Note 2) and allows recipients to defer taxable income until exercise or even later.

Our paper presents empirical evidence on the relationship between executive compensation and firm performance of the CAC40 (Note 3) listed companies. It is exploratory that executive compensation is ultimately part of a simultaneous system that determines the corporation's value and the allocation of that value among various claimants. Our main results show that the compensation of the French top-executives is not correlated with its economic and financial determinants such as firm performance and firm size. We also find that executives' equity-based pay has no impact on their companies market and accounting performance.

The remaining of the paper is organized as follows. Section 2 of the paper presents a theoretical and empirical literature review about executive compensation and firm performance. Section 3 develops the hypothesis and the empirical methodology used in this paper. In section 4, we describe the data used in this paper and discuss endogenous and exogenous variables of the model. The empirical results and their interpretation are presented in section 5 while section 6 summarizes the key findings.

2. Literature review

Empirical studies on stock options can be divided into two broad categories. The first one focuses on the impact of stock options on financial and investment decisions. The second deals with the relationship between stock-options and performance. The next two subsections review the above-mentioned categories of empirical studies on stock options.

2.1 Stock-options and financial and investment decisions

The main works studying the stock-options and financial and investment decisions have assessed the impact of stock options on financial risk, investment choice and dividend policy, respectively.

The study of Agrawal and Mandelker (1987) focuses on 209 American companies that have made acquisitions between 1974 and 1982. The authors examine the relationship between shares and stock-options ownership and the

characteristics of financial and investment decisions. Their results show that the detention of stock-options by top-managers improve their financial and investment decisions. For example, for a first panel of companies where managers hold an average of 26.1% of the capital in the form of shares and options, the variance of return on assets rose by 12.61%. The latter variance amounts to 5.42% for a panel of companies where the executives hold only 6% of capital in the form of shares and options. The authors found a positive relationship between the holding of shares and options by management and debt levels. Following an acquisition, the panel of companies where top-executives hold an average of 19.69% of the capital knows a growth of debt significantly higher than that observed in a panel where the average equity participation is 4.53 %. They argue that stock-options play a significant role in risk-taking by the executives and so aligning their interests with those of shareholders.

Defusco et al. (1990) examine the long-term effects of stock options grant on the stock market performance (stocks abnormal returns), accounting performance (asset returns and variance), financial decisions (capital structure and dividend policy) and investment decisions (capital expenditures, R&D and advertising). Their study covered 562 companies listed on the New York Stock Exchange which grant stock-options to their executives between 1978 and 1982. The empirical results show negative cumulative abnormal stock returns in the period following the adoption of stock-option plans. Moreover, over the five years following the adoption of the plan, the average return on assets decreased from 12.45% (at the beginning of period) to 8.63% (at the end of period). Regarding financial decisions, results show a positive significant relationship between stock-options and debt ratio. This is consistent with the hypothesis that stock-options motivate executives to take risky financial decisions.

Gaver and Gaver (1995) test the relationship between managerial compensation and investment opportunities for a sample of 321 American companies in 1992. Their basic assumption is that the more the company is growing rapidly (high investment opportunities), the more the information asymmetry between shareholders and managers becomes important. Thus, firms with high investment opportunities are more likely to grant long-term incentive pay, such as stock-options, to their top-executives. The authors conclude that the incentive managerial package can reduce long-term costs associated with information asymmetries within companies of high growth opportunities.

Ofek and Yermack (2000) suggest that enabling top-executives to access capital through a stock or stock-options compensation is beneficial to shareholders. Indeed, they consider that the managerial ownership can solve agency problems by encouraging top-executives to make financial decisions and investments in the interest of shareholders. According to the authors, manager stock-options ownership emits positive signals about the ability of the company to reduce agency costs.

Fenn and Liang (2001) show that the detention of stocks and stock-options has a significant impact on the distribution of dividends. For a sample of 1100 American non-financial companies observed between 1993 and 1997 results show that a 100% increase in the level of stock-options granted led to a 38% decline in the dividend distribution rate. These results are consistent with those obtained by Lewellen et al. (1987) and Gaver and Gaver (1993).

2.2 Stock-options and firm performance

Jensen and Meckling (1976) suggest that there is a relationship between executive compensation and firm performance. The equity-based compensation (including stock-options) has been the subject of several studies trying to show whether there was a link between their grant and the firm performance.

Mehran (1995) shows that there is a significant and positive relationship between pay structure (as measured by the share of capital held by top-executives) and firm performance. He focused on 153 American companies in the industrial sector for the period 1979 to 1980. According to the author, performance which is measured by Tobin's Q and return on assets is linked in a positive and meaningful percentage to the stock and stock options top-executives ownership.

Some authors have used other measures of compensation such as fixed salary, bonus, stock-options market value and incentive value of stocks and options granted. Hall (1998) and Hall and Liebman (1998) detected significant and positive coefficient in the econometric relationship between stock-options grant and firm performance.

Murphy (1985), Hubbard and Palia (1995) and Morgan and Poulsen (2001) are among the main authors who tested the relationship between compensation and stock market performance. According to these authors, the best empirical test of the pay to performance relationship is the one directly linking compensation to market performance.

Yermack (1997) analyses the effect of 620 stock-options plans on stock prices performance for the period between 1992 and 1994. He finds that the stock market performance improves by 2% 50 days after the stock-options award. However, the stock market performance improvement does not result from the stock options grant, but from the disclosure of good news about the firm earnings.

Hanlon et al. (2003) examine the relationship between stock-options value granted to the 5 top-executives and performance. Their sample consists of 1965 non-financial companies in the United States over the period 1993 to 2000. The econometric estimates show that the stock-option value measured using the Black-Scholes formula is

associated positively to future earnings. Indeed, an increase of one dollar in the value of stock options results in an increase in earnings of 3.82 dollars.

Core et al. (1999) analyse the impact of top-executives stock-options ownership on the accounting and stock market performance for 205 large American companies. The accounting performance is measured by asset returns, while the stock market performance is measured by stock returns. As a first step, the authors consider the compensation level and the board composition of directors which enable them to judge the quality of corporate governance. Their main result suggests that poor governance system (high level of pay and poor director board composition) is usually associated with bad accounting and stock market performance.

3. Hypothesis and empirical methodology

From a theoretical view, the present paper is based on a comparison between two conflicting approaches in the field of managerial compensation: the optimal contract approach (OCA) and the managerial power approach (MPA) (Note 4).

The first approach (OCA) assumes that managerial compensation is set in an optimal way. It is a confirmation of the agency theory assumptions which assert that top-executives must be paid in an optimal way in order to align their interests with those of shareholders. Empirically, many authors consider that their results validate the agency theory hypotheses. For example, Demsetz and Lehn (1985), Core and Guay (1999) and Himmelberg et al. (1999) state that pay contracts are optimal. Thus, the level of capital and stock-options ownership by top-managers is value-maximizing for their companies.

On the contrary, the managerial power approach considers that there is no significant relationship between pay and performance. According to this approach, executive compensation is not the result of an optimal incentive contract but rather from a managerial power. Indeed, with a decision-making authority and an important informational advantage, top-executives are beyond the control of shareholders. They dominate the board of directors and its committees. This fact justifies a high level of compensation which is unrelated to the performance of their companies. Jenter (2001), Meulbroek (2001), Hall and Murphy (2002), Lambert and Larcker (2004) and Bebchuk and Fried (2003) are among the authors who consider stock-options as inefficient.

In empirical terms, we aim to test these two approaches on the CAC 40 top-executives. We consider the null hypothesis that no relationship between performance and option grants. This means that under the null hypothesis compensation is the result of managerial power. The alternative hypothesis states that this managerial compensation is motivated by an optimal incentive contract.

Before explaining our hypothesis, we present our empirical methodology. Following Mehran (1995), Core et al. (1999) and Hanlon et al. (2003), the empirical methodology used in this paper is conducted in two stages. In the first stage, we regress compensation variables on different determinants of executives pay considered by the theoretical and empirical literature.

The model to be tested in the first step has the following general form:

$$Compensation = f(performance, size, governance\ quality, growth\ opportunity, financial\ risk)$$

where f is a known function.

During the second stage, we regress performance measures on compensation and control variables. The second stage model is of the following form:

$$Performance = f(compensation, control\ variables)$$

The null hypothesis is true if compensation and performance are uncorrelated or negatively correlated whereas the alternative is supported in the opposite case i.e if the performance is positive and significant.

We use panel data to estimate the two models in order to strengthen the power of our tests. This choice is justified by the small size of our sample. We do not use firms fixed effects although they allow companies to control unobserved heterogeneity. Indeed, Zhou (2001) suggests that controlling companies fixed effects reduces considerably the power of tests to detect compensation impact on performance. Zhou (2001) argues that compensation varies considerably from one company to another (cross-section changes) but remains low in the same company.

4. Data description and variables discussion

4.1 Data description

Our data concerns 34 companies listed on the French stock-exchange major index CAC 40 for the period from 1998 to 2005. The small size of the sample is justified by the availability of stock-options data concerning companies of the CAC40 index. Two sources were used to collect our data: companies' annual reports and Datastream database. Based on the annual reports, we manually collected data on top-executives and employees compensation. This data concern the fixed and variable compensations as well as options grants. Annual reports were used also to get data on turnover and number of stock-options' recipients. The price to book ratio, the debt level, the stock price return, the asset returns, the equity returns and the dividend distribution rate were collected from Datastream. However, six

companies have been excluded from the CAC40 listed companies because of the lack of information on their executive compensation. The final sample is composed of 34 companies.

Descriptive statistics are summarized in Table 1. The three stock-options variables are expressed in percentage of issued capital. They concern the number of stock-options granted to the chief executive officers (CEOs) (variable: OGC), the first 10 top-executives (variable: OGE) and finally to all employees of the company (variable: OGA). Regarding the fixed compensation (FIX) and the variable compensation (VAR), the two variables were measured in terms of growth rates. Performance variables namely stock market return (RSM), return on assets (ROA) and return on equity (ROE) and the dividend distribution variable (DIV) are expressed as a percentage. In order to control some determinants of pay and performance, we use some control variables as the logarithm of sales (controlling the size, SIZE), debt (controlling the financial risk, DEBT), price to book ratio (controlling the growth opportunities of the company, PBV) and the logarithm of the total number of stock-options recipients (controlling the quality of governance within the company, REC).

<Insert Table 1>

4.2 Variables' discussion

The purpose of this section is to present the different variables to be used and justify their choice relative to the earlier literature.

4.2.1 Compensation variables

Several variables are used to measure executive compensation. They can be splitted into two categories. The first one concerns stock-options grant. Three measures, expressed as a percentage of the issued capital, are used. The stock-options granted to the CEO is our basic variable. Indeed, decisions made by corporate CEO are the most important within a company. This variable is used to measure the relationship between their decisions and the firm performance. The variable measuring the options granted to the first ten top-executives is included to reflect the fact that the CEO is not the only part to make strategic decisions in the company. Finally, the total options granted to all employees reflect the company general policy of granting stock-options plans.

The second category concerns the fixed (salary and bonus) and variable (but not linked to the stock-price) compensations of the CEO set annually by the compensation committee of the board of directors. They are expressed as a growth rate. The fixed compensation is composed of the net salary and bonuses paid to the CEO. The pay variable depends on some goals which are often measures of financial performance or personal goals. In the recent literature, this classic remuneration (fixed and variable) is not taken into account in the models since several authors have concluded that it has no relationship with firm performance. Our choice to include these variables is due to the fact that in France this compensation is still an important part of CEO executive pay.

4.2.2 Performance variables

In this study, we use the performance measures widely adopted by the literature: stock market return, asset return and equity return. The stock market return is the performance's measure the most associated to managerial "equity-based" compensation, including stock-options (see Joskow and Rose, 1994, Hall and Liebman, 1998 and Hall, 1998 for more details). However, some authors suggest that accounting performance measures are so important in determining the managerial compensation level. Paul (1992), for example, considers that accounting returns provide the board of directors with information on shareholder value created by top-executives. In order to be consistent with the previous literature, we consider two measures of accounting performance namely the asset returns (operating income / total economic assets) and the equity returns (net income / total equity). Finally, we introduce a variable measuring the growth rate of dividend distribution. We introduce this variable in our model to assess whether the granting of stock options has an effect on dividend distribution policy within the company (see Lambert et al., 1989 and Fenn and Liang, 2001). We hypothesize inverse relationship between stock options and dividend payments. We assume that the payment of a dividend will result in a decrease in the stock price. Since executive stock option plans generally are not "dividend protected" and there is a very high probability that the option will finish in the money, the payment of dividends will result in a decrease in the value of the executive's stock options. This suggests that managers have an incentive to reduce dividends in order to increase the expected value of their stock options.

4.2.3 Control variables

Some variables are included in our model to control for the firm size, the growth opportunities, the financial risk and the corporate governance quality. They are assumed to control potential effects on performance and compensation.

The size of the firm is measured by the logarithm of sales. The role of firm size in affecting managerial compensation is widely studied in the literature (see, for example, Baker and Hall, 1998). It is often seen as a major determinant of executive pay and can affect performance in two different ways (see Short and Keasey, 1999). First, big companies will have greater opportunities to generate internal funds and access to external financing sources allowing them to undertake more projects and therefore generating profits. Second, the economies of scale allow big companies to set entry barriers and benefit from higher performance.

In order to measure the firm growth opportunities and as many authors suggest, we use the variable price to book value (as measured by the ratio: stock price / book value of shares). Note that this variable is also used as a measure of performance (Mehran, 1995 and Core and Guay, 1999). However, following the work of Berdot et al. (2006), we consider the price to book ratio as a growth indicator.

The variable debt (measured by the ratio: debt / total assets) is included to control several factors. First, to measure the creditors' influence on company management and performance (Stiglitz, 1985). Then, as Grossman and Hart (1982) and Jensen (1986) suggest, the debt can be used by managers in order to report their commitment to generate cash flows that allow to refund these debts. Thus, the debt becomes a source of resolving conflicts of interest between managers and shareholders by reducing managerial discretion.

In order to control the quality of corporate governance, we use a variable measuring the number of stock options' recipients in the company. The previous literature has often used the number of independent or external directors in the board as controlling governance efficiency (see Core et al., 1999). However, recent financial scandals have shown that these independent or external directors can not guarantee a good corporate governance quality. To overcome this disadvantage, we use a direct measure that reflects a notion of fairness within a company when granting stock options. We assume that the greater is the number of stock options' recipients, the most important the company's board of directors is seen as "fair" which reflects a good quality of governance (Note 5).

5. Empirical results

In this section we present the main outputs of our models and their respective interpretations.

5.1 Compensation determinants

Table 2 presents the results of regressing compensation on different determinants. This regression has the following form:

$$ComOpt_{it} = \alpha_{it} + \beta_1 SIZE_{it} + \beta_2 PBV_{it} + \beta_3 SEBT_{it} + \beta_4 REC_{it} + \beta_5 RSM_{it} + \beta_6 ROA_{it} + \varepsilon_{it}$$

where i and t, denote firm and time, respectively. α is an intercept. The variables $SIZE_{it}$ $PBV_{.it}$, $DEBT_{it}$, REC_{it}, RSM_{it} and ROA_{it} are as described previously. β_k, are the coefficients to be estimated and ε_{it} is an error term. $ComOpt_{it}$ are the three dependent variables used, sparately, in three different regressions.

<Insert Table 2>

Table 2 reports estimation results. The *t*-statistics are reported between brackets.

The first regression results regarding CEO compensation show that the variable OGC has no statistically significant relationship with stock market and asset returns, respectively. The coefficient related to governance is negative and statistically significant. The relationship between CEO compensation and firm size is negative, which is unexpected regarding our assumption (Note 6). There is also a positive significant relationship between the percentage of stock options granted to the CEO and the financial risk as well as growth opportunities. The conclusion of these results is that stock-options granted to CEO are negatively correlated with the firm performance and the firm size which supports the null hypothesis of a significant relationship based on the managerial power approach assumptions.

The same conclusion holds for the 10 top-executives recipients of stock-options (OGE variable). These managers have an important decision-making power. But their stock options appear to be motivated by considerations other than firm performance. In addition, the sign of control variable coefficients are opposite to those suggested by the literature except in the case of financial risk. The sign of the coefficient of the variable measuring the impact of the governance quality is negative. This suggests that a poor governance system within the company is synonymous of more options attributed to key executives. This conclusion is in line with the hypothesis of managerial power.

Finally, when the dependent variable is the stock-options granted to all employees, the results show a positive and meaningful relationship with the stock market returns. This result is unexpected to the extent that employees do not have an important influence on market price. However, by testing the relationship between stock-options granted to employees and firm performance, Core and Guay (2001) conclude that a significant and positive relationship can be detected. It should be noted that the coefficient of the variable LNOB is positive and statistically significant. This result is interesting. It means that when the company governance system is good, it assigns more stock-options to all employees.

In light of the results in Table 2, we conclude that stock-options granting to the CAC40 top-executives, do not result from the performance or other determinants of the managerial compensation. In addition, it shows that poor corporate governance leads to more stock-options granting to the top-executives. Our results suggest that stock options granted to the CAC40 top-managers result from a power exerced by the latters on the board of directors.

The absence of a relationship between pay and its determinants is not probably synonymous to managerial power within the company. Joskow and Rose (1994) and Hall (1998) consider that current compensation is more dependent on its past determinants. We test their finding by considering the following regression :

$$ComOpt_{it} = \alpha_{it-1} + \beta_1 SIZE_{it-1} + \beta_2 PBV_{2t-1} + \beta_3 DEBT_{it-1} + \beta_4 REC_{it-1} + \beta_5 RSM_{it-1} + \beta_6 ROA_{it-1} + \varepsilon_{it}$$

Table 3 groups the results of these regressions. T-statistics show that five over six coefficients related to the performance variables in the three regressions are not significant. Considering the other determinants of compensation, almost all coefficients are either negative or non significant. This result shows that the current stock-options granting to the CEOs is motivated by considerations other than those suggested by the optimal contract approach. This is true for the CEOs, the 10 top-executives, as well as for all employees. The results show that a poor quality of corporate governance allows more stock-options granting for top-executives (the coefficients are negative and statistically significant). The stock market and the economic performance effects are not significant.

<Insert Table 3>

In order to conduct a comparative analysis between stock-options and salary (fixed and variable pay), we consider further dependent variables: the fixed salary growth and the variable salary growth. The two regressions have the following form:

$$ComFV_{it} = \alpha_{it} + \beta_1 SIZE_{it} + \beta_2 PBV_{it} + \beta_3 DEBT_{it} + \beta_4 REC_{it} + \beta_5 RSM_{it} + \beta_6 ROA_{it} + \varepsilon_{it}$$

with $ComFV_{it}$ denotes the two forms of compensation : fixed, FIX_{it} and variable, VAR_{it}.

Results of the regressions are presented in Table 4. They show a total independence between fixed and variable compensation on the one hand and control variables on the other hand. Excluding coefficient of the stock market returns in the second regression, all the other factors are not statistically significant.

<Insert Table 4>

As we did in the case of stock-option grants, we regress fixed and variable pay on lagged determinant variables. The regression is as follows:

$$ComFV_{it} = \alpha_{it} + \beta_1 SIZE_{it-1} + \beta_2 PBV_{it-1} + \beta_3 DEBT_{it-1} + \beta_4 REC_{it-1} + \beta_5 RSM_{it-1} + \beta_6 ROA_{it-1} + \varepsilon_{it}$$

Table 5 shows the results of the two regressions. The fixed pay of one year is statistically independent from the compensation determinants of the previous year. Concerning the pay variable, the coefficients are statistically significant except for the asset return variable. However, in the case of the size, growth opportunities and financial risk series, the coefficients have an unusual signs from the point of view of the OCA. The stock market return and the governance quality have a positive impact on the variable pay.

<Insert Table 5>

To conclude, the overall results for the fixed and variable pay confirm what has been found in the case of stock-option grants. The CAC40 CEOs and top-executives compensation seems to be unrelated to the performance of their companies. Thus, managerial power seems to be the source of the CAC40 top management compensation.

5.2 Firm performance

Table 6 presents the results of the compensation effect on various measures of performance. We use the following regression :

$$PerfDiv_{it} = \alpha_{it} + \beta_1 SIZE_{it} + \beta_2 PBV_{it} + \beta_3 DEBT_{it} + \beta_4 REC_{it} + \beta_5 OGC_{it} + \beta_6 OGE_{it} + \beta_7 OGA_{it} + \beta_8 FIX_{it} + \beta_9 VAR_{it} + \varepsilon_{it}$$

with $PerfDiv_{it}$ are variables measuring, respectively, the performance and the dividend distributions. RSM_{it} denotes firm market performance, ROA_{it} asset returns, ROE_{it} return on equity and DIV_{it} the dividend growth rate.

Results show that firm performance is independent of executive compensation. Indeed, the majority of the coefficients are statistically not significant or of an unexpected sign. Moreover, fixed and variable salaries are independent of the different performance measures and the dividend distribution. Regarding stock-options, we find that for CEOs and the 10 key executives, the coefficients are not significant or have a negative sign.

<Insert Table 6>

The most relevant conclusion can be drawn from the last regression of dividend distribution. Results show that stock-options granted to the CEOs and the 10 top-executives have a positive and statistically significant relationship with the distributed dividend growth rate. This result is in contrast with the finding of Lambert et al. (1989) who suggest that stock options grant reduces the level of dividend distributed to shareholder relative to the expected level of dividend without options grant. This can be explained by the fact that stock options grant may not affect the manager's choice of corporate dividend policy immediately. It seems important to look for these changes over a relatively long period of time.

In table 7, we report the results of the regression including lagged independent variables. The regression is of the following form:

$$PerfDiv_{it} = \alpha_{it} + \beta_1 SIZE_{it-1} + \beta_2 PBV_{it-1} + \beta_3 DEBT_{it-1} + \beta_4 REC_{it-1} + \beta_5 OGC_{it-1} + \beta_6 OGE_{it-1} + \beta_7 OGA_{it-1} + \beta_8 FIX_{it-1} + \beta_9 VAR_{it-1} + \varepsilon_{it}$$

This regression does not present further evidence. The stock-options granted to top-managers and to all employees have no effect on the company future performance. This is also the case for fixed and variable pay. The majority of the other variables do not have a statistically significant relationship with performance measures and with dividends distribution.

<Insert Table 7>

Our results show that the granting of stock-options to the top-managers of the CAC 40 is in line with the managerial power approach rather than with the optimal contract one.

6. Conclusion

In this paper we tested the relationship between stock options grant and firm performance. Regarding the causality relationship between pay and performance, the empirical study was conducted in two stages. In the first stage, we regress the stock-options compensation on its determinants namely performance, opportunity growth, size, financial risk and governance. In the second stage, we tested the hypothesis that the stock-options granted to top-executives will improve the stock market and accounting performance.

Our empirical results show that executive compensation on the CAC 40 is not justified from the point of view of the agency theory. We do not find any empirical support for the optimal incentive contract approach. However, our results were consistent with the assumptions of the managerial power approach. We show that the top-executives compensation of the major French companies listed on the CAC 40 is not the result of its usual determinants, particularly the performance. Additionally, stock-options granted to top-executives are not synonymous of shareholder value creation. The result seems to be surprising from the agency theory point of view. One possible explanation for the lack of a relationship between pay and performance as part of a system of governance is the existence of a high degree of managerial entrenchment and power. This area is left for further research.

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Notes

Note 1. See Rosen (1992) for an overview of both theoretical and empirical literature on this subject..

Note 2. For the period of our analysis, French companies were allowed to do not expense stock options when granted.

Note 3. CAC 40 is the acronym of the major French Index “Cotation Assistée en Continue 40”. It is composed by the fourty major French companies listed on the Paris’s stock exchange.

Note 4. The previous empirical literature often makes the difference between the plans based on fixed values of options and those based on fixed number of options. In France, the practice rather belongs to the second category. During a shareholders meeting, shareholders adopt a resolution which consists in fixing a certain number of options to be distributed to the employees during the next years in the context of many stock options plans. Fixing the number of stock options by plan and by employee’s categories (manager, staff and others…) is decided by the board

of directors.

In order to benefit from a high number of stock-options it is more attractive to the managers that the number of beneficiaries being as low as possible.

Note 5. Abowd and Kaplan (1999), Core and al. (2001) and Bebchuk and al. (2002).

Note 6. See paragraph 2 of sub-section 4.2.3.

Table 1. Descriptive Statistics

Variables	Mean	Std-dev	Median	Max	Min
Compensation (%)					
OGC	0.12	0.25	0.06	2.63	0
OGE	0.14	0.27	0.09	3.40	0
OGA	1.33	3.80	0.77	6.08	0
FIX	92.03	87.88	3.24	905.14	-53.60
VAR	26.00	69.99	10.48	418.66	-100
Performance (%)					
DIV	15.74	40.15	10.90	262.85	-100
RSM	9.13	37.35	7.93	235.48	-75.89
ROA	-19.73	104.18	3.29	479.38	-475.67
ROE	11.60	31.01	07.84	396.97	-73.98
Control					
SIZE	9.71	0.85	9.64	11.87	7.35
PBV	2.98	2.73	2.27	24.33	-1.27
DEBT (%)	27.56	17.29	25.15	69.69	0
REC	1214.18	2521.43	639	31493	0

Table 2. Regression of the stock-options compensation on current determinants

$ComOpt_{it} = \alpha_{it} + \beta_1 SIZE_{it} + \beta_2 PBV_{it} + \beta_3 DEBT_{it} + \beta_4 REC_{it} + \beta_5 RSM_{it} + \beta_6 ROA_{it} + \varepsilon_{it}$			
	Dependent variables		
	OGC_t	OGE_t	OGA_t
	Estimates		
Independent variables	(t-student)		
α	0.275	0.546	3.384
	(5.615)***	(12.224)***	(7.362)***
β_1	-0.011	-0.034	-0.326
	(-3.307)***	(-6.993)***	(-7.730)***
β_2	5.74E-03	-0.014	-0.034
	(1.802)*	(-5.374)***	(-1.551)
β_3	0.174	0.075	-1.038
	(8.679)***	(2.774)***	(-5.005)***
β_4	-0.020	-0.010	0.178
	(-5.171)***	(-2.529)**	(5.246)***
β_5	-6.83E-03	-0.015	0.117
	(-0.807)	(-1.121)	(2.077)**
β_6	-3.35E-03	-0.014	-0.067
	(-0.631)	(-2.913)***	(-1.934)*
adjusted R^2 (%)	94.24	83.65	80.31
Obs number	113	100	126
Fischer	306.696***	79.32***	80.929***
***, **, * denote significance at the significance levels 1 %, 5 %, and 10 %, respectively			

Table 3. Regressions of the stock-options compensation on lagged determinants

$ComOpt_{it} = \alpha_{it-1} + \beta_1 SIZE_{it-1} + \beta_2 PBV_{it-1} + \beta_3 DEBT_{it-1} + \beta_4 REC_{it-1} + \beta_5 RSM_{it-1} + \beta_6 ROA_{it-1} + \varepsilon_{it}$			
	Dependent variables		
	OGC_t	OGE_t	OGA_t
	Coefficients		
Independent variables	(t-student)		
	0.238	0.419	3.567
α	(4.124)***	(5.801)***	(7.740)***
β_1	-0.010	-0.023	-0.231
	(-1.922)**	(-3.497)***	(-5.141)***
β_2	1.64E-03	-9.03E-03	-0.041
	(0.585)	(-2.942)	(-3.133)***
β_3	0.124	0.021	-1.013
	(4.315)***	(0.730)	(-6.032)***
β_4	-0.015	-9.72E-03	-2.23E-03
	(-4.069)***	(-2.528)**	(-0.068)
β_5	4.30E-03	4.74E-03	9.34E-03
	(0.361)	(0.424)	(0.150)
β_6	-4.50E-03	-0.014	-0.050
	(-0.926)	(-2.381)**	(-1.518)
R^2 adjusted(%)	8.33	82.55	91.74
Obs number	105	97	110
Stat Fischer	2.576**	76.7***	202.898***

Table 4. Regressions of the fixed and variable compensation

$ComFV_{it} = \alpha_{it} + \beta_1 SIZE_{it} + \beta_2 PBV_{it} + \beta_3 DEBT_{it} + \beta_4 REC_{it} + \beta_5 RSM_{it} + \beta_6 ROA_{it} + \varepsilon_{it}$				
	Dependent variables			
	FIX_t		VAR_t	
Independent variables	Coefficients	(t-student)	Coefficients	(t-student)
α	-114.598	(-0.613)	-9.416	(-0.279)
β_1	11.721	(0.759)	0.692	(0.213)
β_2	6.721	(1.208)	2.607	(1.368)
β_3	2.324	(0.075)	26.076	(1.227)
β_4	-0.792	(-0.104)	-0.328	(-0.094)
β_5	-45.723	(-1.762)	41.004	(2.726)***
β_6	4.203	4.203	0.639	(0.192)
R^2 adjusted(%)	-4.77		11.72	
Obs number	70		70	
Stat Fischer	0.476		2.527**	
***, ** the coefficients are significatifs respectively to the levels of 1 %, 5 %.				

Table 5. Regressions of the fixed and variable compensation

$ComFV_{it} = \alpha_{it-1} + \beta_1 SIZE_{it-1} + \beta_2 PBV_{it-1} + \beta_3 DEBT_{it-1} + \beta_4 REC_{it-1} + \beta_5 RSM_{it-1} + \beta_6 ROA_{it-1} + \varepsilon_{it}$				
	Dependent variables			
	FIX_t		VAR_t	
Independent variables	Coefficients	(t-student)	Coefficients	(t student)
α	-90.934	(-0.386)	115.133	(2.715)***
β_1	5.775	(0.286)	-17.952	(-5.274)***
β_2	1.847	(0.323)	-3.912	(-2.973)***
β_3	-36.425	(-0.636)	-49.074	(-2.834)***
β_4	7.335	(0.587)	15.371	(5.789)***
β_5	25.474	(0.692)	51.988	(3.672)***
β_6	3.226	(0.353)	-0.139	(-0.045)
R^2 adjusted(%)	-10.38		66.37	
Obs number	71		71	
Stat Fischer	----------		24.03***	

Table 6. Regressions of the performance and dividends on current determinants

	RSM_t	ROA_t	ROE_t	DIV_t
	Coefficients			
Independent variables	(t-student)			
α	0.623	-1.559	0.674	-0.799
	(1.855)*	(-1.794)*	(7.372)***	(-2.698)***
β_1	-0.004	0.139	-0.016	0.045
	(-0.127)	(1.800)*	(-2.024)**	(1.884)*
β_2	-0.009	0.040	0.009	0.013
	-0.530	(1.036)	(1.640)	(1.234)
β_3	0.163	0.799	-0.044	-0.311
	1.012	(2.445)**	(-0.892)	(-2.527)**
β_4	-0.071	0.024	-0.052	0.061
	(-2.520)**	(0.413)	(-5.060)***	(2.253)**
β_5	20.451	-435.635	-14.261	46.863
	(0.630)	(-4.872)***	-1.610	(2.681)***
β_6	-52.118	551.954	-27.976	61.049
	(-1.543)	(3.108)***	(-2.369)**	(1.930)*
β_7	-2.268	-86.053	2.188	-4.110
	(-0.474)	(-3.542)***	(4.813)***	(-1.002)
β_8	-0.001	-0.0003	-7.31E-05	-0.0002
	(-0.654)	(-0.049)	0.791	(-0.139)
β_9	-0.021	-0.241	-0.018	-0.010
	(-0.464)	(-2.464)**	-1.521	(-0.199)
R2 adjusted (%)	61.66	77.48	49.11	83.47
Obs Number	60	42	54	60
Stat Fischer	11.543***	16.676***	6.683***	34.112***
***, **, * the coefficients are significatifs respectively to the levels of 1 %, 5 %, and 10 %.				

Table 7. Regressions of performance and dividends on lagged determinants

	RSM_t	ROA_t	ROE_t	DIV_t
	Coefficients			
Independant variables	(t student)			
α	0.149	-3.543	0.321	0.520
	(0.382)	(-1.986)*	(1.752)*	(1.686)
β_1	0.009	0.220	0.010	-0.008
	(0.252)	(1.414)	(0.666)	(-0.343)
β_2	-0.024	-0.033	0.025	-0.004
	(-1.726)*	(-0.548)	(4.134)***	(-0.464)
β_3	0.260	0.231	0.104	-0.091
	(1.808)*	(0.430)	(1.390)	(-0.570)
β_4	-0.007	0.293	-0.057	-0.033
	(-0.203)	(3.405)***	(-4.264)***	(-1.077)
β_5	11.404	-146.249	-3.898	-1.713
	(0.374)	(-1.491)	(-0.262)	(-0.069)
β_6	1.822	93.162	2.862	15.722
	(0.078)	(0.606)	(0.142)	(0.388)
β_7	-11.623	-90.228	-0.576	-1.182
	(-2.930)***	(-4.863)***	(-0.496)	(-0.213)
β_8	-0.002	-0.009	-0.0002	-0.0002
	(-1.238)	(-1.405)	(-1.247)	(0.042)
β_9	-0.105	-0.056	-0.054	0.057
	(-3.230)***	(-0.529)	(-3.278)***	(1.039)
R^2 adjusted(%)	61.66	77.48	49.11	83.47
Obs number	60	42	54	60
Stat Fischer	11.543***	16.676***	6.683***	34.112***
***, **, * the coefficients are significatifs respectively to the levels of 1 %, 5 %, and 10 %.				

The Effect of Macroeconomic Policies on Poverty in Iran

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Abstract

The objective of this study is to analysis the effectiveness of government intervention on poverty groups using a general equilibrium model. The social accounting matrix of year 2002 was used to estimate the GE model. The results indicate that absolute poverty line for the urban and rural regions are 3.7 and 2.4 million Rials respectively. Also the result shows that the majority of Iranian households are living under the poverty line. Thus, it is expected that the average propensity to consume among the households is high but on the other hand the average propensity to save is low.

Keywords: Iran, intervention, Poverty line, household, general equilibrium

1. Introduction

One of the main objectives of the government economic development programs in each country is to improve the economics conditions of people and reduce the poverty of the society. A structural change is required to be applied to reduce the poverty situation of the society. This could be done by an economic and social solution of poverty decreasing policy. Some economists believe that poverty is as a result of some economic – social factors. So it is necessary to try to find the main elements of poverty. A short term solution is a direct or indirect payment to the consumers. Subsidy on basic goods can be considered as a short – term support policy. But the long term aim is that the government has to protect the poverty groups by providing a necessary revenue acquisition condition. The creation of economic chances for poor people in order to combat with poverty is another long term solution. But the current government intervention policy doesn't provide any desirable chances for the poverty groups. In this study an attempt was made to use a general equilibrium model to analyze the effectiveness of government intervention policy regarding to the poverty issues.

2. Literature Review

Most of the previous studies have worked on only one of the components of government expenditure as a factor affecting on the poverty.

Cane (2000) in Indonesia investigated the expenses of the road construction on the poverty. In this study they tried to separate the different states with suitable and unsuitable road. The results showed that one percent increase in the investment causes a 0.3 percent decrease in poverty in a 5 years period. Balsa Cane and Purina's study (2002) in Philippines showed that one percent increase in accessing to the road with instructive facilities decreases the income of poor people by 0.32 percent. Van D wall's study (1998) in Vietnam showed that the expanding of the irrigation facilities to the poor households who had small land increases the poor households' income more than the rich households. Fane and Junk findings (2002) showed that a 10 percent increase in investment on irrigation projects causes a 1.13 percent decreases in poverty index. Fane (2003) in his study showed that among the different components of government expenditure in rural sector, investment in research and extension, irrigation, rural instruction and infrastructures had more effect on decreasing the poverty. Lion man and Schubert (2004) by the Neo Keynes standard model investigated the government expenditure effect on consumption behavior of the people. The results of their study showed that an increase on the government expenditure could cause an increase in private consumption. Bhasin and et al (2005) investigated the effects of eliminating of commercial taxes on the poverty and the distribution of the rich people income. In this study the households are divided to a number of groups such as; the farmer with land, Government employers, private sector employers, the labors without land and unemployed people. The statistic general equilibrium model was used and the data were calibrated for the year 1999 and in order to access to the equilibrium condition before making the scenario the GAM soft ware was used. The effects of

shocking (the eliminating the trade taxes) on the poverty and households income by using the DAD software and the effects of income distribution with PCGLVE software was analyzed. In this research two scenarios were planted and their effects were followed. These scenarios included the perfect eliminating of import tariffs for the total import with the 100 percent increase in tax on the value added and the eliminating of all export taxes and the 100 percent increasing on value added. The result showed that the first scenario causes the decreasing of poverty and the second scenario causes a worse condition for the poor people.

Corryton and Cockburn (2005) in Philippine used a CGE model with 12 production sectors to investigate the effect of a reduction in tariffs on the poverty .Their model had 12 production sector, including 4 agricultural sub sectors, 5 industrial sub sectors and 3 services' sectors. In order to investigate the poverty resulting from the change in household income and consumptive price of consumer because of reduction of tariffs, the FGT index was used. To examine the income distribution of people a Gini coefficient was used. In overall, the results showed that any reduction in tariffs causes a decrease in the consumer price by 2.57 percent and so the household real income increase by 0.9 percent. Household consumption expenditure price index was calculated after the tariffs' reduction for the rural and urban household.

3. Method and Material

General equilibrium models (GE) have been used since early 1980s. The GE Models have advantages of showing the relationship between production sectors at micro and macro levels and also affects on changing of policies in different economic sectors. The literature related to the general equilibrium model shows that the theory of the model was developed since 1930s. Uhansen (1960) used the general equilibrium model for the first time to study the Norway's economy. The structure of this model is based on the definition of Walraws' general equilibrium model which was formulated by Arrow and Debru in the 1950s. In this study the effect of growth in households' expenditure on poverty was examined. The changes in consumption and prices levels were estimated by increasing of expenditure by 20 and 50 percent respectively. The next step was to examine the results on a selected group of expenditure at rural and urban household levels. In order to evaluate the expenditure change on, the FGT index was used. The FGT index is as follow (Datt, 1998) :

$$P_\alpha = \int_0^z \left[\frac{Z - X}{Z}\right]^\alpha f(X)dX \quad \alpha \geq 0 \tag{1}$$

Whereas, variable x shows the household consumption expenditure, f(x) is the household consumption expenditure function (the ratio of population who consume the x expenditure, z represents the poverty line and α is a non-negative parameter. The above function can be written in a simple form (Minot & Goletti, 2001):

$$P_\alpha = \left(\frac{1}{N}\right)\sum\left(\frac{Z - X}{Z}\right)^\alpha \tag{2}$$

Where, N is the numbers of population. The higher value of α shows the inequality between the poor people. In this study three values of; 0, 1, 2 for α were used. The required data for this study are based on the last social accounting matrix of year 1380 which was collected from the Central Bank of Iran. The matrix has 14 rows and parallel columns including agricultural and none agricultural goods and activities, production factor (labor and capital), institutions (urban and rural households and government), various taxes (i.e. income tax, sale tax, import tax), and national saving and investment. The data for analyzing the poverty such as monthly expenditure and household level of selected urban and rural regions are collected by the Iran statistic center annually. The data's related to the consumption expenditure of the urban and rural households of the year 1385 were obtained from Iran statistic center for 2000 urban and rural households. The GAMS software was applied to estimate the model and the DAD soft ware was use to calculate the FGT index d .

3. Results and Discussion

The FGT index proposed by Foster, Greer and Thorbecke in 1984 was used. The FGT index is considered as a function of poverty gap ratio which is formulated in equation 2: n shows the numbers of all households, z, and poverty line, Y_i, household income. The three values for α are; the census ratio, α = 0, to measure the poverty gap α = 1 and to measure the poverty intensity α = 2. In fact if α is more than 1, more sensitivity and weight would give to the poverty. The high value of P_2 indicates that the most weight is given to the households who have a highest distance from the poverty line. So as the index increases the income gap between households will increase.

This index could be calculated within the sub-sectors which have special social – economic impact in the regions. Thus the index can show the poverty intensity in the different groups of poor people. The individual poverty index is shown in Figure (1). According to the figure an increase in the individual income in order to reach to the poverty line doesn't cause any change in the poverty census ratio. The relation between the poverty gap index P_1 and income also is negative and has a constant slope. It means that by increasing the income of poverty groups, their distance to the poverty line will decrease in linearly. The index of poverty index gives a higher weight to the poor

people. According to this index the level of poverty gap of poor people has a higher value. This finding confirms the convexity of poverty intensity curve related to the income level which is shown in figure 1 (Ravallion, 1994).

The FGT index was used to calculate the percent of the individuals who are under the poverty line the poverty gap and poverty intensity as a result of decreasing in government expenditure. The effect of a reduction in government expenditure in general equilibrium model would decrease the commodity contribution in government consumption and decreases taxes. A decrease in tax level would increases the consumers demand. A reduction in government expenditure could lead to decrease the producers' costs and internal prices. As a result of reduction in prices the individual demand has increased significantly.

Reduction in the price of composed consumer goods has increased the real income of households and their expenditure and saving capacity. The result of General Equilibrium model indicate that the demand of consumption goods has a inverse relation with the price of composed goods and a direct relation with the consumption expenditure. So the level of changing in price of consumer goods due to the different levels of reduction in government expenditure has been estimated within the model at rural and urban regions. The computed poverty indexes in the present condition are presented in the table (1). In order to calculate this index the poverty line was used. According to the results of this study the absolute poverty line for the urban and rural regions in the year 1385 in Iran were 3716040 and 2386543 Rials respectively per month. Of course it shouldn't be forgotten that the absolute poverty line value isn't so important in this study. The result also indicate that about 28.78 percent of rural households and 39.7 percent of urban households are living below the poverty line. The poverty gap for the two groups is 6.18 and 9.6 percent respectively. The table (1) shows the poverty line and the related indices.

The scenarios of decreasing the government expenditure is included five levels, 10, 20, 30 and 50 percent. According to the theoretical basis, it is expected that by reducing the government expenditure the investment of private sector and employment increases. It is also expected that reduction in taxes would causes the production cost to decrease and the price of the goods and produced services will decrease. The results of government expenditure reduction on poverty indexes in urban and rural areas are given in tables 2 and 3.

The results presented in the table 3 indicate that the present of difference in poverty indices among the urban and rural groups will decrease the government expenditure. In both groups decreasing of the expenditure will lead to reduction in poverty gap and intensity continuously. For example a 50 percent decreases in the expenditure, the index of the poverty gap between the urban households decreases more than 8 percent while this figure for the rural households is 7 percent. Also the absolute amount of the poverty gap in the urban region with a 50 percent decrease is more than rural region. So a 50 percent decrease in the expenditure, the index of poverty intensity among the urban households will improve by 7.6 percent while the same figure for the rural households is 6.28 percent. In over all, according to the findings of this study it seems that the poverty intensity and poverty gap in the urban regions of Iran is greater than the rural regions (table 3). Between poverty gap and poverty intensity is a positive and relatively high correlation; hence in the region which the poverty gap is high, the poverty intensity is high too. It should be mentioned that it might be possible in a special region the poverty gap be more than the other regions and at the same time the poverty intensity be lower. This means that in the region which the poverty intensity is more, the distribution of income is more unjust in a way that majority of the population are low income. With decreasing government expenditure from 10 to 50 percent, the poverty gap among the urban households will decrease by 2.33 to 8.47 percent.

The poverty intensity will decrease with the decrease of the expenditure by about 3.2 percent to 7.6 percent. Also a decrease in government expenditure by 10 to 50 percent the poverty gap in the rural region will decrease by 1.1 to 7.01 and the index of poverty index will decrease by 1.38 percent to 6.28. It can be seen that the amount of change in poverty gap and poverty intensity in the urban region is more in relation to the rural regions.

5. Conclusion

It can be summarized that based on the results of this study, a considerable percentage of Iranian households are below the poverty line. Hence it is expected that the average propensity to consume among the households be too high, but as it was seen, the average propensity to consume is low. In terms of theory, it that be said that in the condition of Iran with a high inflation rate, the opportunity cost of consumption is high. On the other hand with a high propensity of saving and investment in the society, it can be said that the individuals try to overcome the high inflation rate they try to save and invest more. This behavior of society could relatively explain the reasons why the consumption expenditure does not increase by an increase in income level.

According to the findings of this study it can suggest that in order to reduce the number of people under the poverty line some policy measures should be taken. First of all government should try to reduce the inflation rate by increasing the production capacity of the society. This can be done by encouraging the private sector to invest in production section rather that in services section. The security for investment is an important element in Iran that should be done by the government. Parallel to inflation reduction policies, it is also needed to increase the real income of the low level population by providing them cheap foods and public services. The distribution of wealth and income is not fair in Iran. The gap between rich and poor is increasing significantly as a result of poor tax management system. So it can be suggested an efficient and justice wealth distribution system in Iran.

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Table 1. poverty line and the FGT indices, 1385

Household	Absolute poverty line	F(0)	F(1)	F(2)
Urban	3716040	39.7	9.6	3.5
Rural	2386543	28.78	6.18	2.2

Source: findings of the Study

Table 2. the effect of decreasing the government expenditure on the poverty indexes of urban regions

Poverty indexes	Present condition	Decreasing of the expenditure by 10 (percent)	Decreasing of the expenditure by 20 (percent)	Decreasing of the expenditure by 30 (percent)	Decreasing of the expenditure by 50 (percent)
Poverty gap $\alpha = 1$	9.6	9.39	9.22	9.12	8.85
	The changes in relation to the present situation (percent)	From -2.23 to –8.47			
Poverty intensity $\alpha = 2$	3.5	3.39	3.38	3.3	3.25
	The changes in relation to the present situation (percent)	From -3.2 to -7.6			

Origin: research findings

Table 3. The effect of decreasing the government expenditure on the poverty indexes of rural regions

Poverty indexes	Present condition	Decreasing of the expenditure by 10 (percent)	Decreasing of the expenditure by 20 (percent)	Decreasing of the expenditure by 30 (percent)	Decreasing of the expenditure by 50 (percent)
Poverty gap $\alpha = 1$	6.18	6.11	6.02	5.92	5.77
	The changes in relation to the present situation (percent)	From -1.1 to –7.01			
Poverty intensity $\alpha = 2$	2.2	2.17	2.15	2.09	2.07
	The changes in relation to the present situation (percent)	From -1.38 to -6.28			

Origin: research findings

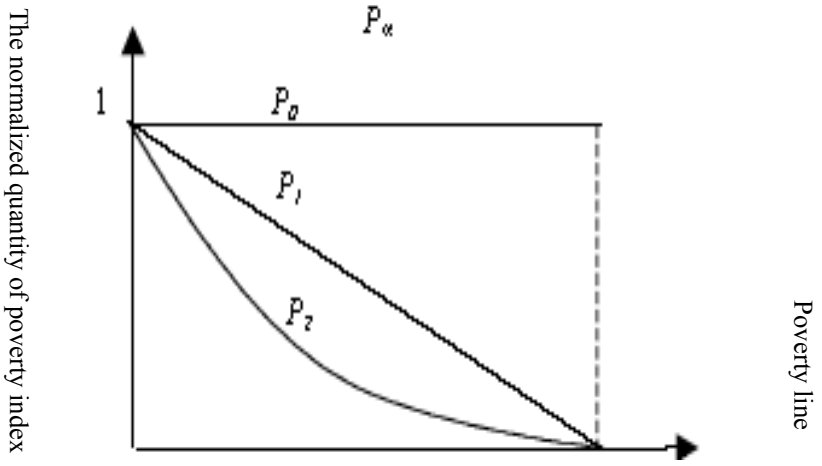

Figure 1. measuring the poverty of individual

Pinpoint and Synergistic Trading Strategies of Candlesticks

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Abstract

The candlestick trading strategy is a very popular technical method to convey the growth and decline of the demand and supply in the financial market. In this paper, we aim to investigate the predictive power of the candlestick two-day patterns, and to determine the key factors to improve performance. The data set of this study includes daily opening, high, low, and closing prices, and daily volumes of all electronic securities in the Taiwan Stock Exchange between 1998 and 2007.

The result of this paper indicates that the harami pattern can obtain information about short-term price movements derived from the demand and supply in Taiwan stock market, because the performances from the harami signals are significantly positive overwhelmingly. The main contribution of this study is that it improves these trading strategies with three confirmation factors, that is, the open of the day after a reversal pattern, the changes of real bodies between two days, and the changes in volume. In addition, this is the first time that candlesticks research has employed the Quantile Regression Model.

Keywords: Candlestick, Reversal pattern, The QR model, Technical analysis

1. Introduction

Since Steve Nison introduced this new charting technique to the Western world from Japan in 1970s (Nison, 1991), this analysis avenue is highly recommended by financial traders and investors around the world. Practitioners prefer to make money without risk, but academicians' interest is in finding out the context of price developments. In other words, the fundamental basis and the statistical significance behind the patterns are often subordinated by the devotees of the technicians. It is a difficult task between serving the academician and serving the technician. In the past, the academician loved to pick on the technician (Malkiel, 1981). As the rising of behavioral finance, scholars pay more attention to technical analysis, because behavioral finance and technical analysis call the rationality of investors in question. Kahneman & Tversky (1979) address the reflection effect, heuristic-driven bias in their prospect theory to reveal the irrationality of investors as they faced gain and loss. Even so, technicians convert the mental emotion of investors into chart patterns in particular time intervals, and reveal the real fear and greed of the investors. Thus positive feedback rules (De Long et. al., 1990) reveal trend-chasing in price movement and anchoring (Kahneman & Tversky, 1979) seems explain the support and resistance trading rules in technical analysis.

The procedures of technicians violate the efficient market hypothesis which argues that advantages would diminish and trading methods would self-destruct when it would soon be used by its adherents. So the value of charting analysis has been neglected by the academic palace in the past. Thanks to behavioral finance, this is changing. The academician discusses charting analysis gradually. Practitioners divide technical analysis into two groups-visual patterns in charts and mathematical indicators by calculating. Most of the empirical research related to technical analysis revolves around visual patterns. For instance, Levy (1971) reviews thirty-two patterns of stock prices and examines the excess returns. Brock, Lakonishok & LeBaron (1992) treat support and resistance as trading rules. Their results provide strong support for technical strategies. In addition, Osler (1997) utilizes head and shoulders patterns as a filter to test the significance of abnormal returns of stock prices.

The candlestick technique is also a visual patterns approach. It was created in Japan in the 18th century by a man named Munehisa Honma (Nison, 1991; Caginalp & Laurent, 1998). A few centuries latter, Steve Nison introduced it to the Western world where it has been increasingly popular (Nison, 1991). This method reflects more information, especially regarding the psychology in the market, than others. As for recent research about candlesticks, Fock, Klein, & Zewergel (2005) use five-minute data from the index futures on German stock index (DAX) and the bond futures on German government bonds (FGBL) to test candlesticks against a benchmark built from randomization. Other studies employ daily data, for instance, Caginalp & Laurent (1998) examine eight three-day reversal patterns for all S&P 500 stocks over 1992-1996. Marshall, Young, & Rose (2006) test 35 stocks on the Dow Jones Industrial Average over the period 1992-2001. After this, Marshall, Young, & Cahan (2006) use the same method to study the Japanese stock market. Their results provide depressing findings for candlestick trading strategies. In addition, Goo,

Chen, & Chang (2007) utilize the daily data of 25 component stocks in the Taiwan Top 50 Tracker Fund and Taiwan Mid-Cap 100 Tracker Fund over the period from 1997 to 2006, and found strong support for candlestick techniques. None of the above takes trading volume or positions into consideration, which are considered to confirm the forecasting power of candlesticks in practice. The motivation for this study has been developed.

Candlestick charts have more advantages for research than other technical analysis methods. They have more precise definitions, the time intervals are fixed and its signals are well-deploying (Caginalp & Laurent, 1998). Because of the growth in behavioral finance in recent years, it has been found that emotional and mental reactions are important decisive factors in financial market behavior. Its findings correspond with that of candlesticks which reveal the dark forces of the demand and supply on financial markets by tracking daily price movements. By considering statistical analysis, charting analysis is able to offer objectivity in financial markets, and by trading regularly, the candlestick pattern is consistently one of the best strategies for investors (Caginalp & Laurent, 1998).

Candlestick reversal patterns are notable when they occur in high-price areas or in low-price areas (Nison, 1991; Pring, 2002). Besides, trading volume always plays an important role for measuring popularity and reveals the aspiration of "accumulation" or "distribution". Thus, this study takes the changes of volume patterns into consideration. This task is distinct from previous research which combined mathematical indicators (Fock et al., 2005) or implemented stop-loss strategies (Goo et al., 2007). The key contribution of this paper is looking into the improvement of trading strategies using candlesticks by three criteria: the open of the day after the pattern, the gap of the two real bodies, and the change in volume. This task has not done in any previous study. Specifically, we employ quantile regression (QR hereafter) model to test the effect of the three criteria described above. To the best of our knowledge, this is the first research to use QR model on technical analysis methods.

This paper reveals that the returns of the candlesticks strategies are related to the three factors, the open of the day after the pattern, the real body of the candlestick, and the change in volume. The harami pattern is just best strategies of those tested in this paper for investors in Taiwan stock market.

The rest of this paper is structured as follows. Section 2 describes the data and methodology. Section 3 presents the QR model. Section 4 discusses the empirical results. Finally, concluding remarks are in section 5.

2. Data Collection and Methodology

2.1 Data

The data of this paper consists of daily prices and volumes for 69 electronic securities as posted by the Taiwan Stock Exchange. The time period covers ten years from 1998 to 2007. The data include four essential prices for candlesticks: opening, high, low, and closing prices.

2.2 Pattern Definitions

A single candlestick line includes information on the opening, high, low, and closing prices in a particular time period. The range between the opening and closing prices is called the real body. If the real body is white, it means that the closing price was higher than the opening price, and vice versa. The lines above and below the real body are called the shadows. Candlesticks are more used by daily data than intraday data (Nison, 1991). Presumably this is because investor reaction needs some time to be incubated. Popular daily candlestick patterns include single lines, two-day patterns, and three-day patterns. Several consecutive single lines can combine to form one pattern divided into continuation and reversal patterns. Continuation patterns imply that the previous trend will continue, and reversal patterns hint that the direction of price will change. In general, investors pay more attention to reversal patterns, because they always change the inertial trend. In this paper, we consider three bullish patterns and three bearish patterns, and they are all combined with two single lines (shown in Fig.1).

2.3 Methodology

The first arrangement of defining reversal patterns is identifying what is an uptrend or a downtrend. We employ a five-day moving average according to Caginalp & Laurent (1998). And the moving average on day t is defined by:

$$MA_5(t) = \frac{C(t-4) + C(t-3) + C(t-2) + C(t-1) + C(t)}{5}$$

Where C(t) is the closing price on day t.

An uptrend on day t is defined by:

$$MA_5(t-6) < MA_5(t-5) < \cdots < MA_5(t-1) < MA_5(t)$$

On the contrary, a downtrend on day t is defined by:

$$MA_5(t-6) > MA_5(t-5) > \cdots > MA_5(t-1) > MA_5(t)$$

Next, we must define how to measure the returns of the profit by the candlestick reversal patterns. This paper measures profits based on three rules. First, the beginning of the measuring is at the opening price on the day following a reversal pattern. Secondly, the end of the measuring is at the closing price on each holding day. Thirdly, positions are held for one to five days. Short-term candlestick strategies are used (Nison, 1991; Morris, 1995), and

opposite patterns occur for more than five holding days. So we adopt the frame of five days.

In this study, we will use quantile regression developed by Heckman (1979) to test the predictive power of candlestick reversal patterns. In comparison with the ordinary least square method, the QR model offers a relatively rich description of the conditional mean for extreme cases in the samples.

3. QR Model

There is no consistent conclusion for the predictive power of candlesticks in previous findings. This paper attempts to improve candlestick trading rules on an even more pragmatic basis. To begin with, this study examines the returns of six reversal pattern of candlesticks without restriction. Then, the "confirmations" of candlesticks are part and parcel (Pring, 2002), and we inspect three criteria for modifying the predictive power of the six reversal patterns.

First, the open of the day after the pattern is very important. For example, if the open of the day after a bearish reversal pattern is higher than the close of the last day, the buyer will slack off slightly, and the device of the shorter will be held back, and vice versa. We define a variable named $\triangle OPEN$ to test this effect.

Secondly, we take the real body of the candlestick into consideration. The gap of the two real bodies of one reversal pattern exhibits well-matched strength. In harami, the smaller the second real body, the more potent the pattern, because the smaller the real body, the greater the ambivalence and the more likely a trend reversal will occur (Nison, 1991). In other patterns, like the piercing, if the two real bodies are both large, the reliability of this pattern will increase since the bears depleted their energy. Thus, the smaller the gap of the two real bodies of the piercing is the better. We name this variable as $\triangle RB$**.**

Thirdly, volume is a measure of demand and supply, and a confirmation of price trends. Changes of volume patterns will be the omen of the reversal of a trend. We name this variable as $\triangle lnQ$. Above of all, these three variables are potential triggers for the pivot point of candlesticks.

By using six reversal patterns and holding days, a QR model is applied to discuss whether these three variables can significantly affect the rate of return.

4. Empirical results

4.1 Candlesticks statistics

In Table 1, the mean rates of return for each candlestick reversal pattern on each holding day are presented. It shows that the bullish harami are positively significant on holding four days and five days, the dark-cloud cover is negatively significant on holding five days, the bearish engulfing are negatively significant on holding three days to five days, and the bearish harami are positively significant on holding one day to five days. They are negative results except the harami. We review three criteria for modifying the predictive power of the six reversal patterns as follows.

4.2 QR statistics

4.2.1 Piercing

In Tables 2 to 6, in spite of holding days, the $\triangle OPEN$ coefficients are significantly negative. However, the other two variables are both insignificant. This result indicates that this pattern was generally influenced by the open after the pattern. By the meaning of demand and supply, the trend is in a falling market originally, and the second day of this pattern opens sharply lower under the low of the prior day. This atmosphere strengthens the confidence of the bears , but good times don't last long. Subsequently, prices push higher above the mid-point of the prior day's real body. This peripeteia will either make the bears worry about their positions, or mean that it is time to finish the bottom. Accordingly, if the next day after this pattern opens lower via a gap, the bears will be allured to bear-cover, and thus it will stimulate a surge for an uptrend.

4.2.2 Bullish Engulfing

Tables 7 to 11 present QR estimates of the bullish engulfing. The $\triangle OPEN$ coefficients are significantly negative on holding for one day in this pattern. But on holding for three to five days, the $\triangle RB$ coefficients are significantly positive. When the quantiles develop, the $\triangle RB$ coefficient increases.

4.2.3 Bullish Harami

In Tables 12 to 16, three variables, i.e. $\triangle OPEN$, $\triangle RB$ and $\triangle lnQ$, are almost insignificant, and the few existing significances are decentralizing in some holding days and quantiles. Only the $\triangle lnQ$ coefficients are significantly positive on holding for one day in the 90^{th} quantile at 1% (see Table 12). This pattern is considered a brake in the trend, because the second line of the pattern requires a narrow range built by the open and the close. This is just a lull before it changes and the trading area of the second day forming this pattern reduces, so it needs enormous popularity to reverse.

4.2.4 Dark-Cloud Cover

The dark-cloud cover is influenced by the three main variables in this study. The variable $\triangle OPEN$ is significantly positive on holding for one day and two days (see Table 17 and 18), and the variable $\triangle RB$ is negative on holding for tow days to four days in high return areas (see Table 18 and 19), that is quantiles are larger than the 50^{th}. The

variable $\triangle lnQ$ is significantly negative on holding for one day except at the 90th quantiles. This reveals that the open of the day following this pattern is higher, and the trading areas of the two days formed this pattern are both large, and the volume of the second day that formed this pattern is smaller signifying that this pattern enhances profits. The rationale behind this pattern is abundantly clear. Originally, the open of the second day is above the prior day's high, thus the atmosphere of the market abounds with contentment, however the end of the market closes near the low of the prior day, at least penetrating it by half. In such a scenario, the bulls lost heart, and the control of the market has moved from the bulls to the bears. This pattern may be regarded as the last flounce of the bulls with spent force.

4.2.5 Bearish Engulfing

In Tables 22 to 26 and in their low return areas, the variable $\triangle OPEN$ is extremely significantly positive. In general, when the quantiles develop, the $\triangle OPEN$ coefficient decreases. In high return areas, the coefficients are even negative. This means that the day after this pattern opens low signifies a reinforcing condition. This pattern occurred after a uptrend, and all potential buyers have already jumped into the market, resulting in a price rise that is difficult for the following buyers, whereas swarmming with shorting force from profitable sellers along the uptrend.

4.2.6 Bearish Harami

In Tables 27 to 31, the variables $\triangle OPEN$ and $\triangle RB$ are significantly positive in high return areas. The greater $\triangle RB$, the greater the return becomes. Because this pattern essentially is a wait-and-see situation, it shows the doughy bears when $\triangle RB$ is small. It's worth mentioning that these three variables are insignificant in low return areas whereas $\triangle OPEN$ and $\triangle RB$ are extremely significant in high return areas on holding for three days to five days.

In a nutshell, if investors want to use the bearish harami for trading, they have to notice the problems which are the gap of the two real bodies of the pattern and the open of the day following the pattern. Furthermore, in regards to the trading volume aspect, it reveals less significance than the other two factors in high return areas, because the change from uptrend to downtrend price has its own gravity, like Free-Falling Objects. This pattern is very similar to the Western inside day. From supply and demand aspect, in the uptrend, a white line occurs, and on the following day opens lower and the price ambulates in a limited boundary. At the same time, no one buy any further, everything just stops and the market "catches its breath". The harami just like the brake of the trend and the condition should be stopped in the while and the price will move in a very small range.

5. Conclusion and Suggestion

Our evidence suggests that the harami pattern is just the best trading rule in six candlestick reversal patterns tested for this study in Taiwan stock market, because this strategy is more frequent and most trustworthy according to our results. The results of the mean rate of returns are not significantly positive, but they have a relationship with the confirmative criteria, are the open after the pattern, the gap of the two real bodies, and the volume change in the second day of the pattern.

To the best of our knowledge, this study is the first to test the predictive power of candlestick reversal patterns with the Quantile Regression Model and address the problem of confirmative factors. The other contribution of this paper is that it takes trading volume and positions into consideration, which be said to the confirmation of candlesticks. It is the key to the optimization of the oldest form of technical analysis, the candlestick trading strategy. In the previous studies, Fock et al. (2005) use the indicators to improve the performance of candles, and Goo's et al. (2007) take stop-loss strategies into consideration. Both of their methods improved the candlestick strategies. We optimize the candlestick trading strategies by other means.

When evaluating the effectiveness of a reversal pattern, another key factor should be considered, the support or resistance level. This is because technical analysts believe that investors are willing to sell at the peak and to buy at the bottom (Brock et al., 1992). Therefore, future studies should address this topic with the candlestick trading strategy.

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Table1. The average returns of six candlestick reversal patterns

	Holding-day				
	1	2	3	4	5
Piercing	0.19%	1.55%	1.51%	1.78%	1.53%
Bullish Engulfing	-0.11%	-0.09%	-0.14%	-0.17%	-0.02%
Bullish Harami	-0.03%	-0.08%	0.47%	2.31%*	5.78%**
Dark-Cloud Cover	-0.37%	-0.50%	-0.64%	-0.83%	-1.14%*
Bearish Engulfing	0.02%	-0.15%	-0.38%***	-0.57%***	-0.87%***
Bearish Harami	0.42%***	0.47%***	0.70%***	0.70%***	0.54%***

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level.

Table 2. Estimation Results for the Quantile Regression—Piercing—holding for 1 day

Variables	5^{th}	10^{th}	25^{th}	50^{th}	75^{th}	90^{th}	95^{th}
$\triangle OPEN$	-0.1967	-0.2987***	-0.1441	-0.0241	-0.1343	-0.4928***	-0.7416***
	(0.2790)	(<0.0001)	(0.1070)	(0.7810)	(0.5040)	(0.0090)	(<0.0001)
$\triangle RB$	-0.0136	-0.0051	-0.0017	-0.0043	-0.0122	-0.0043	0.0009
	(0.2360)	(0.4030)	(0.7160)	(0.2940)	(0.1530)	(0.6500)	(0.9230)
$\triangle lnQ$	-0.0045	0.0010	-0.0009	0.0030	0.0130**	0.0062	0.0023
	(0.4630)	(0.7630)	(0.7890)	(0.3920)	(0.0350)	(0.4070)	(0.8160)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 247. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 3. Estimation Results for the Quantile Regression—Piercing—holding for 2 days

Variables	5^{th}	10^{th}	25^{th}	50^{th}	75^{th}	90^{th}	95^{th}
$\triangle OPEN$	-0.7404***	-0.4610**	-0.4102**	-0.1173	-0.0035	-0.2197	-0.5448
	(0.0050)	(0.0500)	(0.0200)	(0.4690)	(0.9880)	(0.5360)	(0.5640)
$\triangle RB$	0.0236*	0.0135	-0.0028	-0.0055	-0.0026	0.0165	0.0010
	(0.0990)	(0.1960)	(0.7470)	(0.4960)	(0.7930)	(0.2050)	(0.9640)
$\triangle lnQ$	-0.0106	-0.0095	-0.0032	-0.0005	0.0071	0.0204	0.0154
	(0.3760)	(0.2630)	(0.6020)	(0.9350)	(0.5160)	(0.1310)	(0.6410)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 247. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 4. Estimation Results for the Quantile Regression—Piercing—holding for 3 days

Variables	5^{th}	10^{th}	25^{th}	50^{th}	75^{th}	90^{th}	95^{th}
$\triangle OPEN$	-0.2200	-0.2834	-0.3499	-0.3893**	-0.0305	-0.1762	-0.0258
	(0.7070)	(0.4320)	(0.1830)	(0.0390)	(0.9090)	(0.7170)	(0.9820)
$\triangle RB$	0.0135	0.0024	0.0029	0.0001	0.0053	0.0060	-0.0114
	(0.4700)	(0.8980)	(0.8160)	(0.9880)	(0.6810)	(0.7200)	(0.7630)
$\triangle lnQ$	-0.0192	-0.0142	-0.0110	-0.0150	0.0062	0.0329	0.0318
	(0.2160)	(0.2350)	(0.2440)	(0.0440)	(0.6100)	(0.2890)	(0.3590)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 247. The

upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 5. Estimation Results for the Quantile Regression—Piercing—holding for 4 days

Variables	5th	10th	25th	50th	75th	90th	95th
△*OPEN*	-0.3623	0.0987	-0.1345	-0.2868*	-0.1198	-0.0114	0.1293
	(0.7360)	(0.7790)	(0.6470)	(0.0980)	(0.7120)	(0.9810)	(0.9060)
△*RB*	0.0120	-0.0036	0.0031	0.0036	0.0333*	0.0220	0.0130
	(0.7000)	(0.8550)	(0.8490)	(0.6800)	(0.0660)	(0.3970)	(0.8270)
△*lnQ*	-0.0262	-0.0115	-0.0051	-0.0217***	0.0042	0.0401	0.0333
	(0.4320)	(0.3410)	(0.6490)	(0.0020)	(0.7940)	(0.2620)	(0.8170)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 247. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 6. Estimation Results for the Quantile Regression—Piercing—holding for 5 days

Variables	5th	10th	25th	50th	75th	90th	95th
△*OPEN*	-0.6192	-0.0125	-0.0665	-0.3091	-0.0389	-0.3418	-0.1718
	(0.6210)	(0.9770)	(0.7860)	(0.1520)	(0.8740)	(0.6510)	(0.8910)
ΔRB	0.0021	-0.0035	0.0269*	0.0066	0.0104	0.0551*	0.0497
	(0.9740)	(0.8610)	(0.0630)	(0.5430)	(0.4220)	(0.0510)	(0.5580)
ΔlnQ	0.0100	0.0026	-0.0161	-0.0102	-0.0040	0.0294	0.0528
	(0.8000)	(0.8660)	(0.1180)	(0.2430)	(0.7380)	(0.5430)	(0.5250)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 247. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 7. Estimation Results for the Quantile Regression—Bullish Engulfing—holding for 1 day

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	-0.1422*	-0.1061	-0.1585**	-0.0962***	-0.1113*	-0.2596***	-0.7074***
	(0.0520)	(0.2330)	(0.0120)	(0.0070)	(0.0980)	(0.0050)	(<0.0001)
ΔRB	>-0.0001	0.0002	-0.0001	0.0004**	0.0006*	0.0003	0.0001
	(0.9930)	(0.6010)	(0.7540)	(0.0480)	(0.0680)	(0.5490)	(0.7770)
ΔlnQ	-0.0027	-0.0031	-0.0019	-0.0020	-0.0046*	0.0022	-0.0009
	(0.4430)	(0.2310)	(0.3680)	(0.1310)	(0.0650)	(0.5910)	(0.7750)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 1161. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 8. Estimation Results for the Quantile Regression—Bullish Engulfing—holding for 2 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.0600	0.1292	0.1130*	-0.0423	0.1005	0.1355	-0.1248
	(0.6630)	(0.2850)	(0.0930)	(0.5260)	(0.2760)	(0.5640)	(0.8190)
ΔRB	-0.0004	-0.0003	-0.0004	0.0002	0.0004	0.0017**	0.0019
	(0.3910)	(0.5840)	(0.1540)	(0.5900)	(0.3620)	(0.0340)	(0.2080)
ΔlnQ	0.0021	-0.0023	-0.0034	-0.0059	-0.0046*	0.0017	0.0034
	(0.7450)	(0.5630)	(0.1360)	(0.0160)	(0.0980)	(0.7700)	(0.7750)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 1161. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 9. Estimation Results for the Quantile Regression—Bullish Engulfing—holding for 3 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.3777**	0.3918***	0.1457	-0.0403	0.1388	-0.0666	-0.3957
	(0.0430)	(0.0090)	(0.1410)	(0.6310)	(0.2090)	(0.8370)	(0.5200)
ΔRB	-0.0009	-0.0014	-0.0001	0.0006	0.0010*	0.0027**	0.0045***
	(0.3550)	(0.1330)	(0.8000)	(0.1150)	(0.0510)	(0.0240)	(0.0020)
ΔlnQ	-0.0031	-0.0090	-0.0093**	-0.0052*	-0.0040	-0.0079	-0.0098
	(0.6950)	(0.1760)	(0.0110)	(0.0910)	(0.2540)	(0.3340)	(0.3970)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 1161. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 10. Estimation Results for the Quantile Regression—Bullish Engulfing—holding for 4 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.4533*	0.3014*	0.2015*	0.1313	0.0877	-0.0288	-0.2408
	(0.0730)	(0.0890)	(0.0710)	(0.1540)	(0.4960)	(0.9320)	(0.7460)
ΔRB	-0.0023	-0.0028**	-0.0010*	0.0004	0.0016***	0.0030	0.0054***
	(0.1510)	(0.0150)	(0.0600)	(0.3600)	(0.0060)	(0.0140)	(0.0040)
ΔlnQ	0.0033	-0.0082	-0.0035	-0.0058	-0.0045	-0.0051	0.0001
	(0.7670)	(0.2750)	(0.3980)	(0.0880)	(0.2500)	(0.5240)	(0.9930)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 1161. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 11. Estimation Results for the Quantile Regression—Bullish Engulfing—holding for 5 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.8343**	0.5809**	0.1941	0.1427	0.0368	-0.1155	-0.5103
	(0.0180)	(0.0200)	(0.1110)	(0.1400)	(0.8150)	(0.7320)	(0.3190)
ΔRB	-0.0023	-0.0028**	-0.0021***	0.0006	0.0012*	0.0032***	0.0063***
	(0.1820)	(0.0250)	(<0.0001)	(0.2300)	(0.0930)	(0.0090)	(0.0010)
ΔlnQ	0.0067	0.0004	-0.0037	-0.0027	-0.0010	0.0085	0.0194
	(0.6400)	(0.9670)	(0.4430)	(0.4440)	(0.8340)	(0.3140)	(0.1800)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 1161. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 12. Estimation Results for the Quantile Regression—Bullish Harami—holding for 1 day

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.0084	-0.0362	-0.1383***	-0.0099	0.1039	-0.0942	-0.1061
	(0.9460)	(0.7110)	(0.0060)	(0.8250)	(0.2490)	(0.3730)	(0.2340)
ΔRB	0.0035	0.0035	-0.0035	-0.0024	-0.0023	-0.0061	0.0021
	(0.6340)	(0.5690)	(0.2340)	(0.3660)	(0.6420)	(0.3660)	(0.7760)
ΔlnQ	-0.0025	-0.0021	0.0016	0.0018	0.0054*	0.0141***	0.0065*
	(0.4780)	(0.5020)	(0.3180)	(0.2280)	(0.0640)	(<0.0001)	(0.0710)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 1291. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 13. Estimation Results for the Quantile Regression—Bullish Harami—holding for 2 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.0941	0.0466	-0.0252	-0.0708	-0.0861	0.1476	0.0418
	(0.5610)	(0.7440)	(0.8060)	(0.1770)	(0.4630)	(0.5430)	(0.9270)
ΔRB	0.0226*	0.0169*	0.0032	0.0001	-0.0057	-0.0087	-0.0167
	(0.0850)	(0.0770)	(0.6350)	(0.9740)	(0.3520)	(0.3610)	(0.2810)
ΔlnQ	-0.0058	-0.0084*	0.0001	0.0014	0.0071**	0.0060	0.0050
	(0.3990)	(0.0940)	(0.9840)	(0.4120)	(0.0460)	(0.3390)	(0.6770)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 1291. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 14. Estimation Results for the Quantile Regression—Bullish Harami—holding for 3 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.4285*	0.0470	-0.1696	-0.2863***	-0.1449	-0.0399	-0.0088
	(0.0860)	(0.8120)	(0.1120)	(<0.0001)	(0.2640)	(0.8870)	(0.9880)
ΔRB	0.0292*	0.0147	0.0084	0.0018	0.0095	-0.0057	0.0072
	(0.0780)	(0.2900)	(0.2180)	(0.7080)	(0.1590)	(0.6080)	(0.6920)
ΔlnQ	-0.0091	-0.0010	0.0005	0.0009	0.0019	0.0065	0.0124
	(0.2680)	(0.8860)	(0.8960)	(0.7250)	(0.6350)	(0.3810)	(0.4060)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 1291. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 15. Estimation Results for the Quantile Regression—Bullish Harami—holding for 4 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.1391	0.3737*	-0.1310	-0.3407***	-0.0735	-0.0589	0.0324
	(0.5840)	(0.0800)	(0.2620)	(<0.0001)	(0.6960)	(0.8800)	(0.9630)
ΔRB	0.0066	0.0050	0.0028	0.0057	0.0086	-0.0102	-0.0147
	(0.7140)	(0.7330)	(0.7180)	(0.2560)	(0.3390)	(0.5200)	(0.5000)
ΔlnQ	0.0112	-0.0052	-0.0055	-0.0005	0.0066	0.0093	0.0243
	(0.1890)	(0.5150)	(0.1670)	(0.8440)	(0.1920)	(0.3430)	(0.1310)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 1291. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 16. Estimation Results for the Quantile Regression—Bullish Harami—holding for 5 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.1056	0.5903***	-0.0032	-0.1415	0.1422	0.0969	-0.1751
	(0.7190)	(0.0010)	(0.9860)	(0.2050)	(0.4380)	(0.8240)	(0.8210)
ΔRB	0.0134	0.0199	0.0170	0.0020	0.0045	-0.0158	-0.0203
	(0.5400)	(0.1290)	(0.1480)	(0.7700)	(0.6040)	(0.3000)	(0.4290)
ΔlnQ	0.0156	0.0013	-0.0138**	0.0018	0.0043	0.0145	0.0247
	(0.1540)	(0.8540)	(0.0240)	(0.6210)	(0.4060)	(0.1650)	(0.2080)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 1291. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 17. Estimation Results for the Quantile Regression—Dark-Cloud Cover—holding for 1 day

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	1.0641**	0.7384***	0.7403***	0.7023***	0.6910***	0.5435**	1.0774***
	(0.0160)	(0.0060)	(0.0060)	(<0.0001)	(<0.0001)	(0.0320)	(<0.0001)
ΔRB	-0.0016***	-0.0013*	0.0005	0.0002	-0.0001	-0.0004	-0.0001
	(0.0020)	(0.0780)	(0.3370)	(0.7940)	(0.8580)	(0.8570)	(0.5710)
ΔlnQ	-0.0326**	-0.0345***	-0.0209**	-0.0160*	-0.0144**	-0.0114	-0.0272***
	(0.0340)	(0.0040)	(0.0440)	(0.0680)	(0.0190)	(0.4230)	(<0.0001)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 165. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 18. Estimation Results for the Quantile Regression—Dark-Cloud Cover—holding for 2 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.7482	0.4088	0.3097*	0.6955***	0.7509***	0.8878**	0.2670
	(0.1330)	(0.5300)	(0.0630)	(<0.0001)	(<0.0001)	(0.0230)	(0.6300)
ΔRB	-0.0001	-0.0002	-0.0008*	-0.0006	-0.0013***	-0.0017**	-0.0020**
	(0.9400)	(0.9480)	(0.0960)	(0.2260)	(<0.0001)	(0.0160)	(0.0240)
ΔlnQ	-0.0137	-0.0288	-0.0229***	-0.0106	0.0106	0.0128	0.0114
	(0.6730)	(0.2190)	(0.0070)	(0.1840)	(0.1350)	(0.5860)	(0.7940)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 165. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 19. Estimation Results for the Quantile Regression—Dark-Cloud Cover—holding for 3 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	1.4551**	1.2318	0.3754	0.2773	0.5267**	0.4394	0.5879
	(0.0270)	(0.1970)	(0.4410)	(0.2250)	(0.0160)	(0.3050)	(0.2020)
ΔRB	-0.0006	-0.0002	-0.0008	-0.0014**	-0.0023***	-0.0021***	-0.0037***
	(0.6700)	(0.9890)	(0.6430)	(0.0290)	(<0.0001)	(<0.0001)	(<0.0001)
ΔlnQ	-0.0230	-0.0108	-0.0017	-0.0061	-0.0019	-0.0014	0.0319
	(0.5730)	(0.7460)	(0.9330)	(0.5580)	(0.8480)	(0.9390)	(0.1720)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 165. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 20. Estimation Results for the Quantile Regression—Dark-Cloud Cover—holding for 4 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.4351	0.7260	0.4164	0.4641*	0.8971**	0.1996	0.3702
	(0.6580)	(0.4170)	(0.4010)	(0.0540)	(0.0140)	(0.8330)	(0.3970)
ΔRB	0.0021	0.0008	0.0001	-0.0006	-0.0005	-0.0023	-0.0035***
	(0.3610)	(0.7260)	(0.9600)	(0.4020)	(0.5430)	(0.2390)	(0.0000)
ΔlnQ	0.0150	-0.0093	-0.0090	-0.0073	-0.0179	0.0049	0.0394**
	(0.8150)	(0.7830)	(0.6760)	(0.5190)	(0.2270)	(0.8650)	(0.0370)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 165. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 21. Estimation Results for the Quantile Regression—Dark-Cloud Cover—holding for 5 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.3593	0.3823	0.2857	0.7388***	0.5007	0.3609	0.4371
	(0.8070)	(0.7900)	(0.4570)	(<0.0001)	(0.2480)	(0.5300)	(0.4920)
ΔRB	0.0010	0.0004	0.0008	0.0002	-0.0005	-0.0015	-0.0024
	(0.7600)	(0.9170)	(0.5770)	(0.6850)	(0.5190)	(0.4920)	(0.4070)
ΔlnQ	0.0487	-0.0260	-0.0426***	-0.0126	-0.0108	-0.0241	-0.0200
	(0.6210)	(0.6310)	(0.0070)	(0.1720)	(0.4570)	(0.4660)	(0.4620)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 165. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 22. Estimation Results for the Quantile Regression—Bearish Engulfing—holding for 1 day

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.5795***	0.3263***	0.3093***	0.1392***	0.1624***	0.1648	0.2368
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.0010)	(0.1640)	(0.2780)
ΔRB	0.0001***	0.0001	0.0002	-2.50E-06	-0.0003	-0.0001	-0.0002
	(<0.0001)	(0.5000)	(0.6020)	(0.9360)	(0.1500)	(0.7790)	(0.4530)
ΔlnQ	0.0090**	0.0034	0.0002	-0.0001	0.0012	0.0064*	0.0064*
	(0.0210)	(0.3380)	(0.9170)	(0.9930)	(0.5210)	(0.0570)	(0.0820)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 1554. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 23. Estimation Results for the Quantile Regression—Bearish Engulfing—holding for 2 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.1959	0.3030**	0.4436***	0.3569***	0.1836**	-0.0049	0.0470
	(0.2460)	(0.0240)	(<0.0001)	(<0.0001)	(0.0030)	(0.9680)	(0.7830)
ΔRB	0.0001**	0.0001	0.0002	0.0001**	0.0002	-0.0001	-0.0001***
	(0.0350)	(0.8110)	(0.7300)	(0.0310)	(0.4790)	(0.2060)	(0.0030)
ΔlnQ	0.0096	0.0050	0.0025	0.0019	0.0010	-0.0023	-0.0010
	(0.1870)	(0.4110)	(0.3940)	(0.3440)	(0.6630)	(0.6640)	(0.8850)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 1554. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 24. Estimation Results for the Quantile Regression—Bearish Engulfing—holding for 3 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.6209***	0.5022***	0.3237***	0.1887***	-0.0322	-0.0035	-0.0964
	(0.0030)	(0.0020)	(0.0010)	(0.0010)	(0.6760)	(0.9800)	(0.7350)
ΔRB	0.0002	0.0002	0.0001	0.0001	<0.0001	-0.0002	0.0001
	(0.5100)	(0.6190)	(0.4890)	(0.3170)	(0.8330)	(0.7400)	(0.1680)
ΔlnQ	0.0167*	0.0103	-0.0003	-0.0001	0.0073**	-0.0029	-0.0065
	(0.0760)	(0.1140)	(0.9480)	(0.9660)	(0.0370)	(0.5650)	(0.5240)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 1554. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 25. Estimation Results for the Quantile Regression—Bearish Engulfing—holding for 4 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.6908*	0.6701***	0.4388***	0.1640**	0.0384	-0.3650*	-0.4901**
	(0.0810)	(<0.0001)	(<0.0001)	(0.0180)	(0.6400)	(0.0780)	(0.0430)
ΔRB	0.0002	0.0001	0.0004	-0.0002	-0.0001	-0.0001	-0.0002
	(0.6500)	(0.3880)	(0.6120)	(0.5930)	(0.7080)	(0.2010)	(0.1570)
ΔlnQ	0.0177	0.0124*	0.0020	-0.0003	0.0059	0.0045	-0.0019
	(0.2670)	(0.0840)	(0.6610)	(0.9180)	(0.1100)	(0.5620)	(0.8290)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 1554. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 26. Estimation Results for the Quantile Regression—Bearish Engulfing—holding for 5 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.8843**	0.6057**	0.4248***	0.1270*	-0.0706	-0.1971	-0.1685
	(0.0270)	(0.0130)	(0.0000)	(0.0990)	(0.5680)	(0.1840)	(0.6080)
ΔRB	0.0003***	0.0002**	0.0001	<0.0001	-0.0004	0.0001***	0.0002
	(0.0000)	(0.0220)	(0.4460)	(0.9870)	(0.5340)	(0.0020)	(0.8220)
ΔlnQ	0.0306**	0.0189*	-0.0009	0.0015	0.0026	0.0018	-0.0048
	(0.0290)	(0.0600)	(0.8550)	(0.6660)	(0.6500)	(0.7650)	(0.7230)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 1554. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 27. Estimation Results for the Quantile Regression—Bearish Harami—holding for 1 day

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.2894	0.1438	0.1930**	0.2830***	0.3515***	0.5474***	0.5488***
	(0.2330)	(0.2520)	(0.0180)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ΔRB	>-0.0001***	>-0.0001***	>-0.0001***	>-0.0001	<0.0001	<0.0001	<0.0001***
	(0.0000)	(0.0000)	(0.0000)	(0.1740)	(0.9320)	(0.7740)	(0.0000)
ΔlnQ	-0.0152**	-0.0116***	-0.0028	0.0014	0.0022	0.0106***	0.0086*
	(0.0220)	(0.0040)	(0.2660)	(0.4280)	(0.4030)	(0.0080)	(0.0780)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 882. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 28. Estimation Results for the Quantile Regression—Bearish Harami—holding for 2 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	0.0208	-0.0514	0.1088	0.3716***	0.5900***	0.4127	0.4314
	(0.9690)	(0.8450)	(0.3630)	(<0.0001)	(<0.0001)	(0.1200)	(0.3550)
ΔRB	>-0.0001***	>-0.0001*	>-0.0001	<0.0001	<0.001***	0.0001***	0.0001***
	(0.0010)	(0.0600)	(0.6080)	(0.1410)	(0.0010)	(<0.0001)	(<0.0001)
ΔlnQ	-0.0301**	-0.0102	-0.0036	0.0007	0.0016	0.0080	0.0058
	(0.0240)	(0.1850)	(0.2540)	(0.7520)	(0.6720)	(0.2400)	(0.6470)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 882. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 29. Estimation Results for the Quantile Regression—Bearish Harami—holding for 3 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	-0.0956	0.2358	0.0457	0.3026***	0.5662***	0.4545*	0.5424
	(0.9080)	(0.5680)	(0.7540)	(0.0060)	(<0.0001)	(0.0770)	(0.2470)
ΔRB	>-0.0001	<0.0001	<0.0001	0.0001***	0.0001***	0.0002***	0.0002***
	(0.3180)	(0.9700)	(0.3070)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
ΔlnQ	-0.0193	-0.0044	-0.0062	-0.0013	0.0024	0.0127**	0.0003
	(0.4410)	(0.7100)	(0.1270)	(0.7110)	(0.5750)	(0.0420)	(0.9540)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 882. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 30. Estimation Results for the Quantile Regression—Bearish Harami—holding for 4 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	-0.1921	-0.3560	0.1165	0.3329*	0.5214***	0.5286	0.6108***
	(0.8500)	(0.3970)	(0.4430)	(0.0780)	(0.0010)	(0.1120)	(<0.0001)
ΔRB	>-0.0001*	>-0.0001	<0.0001	<0.0001*	0.0001***	0.0002***	0.0002***
	(0.0650)	(0.3330)	(0.6380)	(0.0920)	(<0.0001)	(<0.0001)	(<0.0001)
ΔlnQ	-0.0314	-0.0187	-0.0083*	-0.0035	0.0022	0.0090	0.0028
	(0.3180)	(0.1330)	(0.0770)	(0.5550)	(0.6390)	(0.2550)	(0.8180)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 882. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

Table 31. Estimation Results for the Quantile Regression—Bearish Harami—holding for 5 days

Variables	5th	10th	25th	50th	75th	90th	95th
ΔOPEN	-0.0065	-0.1969	0.3329	0.3044**	0.5096**	0.4863	0.2884***
	(0.9960)	(0.6770)	(0.1110)	(0.0150)	(0.0150)	(0.1430)	(0.0000)
ΔRB	-0.0001	>-0.0001	<0.0001	0.0001**	0.0001***	0.0002***	0.0002***
	(0.1060)	(0.8500)	(0.7750)	(0.0190)	(<0.0001)	(<0.0001)	(<0.0001)
ΔlnQ	-0.0298	-0.0189	-0.0137**	-0.0069*	0.0023	0.0004	0.0037
	(0.4700)	(0.1260)	(0.0310)	(0.0830)	(0.6940)	(0.9960)	(0.8090)

Note: *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level. The number of observations is 882. The upper numbers are the coefficient of the quantile regression and the p-values are in the parentheses.

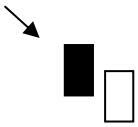
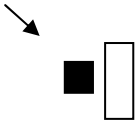
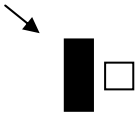
Pattern	Chart	Definition
Piercing		In a downtrend, following a black line the market opens lower, but closes above the mid-point of the prior candlestick's real body.
Bullish Engulfing		In a downtrend, following a black line the market opens lower, but closes above the open of the prior candlestick's real body.
Bullish Harami		In a downtrend, following a long black line the market opens higher than the prior close, and closes below the prior open. The second day's small real body holds within the prior long real body.

Figure 1. Two-day bullish reversal patterns

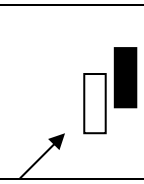
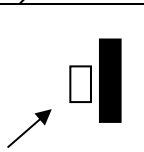
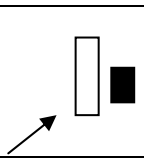
Pattern	Chart	Definition
Dark-Cloud Cover		In an uptrend, following a white line the market opens higher, but closes blow the mid-point of the prior candlestick's real body.
Bearish Engulfing		In an uptrend, following a white line the market opens higher, but closes below the open of the prior candlestick's real body.
Bearish Harami		In an uptrend, following a long white line the market opens lower than the prior close, and closes above the prior open. The second day's small real body holds within the prior long real body.

Figure 2. Two-day bearish reversal patterns

Inflation, Unemployment and the NAIRU in Pakistan (1975-2009)

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Abstract

In a developing country like Pakistan, Phillips Curve approach is employed on a data set of 35 years starting from 1975-2009. Phillips Curve helps in examining the relationship between inflation and unemployment. There is a non-proportional negative relationship between inflation and unemployment (if unemployment is reduced than there is a rising price level in the economy). Non-parametric estimates of the NAIRU are calculated. In this study, results are in the range of 3.21 – 9.01 percent. There is a long-run and casual relationship between inflation and unemployment over the above mentioned period in Pakistan. There is a transitory relationship (shocks) in the short-run, while there is a permanent relationship (shocks) in the long-run. By looking at the relationship established, one can forecast for next 10 years, that there will be an opposite relationship between both variables. This paper documents an empirical evidence for the existence of the Phillips curve in Pakistan i.e., inflation has decreased unemployment.

Keywords: Phillips curve, NAIRU, Granger causality, Impulse response function, Pakistan

Jel Classification Code*:* C22, E31, E50

1. Introduction

Over the last five decades, the subject of price/wage inflation and unemployment has been a major concern for economists and common economic agents. This approach started in 1958, when a British Economist A. W. Phillips wrote an article on "The Relationship between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom" by using a data set from 1862 to 1957. This empirical study was formed by a reasonably smooth curve which is known as "Phillips Curve". Phillips curve shows a trade-off between rate of inflation and unemployment. Phillips Curve interprets that if unemployment is to be reduced than we have to accept the rising price level in the economy. Various theories have been put forward to explain continuing inflation all over the world. In Pakistan, the subject of inflation has been the central issue in most of macroeconomics studies. Various factors are considered in the literature as strong forces for determining price inflation. These factors are monetary expansion, stagnation of output, increasing import prices, increasing wage rates and sticky expectations etc.

1.1. Research Hypothesis

It has been observed that Inflation and unemployment have both direct and indirect relationships. Our hypothesis is to examine the existence of Phillips curve by considering, whether there is a direct or indirect relationship between inflation and unemployment in the context of Pakistan.

1.2. Research Objectives

The objective of this paper is to examine the existence of Phillips Curve in Pakistan, by using a time series data from 1975-2009. The more specific objectives are:

i. To estimate a short-run trade-off between inflation and unemployment, this is implied by the Phillips Curve and the NAIRU.

ii. To estimate a long-run relationship between inflation and unemployment over the last 35 years.

iii. To estimate changes in the unemployment rate, this is Granger cause changes in inflation.

iv. To estimate permanent supply shocks, this drives both inflation and unemployment in the long-run. Whereas, in the short run the usual tradeoff is induced due to demand shocks.

This paper is organized in five sections. Section 2 presented a literature review. Section 3 focuses on inflation, unemployment, NAIRU and unemployment gap in Pakistan. Section 4 provides data source and methodological framework. The empirical results are presented in Section 5, while the final section concludes the study.

2. Literature Review

Paul Samuelson and Robert Solow were among the first researchers, who supported the Phillips hypothesis. Samuelson and Solow (1970) examined the relationship between the inflation and unemployment rate in the United States. An inverse relationship was established between inflation and unemployment. In another study conducted by Solow (1970) and Gordon (1971), results reveal the existence of a negative trade-off relationship between unemployment and inflation using U.S. macroeconomic data. These empirical findings have been known as the "Solow-Gordon affirmation" of the Phillips curve.

Although William Phillips based his hypothesis on a strong theoretical foundation, the debate on whether the Phillips curve really exists or does not exist dates back to the 1960s. Islam *et al.* (2003: 107) has noted that Phillips Curve is open to debates since its inception. Friedman (1968) and Phelps (1967) openly criticized the hypothesis and mentioned that there is no trade-off relationship between unemployment and inflation. Furthermore, Lucas (1976) strongly opposed the proposition of the existence of the Phillips curve. He argued that there could have been a trade-off relationship between unemployment and inflation, subject to the assumption that the policy makers have not created an artificial situation, where high-inflation is pared with low unemployment. Otherwise, the workers would foresee the high inflation in the future and would demand wage increase from their employers. In this case, there could be coexistence of high unemployment and high inflation rate which is known as the "Lucas critique".

In the 1970s, economists began to loose interest in doing research on the Phillips curve. As Debelle and Vickery (1998:384) commented, "The Phillips curve fell into a period of neglect in academic circles during the 1980s, however it remained an important tool for policy makers". 1990s witnessed the revival of the academic interest in the Phillips curve and "the Phillips curve has again been the subject of intensive debate (for example, the symposium proceedings in the *Journal of Economic Perspectives"* (Debelle and Vickery, 1998:384). Generally, empirical findings have shown the mixed results. Some researcher found the significant trade-off relationship between unemployment rate and inflation rates and other does not. Among research studies done in the 1990s, Alogoskoufis and Smith (1991) showed the empirical evidence to support the "Lucas critique" which denied the existence of trade-off relationship. By contrast, King and Watson (1994) tested the existence of the Phillips curve using the U.S. post-war macroeconomic data. Their findings provided empirical support to the existence of the trade-off relationship between unemployment and inflation in the USA over the researched period. Hansen and Pancs (2001) examined the existence of the Phillips curve in Lativa. They also found out that there is a significant correlation between the unemployment rate and the actual inflation rates. Furthermore, Islam *et al.* (2003) examined the hypothesis of Philips curve through US economic data from 1950 to 1999. They find out the weak long-run cointegrating relationship and long-run causality between unemployment and inflations. On the other hand, Hart (2003) tested the Phillips hypothesis by employing the hourly wage earning. He concluded that during inter-war period (1926-66) in Britain, the Phillips curve is "not supported by our data". Furuoka (2007) examined the long-run & trade-off relationship and also causal relationship between the unemployment rate and the inflation rate in Malaysia during the period of 1975-2004).

A recent methodological innovation in assessing the Phillips curve has been the use of panel data analysis. Dinardo and Moore (1999) used panel data analysis to examine 9 member countries of the Organization for Economic Co-operation and Development (OECD). The researchers used the method of Ordinary Least Squares (OLS) and Generalized Least Squares (GLS). Their findings confirmed the existence of the "common" Phillips curve in these OECD countries. Turner and Seghezza (1999) also employed the panel data method and observed the Phillips curve in 21 OECD countries over the period from the early 1970s to 1997. To analyze the pooled data, Turner and Seghezza used the method of Seemingly Un-related Estimation (SURE) rather than the OLS. The researchers concluded that the overall result provided a "strong support" for the existence of the "common" Phillips curve among the 21 chosen member countries of OECD. Arratibel *et al.* (2002) analyzed New Keynesian Phillips curve with forward-looking expectations by using panel data. They found that the unemployment rates have significant relationship with non-tradable inflation rates. By contrast, Masso and Staehr (2005) used the dynamic panel data method and failed to identify a significant relationship between unemployment rate and inflation rates.

Research on the Phillips Curve in Pakistan is very limited. Hasan (1990) supported the existence of a short-run Phillips Curve for Pakistan for the period 1972(Qtr.1) to 1981(Qtr.4). Malik and Tashfeen (2007) observed a negative relationship between inflation and one period lagged unemployment. Satti *et al* (2007) find that future inflationary expectations play significant role in inflation determination. A dynamic correlations between inflation and real marginal cost have been observed i.e., inflation co-moves positively with real marginal cost, both at leads and lags.

Numerous studies on the Phillips curve are available on developed nations; there is huge scope for systematic empirical analysis that testifies the hypothesis in the context of a developing country. Considering important economic and political implications of Pakistan, the Phillips Curve hypothesis entails relationship between unemployment rate and inflation rate.

This paper analyzes the trade-off between inflation and unemployment in Pakistan using secondary data from 1975 to 2009. Following dimensions and factors of the Phillips curve hypothesis are focused.

❖ **NAIRU:** NAIRU is an acronym for Non-Accelerating Inflation Rate of Unemployment. The idea behind the natural rate hypothesis was put forward by Milton Friedman in 1968 and it refers to a level of unemployment, below which inflation rises. If **U*** is the NAIRU and **U** is the actual unemployment rate, the theory says that:

- if U < U* for a few years, inflationary expectations rise, so that the inflation rate tends to accelerate;
- if U > U* for a few years, inflationary expectations fall, so that the inflation rate tends to fall (there is disinflation); and
- if U = U*, the inflation rate tends to be stationary, unless exogenous shock is observed.

❖ **Natural Rate of Unemployment:** It is the unemployment, which occurs when the labour market is in the equilibrium (supply side of unemployment i.e., frictional and structural unemployment). If unemployment is reduced below the natural rate, there is an increased risk of inflation.

❖ **Unemployment Gap:** The difference between the non-accelerating inflation rate of unemployment (NAIRU) and the actual rate of unemployment is termed as unemployment gap. According to Pallis and Katsouli (2003), in the short-term, a trade-off do exists between price inflation and unemployment. If unemployment falls below the NAIRU, price inflation will rise until unemployment returns to the NAIRU, at that time price inflation will stabilize at a permanently higher level.

Co-integration technique is used for analysis. In this study a sophisticated econometric technique with additional tests of forecasting framework is used to examine the effect of changes in inflation on unemployment rate over a 10 years period.

3. Brief Overview of Inflation and Unemployment Rate in Pakistan

3.1. Inflation Rate

The rate of inflation is an important macroeconomic indicator by which the central banks around the world analyze and set their monetary policy. Pakistan is among those countries, which are still experiencing double digit inflation. There has been an increasing trend of inflation from 12 percent in 1975 to almost 22 percent in 2009. Inflation is documented in the range of 3 percent to 22 percent during the said period (see, **Figure 1**).

3.2. Unemployment Rate

In 1970s, average unemployment rate was 3.43 percents. It increased by only 0.1 percent in the year 1980s (3.44%). Afterward, average unemployment rate increased sharply in the year 1990s and 2000s, where average unemployment rate was reported almost 5.56 and 6.97 percent respectively (see **Figure 2**).

3.3. Changes in Inflation (IFR) and Unemployment Rate (UN) in Pakistan

The relationship between unemployment and inflation rate in Pakistan is an interesting example. There have been greater fluctuations in inflation and unemployment rate during the years 1975-2009. Hence, there has been found an inverse relationship between unemployment rate and inflation rate.

$$\Delta IFR = \mathbf{C} + \Delta IFR(-1) + UN + u$$

C = 3.328 (0.046)*; $\Delta IFR(-1)$ = 0.638 (0.000)*; UN = -0.361 (0.050)*

Adjusted R-square = 0.41; D.W = 1.903; F-statistics = 9.672 (0.000)*

Note: * represent 0.05% significance level.

3.4. Unemployment Rate (UN) and Unemployment Gap (UNGAP) in Pakistan

Unemployment Gap is the difference between the non-accelerating inflation rate of unemployment (NAIRU) and the actual unemployment rate (UN). NAIRU is estimated from 1975-2009 and observed as 7.8 percent, while average unemployment rate was 4.9 percent which is less than the NAIRU. It means that inflationary expectations have been raised between these years, so high inflationary tends is observed. Unemployment gap is observed up to 2.81 percent between the said periods. Unemployment and unemployment gap for the period of 1975-2009 are mentioned in **Figure 3**.

4. Data Sources and Methodological Framework

The study uses annual observations for the period of 1975-2009. The data is obtained from Economic Survey of Pakistan (2008-09), International Financial Statistics (2007-08), and World Bank Development Indicators data sets (WDI-2009). This paper reviews; the impact of the unemployment on inflation within the context of Phillips Curve, which is examined in the following manner:

- By examining whether a time series unit root test is applied; an Augmented Dickey-Fuller (ADF) unit root test has been used.
- By finding the long-run relationship among the variable, cointegration test has been applied.
- When the variables are found cointegrated, a Granger causality test based on Vector Error Correction Method (VECM) has been applied to determine the short and long-run causality.
- By describing the reaction of endogenous variable i.e., unemployment at the time of impulse / shock and over subsequent points in time.

4.1. Theoretical Methodology

The simple Phillips Curve could be estimated by using following equations. If we let w_t be the wage rate in time *t*, we may represent the proportional or percentage change in the wage rate as:

$$w_t = \frac{w_t - w_{t-1}}{w_{t-1}} \tag{1}$$

If we assume that w_t is proportional to the excess demand for labour d_t, we may write:

$$w_t = \gamma d_t \tag{2}$$

Where γ is constant. Since the unemployment rate u_t is inversely related to the excess demand for labor, we could write this using our reciprocal function as:

$$d_t = a + c\frac{1}{u_t} \tag{3}$$

Given equation (3), we may then specify w_t as:

$$w_t = \gamma a + \gamma c\frac{1}{u_t} \tag{4}$$

Where w_t is linearly related to the non-linear reciprocal variable u_t. An appropriate linear statistical model may then be:

$$y_t = \beta_1 + \beta_2 x_t + e_t \tag{5}$$

Where $y_t = w_t = (w_t - w_{t-1})/w_{t-1}$

$x_t = \frac{1}{u_t}$ and e_t is a normal random equation error.

Simply, we can write equations with the aid of notation we are using for the variables in our paper, incorporating natural rate of unemployment into the model, the "standard" Phillips Curve could be expressed:

$$IFR_t = \alpha(L)IFR_{t-1} + \beta(L)(UR_t - NAIRU_t) + \varepsilon_t \tag{6}$$

Where, *α (L)* and *β (L)* are polynomials in the lag operation, *NAIRU* is natural rate of Unemployment in Pakistan in the year *t*, and. According to Debelle and Vockery (1998), "most of the existing theoretical and empirical literatures" have been based on the equation 2. The equation could be modified as:

$$IFR_t = \alpha(L)IFR_{t-1} + \beta(L)(UNGAP_t) + \varepsilon_t \tag{7}$$

Where UNGAP is the "unemployment gap" (i.e. the actual unemployment rate minus natural rate of unemployment rate). To support the Phillips curve, we would require negative and significant coefficients for the unemployment gap. The empirical analysis will be based on the equation 3.

4.2. Econometric Methodology

The concept of Cointegration was first introduced by Granger (1981) and elaborated further by Engle & Granger (1987), Phillips & Ouliaris (1990) and Johansen (1991). Engle & Granger Cointegration test requires that

- Time-series, say Y_t and X_t, are non-stationary in levels but stationary in first differences i.e., $Y_t \sim I(1)$ and $X_t \sim I(1)$.

• There exists a linear combination between these two series that is stationary at levels i.e., $v_{it} (= Y_t - \hat{\alpha} - \hat{\beta} X_t) \sim I(0)$.

Thus, the first step for Cointegration is to test whether each of these series are stationary or not. If they both are stationary say at first difference i.e. they are *I*(1), then we proceed to the second step to verify the long run relationship between them.

Augmented Dickey Fuller (ADF) test is usually applied to test stationarity. It tests the null hypothesis that a series (Y_t) is non-stationary by calculating a t-statistics for $\beta = 0$ in the following equation:

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \gamma_t + \sum_{k=2}^{n} \delta_k \Delta Y_{t-k} + \varepsilon_t$$

Where k = 2, 3, …, n. While α, β, γ and δ are the parameters to be estimated and ε_t is white noise error term.

If the value of the ADF statistic is less than the critical value at the conventional significance level (usually the 5 % significance level is desirable) than the series (Y_t) is said to be stationary and vice versa. If Y_t is found to be non-stationary then it should be determined whether Y_t is stationary at first differences $\Delta Y_t \sim I(0)$ by repeating the above procedure. If the first difference of the series is stationary than the series (Y_t) are integrated of order one i.e. $Y_t \sim$ I(1).

If time series are *I*(1), than regressions is applied in their first difference. However, by taking first difference, we lose the long-run relationship that is stored in the data. This implies that one needs to use variables in levels as well. Advantage of the Error Correction Model (ECM) is that it incorporates variables both in their levels and first difference. By doing this, ECM captures the short-run disequilibrium situations as well as the long-run equilibrium adjustments between variables. ECM term having negative sign and value between "0 to 1" indicates convergence of model towards long-run equilibrium and shows how much percentage adjustment takes place every year.

Impulse response functions trace the effects of a shock to one endogenous variable on to the other variables in the VAR; variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR.

This study runs the Granger-causality test based on the following the VECM:

$$\Delta IFR_t = \beta_{1i} + \sum_{i=1}^{n} \beta_{2i} \Delta (UNGAP)_{t-i} + \sum_{i=1}^{n} \beta_{3i} \Delta (IFR)_{t-i} + \beta_4 (ECT)_{t-1} + \varepsilon_t \quad (8)$$

This paper uses the Granger-causality test based on the VECM. There are two advantages to using this method rather than the standard Granger causality test. First of all, the Wald test of the independent variables indicates the short-run causal effect. Secondly, significant and negative error correction term $(ECT)_{t-1}$ indicates the long-run causal effects.

5. Empirical Results

NAIRU is estimated for 1975-87, 1988-98 and 1999-2009 with the values 6.01, 3.21 and 9.01 respectively. NAIRU for overall period i.e., 1975-2009 is estimated as 7.80, which is greater than average unemployment rate of 4.99 percent. Results reveal that inflation was less for the period i.e., 1975-1987 and 1988-1998. While, there was an increasing trend of inflation for the period 1999-2009. Overall incidence of inflation for 1975-2009 has shown an increasing trend. The cumulative effect of this rising expected inflation rate is positive, with unemployment gap is (-) 2.81 percent over a 35 years period. In the short-term, a trade-off exists such that if unemployment rate falls below the NAIRU, inflation will rise until unemployment returns to the NAIRU. At that time inflation will stabilize at a permanently higher level (see, **Table 1**).

The preliminary step in this analysis is to establish the degree of integration of each variable. So a test for the existence of a unit roots in the level and the first difference of each variable in our sample using the Augmented Dickey Fuller (ADF). The results in **Table 2** reveal that both variables are non-stationary in their level data. However, stationarity is found in the first differencing level of the variables i.e., Inflation rate (IFR) and unemployment gap (UNGAP).

In the second stage, the Johansen cointegration test was used to test the long-run movement of the variables. Engle and Granger (1987) have pointed out that only variables with the same order of integration could be tested for cointegration. Both variables were examined for cointegration at their first difference I(1). Akaike Information Criterion (AIC) was used to determine optimal lag length selection, while maximum lag length is set up to level three. **Table 3** shows that optimal lag length for the Johansen cointegration test is one (1), which minimizes the AIC.

Results of the cointegration tests are reported in **Table 4** and **Table 5** respectively. Starting with the null hypothesis of no cointegration among the variables, the trace statistics of 19.23 exceeds the 95% critical value of the λ trace statistic (critical value is 15.49). The null hypothesis is valid up to 5% level of confidence. It is concluded that there is one cointegration relationship involving variables i.e., IFR and UNGAP.

In **Table 5**, λ max statistic rejects the null hypothesis of no cointegration vector against the alternative as the calculated value λ max are 16.49, which is exceeding the 95%t critical value (14.26). Thus, on the basis of λ max statistic there is one co-integration vectors. The presence of cointegration vector shows that there exists a long-run relationship among the variables.

The Granger-causality method based on the VECM was employed to examine the long-run and short-run casual relationships between the two variables. Firstly, the Akaike Information Criterion was used to determine the optimal length for the causality test. As **Table 6** shows, optimal lag length for causality test is two (2) which minimizes the AIC.

The dynamic short-run causality (by using Wald test) and the long-run causality by error correction term (ECT_{t-1}) among the relevant variables are shown in **Table 7**. The causality effect can be obtained by restricting the coefficient of the variables with its lags equal to zero. If the null hypothesis of no causality is rejected, then we conclude that a variable Granger-caused other variable. To recapitulate the findings of the short-run causality test, we conclude that the hypothesis of inflation-unemployment is legitimate in the Pakistan's economy, as there appeared to be a negative relationship. In other words, Pakistan's unemployment rate does "Granger cause" inflation in the short-run.

In the long-run causality test, the error correction term (ECT_{t-1}) is statistically significant and negative. This means that there is a long-run Granger causality between the inflation rate and unemployment rate. The error-correction term is significant with an adjustment coefficient of - 0.259, indicating that inflation rate (IFR) adjusts to its long-run equilibrium level with 25.9% of the adjustment taking place within the first year. The sign of the ECT coefficient also specifies that changes in the inflation rate adjust in an opposite direction to the previous period's deviation from equilibrium. In other words, the long-run Granger causality *does* confirm the existence of the long-run equilibrium relationship between unemployment rate and inflation rate in Pakistan as indicated in the Johansen cointegration test.

Figures 4-7 plot the impulse-response functions of inflation and unemployment to the permanent and transitory shock. The impulse-response functions show due to consequence of transitory and permanent shocks, there had been an increase in unemployment, which has ultimately reduced the inflation rate. A short-run and long-run tradeoff between the two variables is observed. This adverse effect on unemployment of a negative demand shock is very persistent. In fact, the two variables move in the opposite direction at different frequencies. Indeed, the selected cointegrating vector implies that, there is a long-run relationship between the variables, inflation and unemployment. Hence, the analysis enables the conclusion that these supply shocks drive the rare movement of inflation and unemployment in the long run.

Figure 8-11 plot the variance decomposition function of inflation and unemployment. The variance decomposition analysis indicates that inflation rate is the exogenous variable. A high proportion of its shock is explained by the own innovations compared to the unemployment. At the end of 10 years, the forecast error variance for inflation explained by their own innovations is 317.8%, while the forecast error variance for unemployment explained by their own innovation is 87.2%.

At the end, empirical findings of the present study show that there is a long-run relationship and also causality between Pakistan's unemployment rate and inflation rate. These findings provide an strong empirical support for the existence of the Phillips curve, in the context of a developing country like Pakistan.

6. Summary and Conclusion

Inflation is a universal phenomenon. Every one is affected by inflation. Being an economist, it is a social responsibility to explore the reality mentioned by Phillips Curve i.e., increased inflation results into increased job opportunities which ultimately lead to economic growth in the country. This study provides strong empirical existence of Phillips Curve in Pakistan, both in the long- and short–runs. On the basis of this study, one can forecast the future trend for the next ten years will be in favor of Phillips curve. Policy makers can get guidance from this paper for making future policy decisions for Pakistan. This research can be replicated for other developing countries especially SAARC countries, such as Bangladesh, Bhutan, India, Maldives, Nepal, and Srilanka. By assessing the existence of the Phillips curve in SAARC economies can have more insight.

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Table 1. NAIRU Estimates

Sample Period	NAIRU	Average UE	Expected Inflation	UEGAP	R^2
1975-1987	6.01	8.45	Falls	2.44	0.48
1988-1998	3.21	10.04	Falls	6.83	0.42
1999-2009	9.01	6.98	Rises	-2.03	0.33
1975-2009	7.80	4.99	Rises	-2.81	0.41

Source: Authors calculation. UE = Unemployment Rate; UEGAP = Unemployment Gap

Table 2. ADF Unit Root Test

	Levels		First Difference	
	Constant	Constant with trend	Constant	Constant with trend
IFR	-2.518 (4)	-2.190 (0)	-6.429* (0)	-6.580* (0)
UNGAP	-1.484 (0)	-1.875 (0)	-5.597* (0)	-5.543* (0)

Note: Figures in parenthesis indicate number of lag structures. * indicates significance at 1% level.

Table 3. Optimal Lag Length Selection for the Cointegration Test (Maximum Lag length = 3)

Lag Length	AIC
0	9.206
1	7.358*
2	7.455
3	7.604

Note: AIC denotes the Akaike Information Criterion. * indicates optimal lag length selected by AIC

Table 4. The Johansen Cointegration Test (Trace Eigenvalue Statistic)

Eigenvalue	Trace Statistic	5 percent critical value	Prob.**	Number of cointegrating equations
0.402731	19.23154	15.49471	0.0130	None*
0.082036	2.739118	3.841466	0.0979	At most 1

Note: The result corresponds to VAR's with one lag. * denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) p-values.

Table 5. The Johansen Cointegration Test (Maximum Eigenvalue Statistic)

Eigenvalue	Max-Eigen Statistic	5 percent critical value	prob.**	Number of cointegrating equations
0.402731	16.49242	14.26460	0.0219	None*
0.082036	2.739118	3.841466	0.0979	At most 1

Note: The result corresponds to VAR's with one lag. * denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) p-values.

Table 6. Optimal Lag Length Selection for Causality Test (Maximum Lag length = 3)

Lag Length	**AIC**
0	8.948
1	7.583
2	7.474*
3	7.743

Note: AIC denotes the Akaike Information Criterion. * indicates optimal lag length selected by AIC

Table 7. Granger-Causality Test Based on VECM (Dependent Variable: D (IFR))

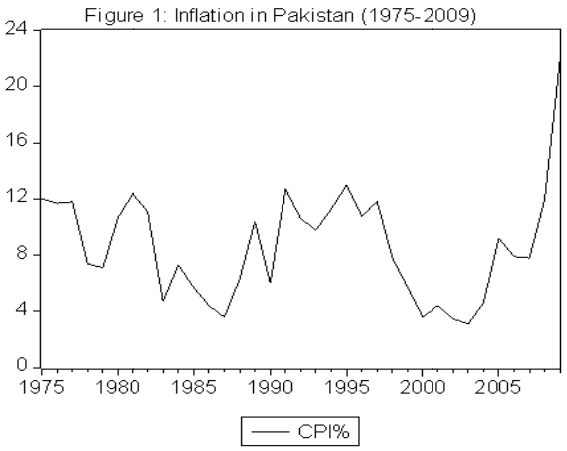
Variable	Degree of Freedom	Wald Test Statistics
D(UEGAP)	2	3.961*
Adjustment Coefficient	Value	t-statistic
$(ECT)_{t-1}$	-0.259	-2.218 **

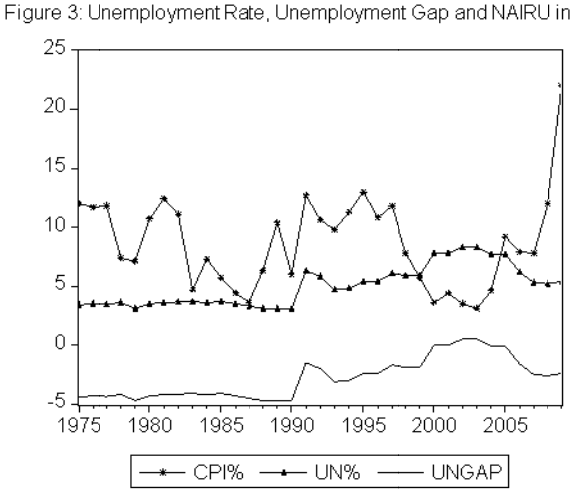
Note: To test for causality when variables are co-integrated, the following Granger causality test based on the VECM could be used:

$$D(IFR)_t = \beta_1 + \sum_{i=1}^{n} \beta_{2i} D(UEGAP_{t-1}) + \sum_{i=1}^{n} \beta_{3i} D(IFR_{t-1}) + \beta_{4i} (ECT)_{t-1} + \varepsilon_t$$

1) Short-run causality: the joint significance of the coefficients is determined by the Wald Test

2) Long-run causality: the level of significance for error correction term (*ECTt-1*) is determined by the t-statistics.





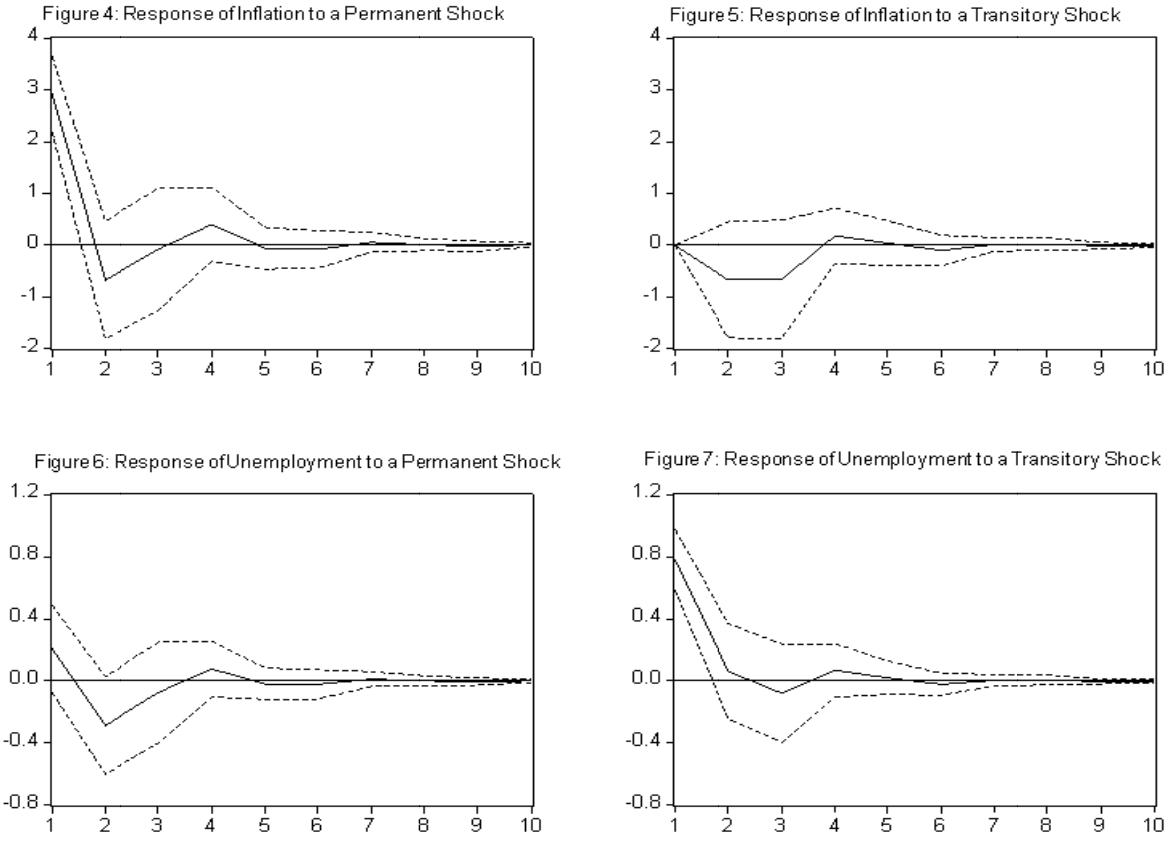


Figure 4-7.Impulse Response Shocks

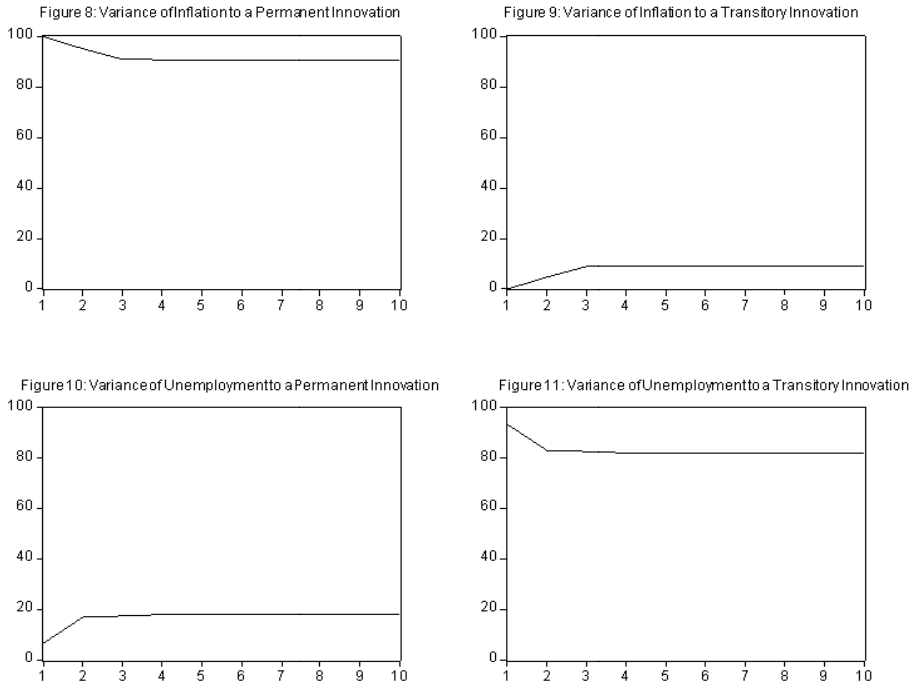


Figure 8-11: Variance Decomposition Analysis

Note: ** indicates significance at 5% level. * indicates significance at 1% level

A Fast-Track East African Community Monetary Union? Convergence Evidence from A Cointegration Analysis

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Abstract

There is a proposal for a fast-tracked approach to the African Community (EAC) monetary union. This paper uses cointegration techniques to determine whether the member countries would form a successful monetary union based on the long-run behavior of nominal and real exchange rates, the monetary base and real gdp. The four variables are each analyzed for co-movements among the five countries. The empirical results indicate only partial convergence for the variables considered, suggesting there could be substantial costs for the member countries from a fast-tracked process. This implies the EAC countries need significant adjustments to align their monetary policies and to allow a period of monetary policy coordination to foster convergence that will improve the chances of a sustainable currency union.

Keywords: Monetary Union, Convergence, Cointegration, East African Community

1. Introduction

With the signing of an agreement for the establishment of the "Permanent Tripartite Commission for East African Co-operation" in 1993, the East African Community (EAC) has advanced its integration agenda rapidly. (Note 1) A treaty establishing the EAC was signed in 1999, a customs union treaty in 2004, and a Common Market Protocol (CMP) in 2009. (Note 2) The EAC has a stated objective to form a monetary union, with 2012 as the suggested target date in a fast-track currency union proposal. (Note 3) Article 5(2) of the EAC Treaty stipulates that "…the Partner States undertake to establish among themselves and in accordance with the provisions of this Treaty, a Customs Union, a Common Market, subsequently a Monetary Union and ultimately a Political Federation...". The 6th extra-ordinary meeting of the Summit of the EAC Heads of State decided that East Africa should move expeditiously towards establishing a monetary union by 2012, while the 11th ordinary summit directed that the preparation for the establishment of a monetary union be moved into high gear upon the coming into operation of the common market.

Macroeconomic convergence of member countries is crucial to the sustainability of a monetary union over the long term. Monetary policy convergence, exhibited mainly in similarity of inflation and interest rates among other indicators, is necessary to ensure a single monetary policy is optimal policy for all the union members. In an influential study Rose (2000) followed by others (a good summary is provided by Rose and Stanley, 2005), estimated that currency union enhances trade among member countries by two to three times. This boosts similarity of the demand patterns and price co-movements. Countries then could become more similar in a currency union than before currency union. If suitability for membership in a monetary union is endogenous, this suggests it may not be crucial for members to meet optimum currency area criteria before currency union. However recent assessment of the EMU experience (see Chintrakarn, 2008; Frankel, 2008) show a much smaller trade impact of the Euro of only about 15%. The endogeneity effect may even be smaller for African monetary unions. Carmignani (2009) and Tapsoba (2009) study the endogeneity effect of trade in African monetary unions and find that currency union increases synchronicity of business cycles but the effect is very small. While trade effects and endogeneity cannot be discounted, these subsequent results cautions against excessive optimism on the magnitude of the effects from an EAC monetary union. First, the trade effect benefits seem to be slow to achieve (about 15% from EMU nearly ten years later). Secondly, the EAC countries are starting from relatively low intra-EAC trade levels. Given the high dependency on primary product exports, the scope for increased trade is unlikely to be as great as more developed countries. (Note 4) Therefore this makes convergence before monetary union critical for the EAC to minimize any adverse effects from a loss of monetary policy for member countries.

No specific enforceable convergence targets have been laid down for eligibility in the proposed EAMU. It is however anticipated that the set of convergence criteria (exchange rates, inflation rates, long-term interest rates, and deficits) that formed the basis of eligibility in the European Monetary Union (EMU) would play a role in some form. With the signing of the CMP the focus is now shifting to the monetary union stage. (Note 5) A crucial question that needs to be answered at the start of this phase is to what degree the EAC countries' monetary policies and business cycles have converged.

No studies have rigorously examined the current state of monetary policy convergence for the EAC. This paper attempts to fill this gap. Our contribution is to provide empirical evidence on the state of convergence for the five EAC member countries with respect to nominal and real exchange rates, the monetary base and real gdp. This paper thus provides convergence evidence from a range of both nominal and real variables. To achieve this, we apply

multivariate cointegration. The monetary base is included as an indicator of monetary policy convergence in absence of consistent long term interest rate data. The monetary aggregate is preferred over other broader aggregates because it is less diluted by intervention by other agents in the financial system, and better able to capture the central bank's policy stance. Indicators of fiscal convergence, such as the debt ratios, are important factors not considered in this paper due to lack of consistent data. Empirical evidence on the state of convergence will help policy-makers in setting realistic convergence targets and a frame–work to monetary union. Knowledge of the current state of convergence becomes even more crucial given the very short time left for monetary policy coordination if the target union date is to be achieved.

Multivariate cointegration analysis has been applied by a number of authors to test convergence especially for the European Monetary Union (EMU) and accession countries. Haug *et al*. (2000) uses cointegration techniques (on data that spans the period 1979 to 95), to analyze which of the European Union (EU) countries would form a successful monetary union based on the nominal convergence criteria laid down in the Maastricht treaty. Their results indicated that not all the 12 original countries could all form a successful EMU over time unless countries made significant adjustment. Brada and Kutan (2002) compare the convergence of monetary policy of the Balkan and Mediterranean candidates for EU membership with those of Germany as a proxy for the European Central Bank (ECB). They interpret cointegration of base money with those of Germany as implying an ability of the country to follow policy leadership of the ECB. They found that among the Balkan transition economies and in Turkey, the ability to follow the policies of the Bundesbank was weak or nonexistent for some countries.

Some authors have examined monetary policy convergence by testing the uncovered interest parity (UIP). The premise is that the difference between domestic and foreign interest rates should correspond to the expected exchange rate change plus a risk premium. When reaching monetary integration this risk premium should disappear. Kasman *et al.* (2008) test this type of convergence between EU (using Germany as reference country), the new Central and Eastern member countries, and several candidate countries. The results suggest UIP holds for Estonia, Croatia and Turkey.

A limited number of studies assess the feasibility of the proposed EAC monetary union. Buigut and Valev (2005) use a VAR to assess the symmetry of structural shocks. The results suggest the demand and supply shocks are generally asymmetric. However the speed and magnitude of adjustment seem similar across the member countries. Buigut (2006) uses a cluster analysis to assign countries in the East and Southern Africa (ESA) region into the most suitable monetary union based on a set of real and nominal convergence criteria. The conclusion of this analysis is that the ESA is not converged enough for an ESA- wide monetary union. However the EAC shows up as a relatively converged subgroup within the ESA.

2. Methodology

2.1 Data

This article analyzes several criteria (viz nominal exchange rates, real exchange rates, and inflation rates, monetary base and real output) for convergence among the EAC countries. A multivariate cointegration frame-work (Johansen, 1994; Johansen, 1995) is used to test the existence of long-run relationships that tie together variables in each criterion across the EAC countries. Because convergence implies co-movements of specific variables over time, the cointegration approach is well-suited to assess the feasibility of the proposed EAC monetary union. Quarterly data from the International Financial Statistics (IFS) CD – ROM (International Monetary Fund, 2009) is used, except for the real output where annual data is used. The nominal exchange rate variable (in national currency per US dollar) spans the period 1997Q1-2008Q4. The period average spot rate (line rf in the IFS CD) is used. The inflation rate is calculated from the CPI (line 64 of IFS) as $\ln(cpi_{t+1}/cpi_t)$, and covers the period 1997Q4 – 2009Q1. The real exchange rate is obtained from (eP^*/P), where e is the nominal exchange rate (national currency per US dollar), P^* is the US CPI, and P is the national CPI. The period covered is 1997Q3-2008Q4. The monetary base is the narrowest form of money and better able to capture the central bank's policy than broader money aggregates (Brada *et al*., 2005). This variable is used in the absence of interest rates. The monetary base data covers the period 2001Q1 - 2009Q1 (line 14 of the IFS CD). (Note 6) For the real gdp quarterly data is not available and annual data covering the period 1981 to 2005 is used. The real gdp is obtained from nominal gdp deflated by the consumer price index. We do not study the fiscal deficits and interest rates because of data availability problems.

2.2 Cointegration models.

If X is an n dimensional column vector of I(1) variables a VAR(p) model can be reformulated into vector error correction model (VECM) of the form;

$$\Delta X_t = \pi X_{t-1} + \sum_{i=1}^{p-1} \pi_i \Delta X_{t-p} + \mu_0 + \mu_1 t + \varepsilon_t \quad (1)$$

$\pi = \alpha\beta'$, where α represents the speed of adjustment to disequilibrium and β is a matrix of long-run coefficients, both full rank $n \times r$ matrices. The μ_0 and μ_1 are $n \times 1$ vectors of constant and trend coefficients, ε_t is a $n \times 1$ error vector assumed multivariate normal, mean zero and variance Ω that is independent across time periods. If the rank is zero ($r = 0$) then $\pi = 0$, which means there is no linear combination of X_t that is stationary. If the rank of π matrix is equal to n then X_t is a stationary process. In the intermediate case, $0 < r < n$, there are r stationary linear combinations of the elements of X_t and $n - r$ stochastic trends (Haug, *et al*. 2000). Given $\pi = \alpha\beta'$, the relation between α and the deterministic term, $\mu_t = \mu_0 + \mu_1 t$, is crucial for the properties of X_t process. Five submodels are commonly derived (see Johansen 1994; Haug *et al.*, 2000; Koukouritakis and Michelis, 2008) from this interaction. We consider the five submodels following the ordering in Haug *et al.* (2000) and Koukouritakis and Michelis (2008) from the most to least restrictive:

Model 0: $\mu_t = 0$, X_t has no deterministic terms and all stationary components have zero mean. (Note 7)

Model 1*: $\mu_t = \alpha\beta_0$, X_t has neither a quadratic trend nor a linear trend. But both X_t and the cointegrating relation $\beta' X_t$ are allowed a constant term.

Model 1: $\mu_t = \mu_0$, X_t has a linear trend, but $\beta' X_t$ does not.

Model 2*: $\mu_t = \mu_0 + \alpha\beta_1 t$, X_t has no quadratic trend but has linear trend that is present in the cointegrating relations.

Model 2: $\mu_t = \mu_0 + \mu_1 t$, allows for quadratic trend in X_t but $\beta' X_t$ has only a linear trend.

Testing for cointegration amounts to finding the number of $r \leq (n-1)$ linearly independent columns in π (i.e. the rank of π). The trace statistic (λ_{trace}) (Johansen and Juselius, 1990) tests the null hypothesis that the number of distinct cointegrating vectors is less than or equal to r against a general alternative that rank $(\pi) = n$. This value is equal to zero when all the eigenvalues, λ_i, are zero. The further away the estimated roots (eigenvalues) are from zero the more negative is $\ln(1 - \hat{\lambda}_i)$ and the larger the trace statistic.

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i) \tag{2}$$

An alternative test, the maximum eigenvalue statistic ($\lambda_{\max}$), tests the null that the number of cointegrating vectors is r against the alternative of $r + 1$ cointegrating vectors.

$$\lambda_{\max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \tag{3}$$

where $\hat{\lambda}_i$ are the estimated values of the eigenvalues (characteristic roots) obtained from the π matrix, and T is the number of usable observations.

In interpreting the results we claim, (as in Hafer and Kutan, 1994; Haug *et al.*, 2000), complete convergence of monetary policy among the set of n countries if we find $n-1$ cointegrating vectors and therefore a single shared common trend. If $0 < r < (n-1)$ then we claim only partial convergence, or partial interdependence among the policies. In this case, maintaining a monetary union would be difficult since policy measures have not converged to one common long run path.

3. Results.

Before carrying out any cointegration tests, we test each time series variable for unit root using the Augmented Dickey-Fuller (ADF) test. The results are presented in Table 1. As can be seen from column two, the test fails to reject unit root, in levels, for the nominal exchange rate for only three (Kenya, Rwandan, and Tanzania) of the five countries. We also test for a second unit root using the first difference. This hypothesis was rejected in all cases (column three). The conclusion is that the nominal exchange rate is I(1) for three countries (Kenya, Rwandan, and Tanzania), but this variable is I(0) for Burundi and Uganda. Therefore only the three countries are included in the cointegration analysis for this variable. The ADF results suggest the real exchange rate is I(1) for all the five countries, thus we use the full set of five countries when analyzing cointegration of this variable. The inflation rate is I(0) for all the five countries. Cointegration analysis is not carried out for this variable. Instead the CPI is used to generate the real exchange rate and real gdp as discussed in Section 2.1. The monetary base is I(1) for four countries (data is not available for Rwanda) and are included in the cointegration tests. The results suggest real gdp is I(1) for all the five countries, and we use the full set of five countries when analyzing cointegration of this variable.

Next is to carry out the cointegration analysis. A separate VECM is set up for each variable. To select the appropriate lag length, the Akaike Information Criterion (AIC) and the Hannan-Quinn Information Criterion (HQIC) are used. For each VECM, the five submodels (model 0, 1*, 1, 2*, and 2) described in Section 2.2 are considered. However in an attempt to identify which of the submodels is most appropriate to use, the five submodels are tested against each other using likelihood ratio (LR) tests. For the nominal exchange rate, the best model seems to be the model 1. For the real exchange rate the better model seems to be model 2, model 2* for the monetary base, and model 1 for the real gdp. The results of cointegration tests for nominal exchange rate, real exchange rate, and monetary base variables based on the λ_{trace} and λ_{max} statistics for the submodels identified by LR are provided in Tables 2, 3, and 4 respectively. Further we show the results for all the five submodels in Tables 5, 6 and 7 for these variables. Table 8 provides the cointegration results for the real gdp from the five submodels.

Consider Table 2 which presents the results for model 1 for the nominal exchange rate variable. Both the λ_{trace} and λ_{max} test statistics suggests one cointegrating equation for this variable at the 5% significance level. The results for the real exchange rate (Table 3) based on model 2 also suggest one cointegrating equation at the 5% significance level. For the monetary base two cointegrating equations are identified at the 5% level based on model 2*. Next we turn to the results for all five submodels shown in Tables 5, 6 and 7. For brevity only the number of cointegrating equations suggested by the λ_{trace} and λ_{max} test statistics are shown for each submodel at the 1% and 5% significance levels. Take the nominal exchange rate variable results provided in Table 5 for example. Both the λ_{trace} and λ_{max} suggest one cointegrating equation at the 5% level for model 0, 1*, and 1. The results in Table 5 indicate the highest number of cointegrating equations obtained is one for any submodel. Since only three countries are included in the analysis ($n = 3$) convergence would be complete if there were two cointegrating equations such that there is only one common trend shared by all the three countries. Because there is at most only one cointegrating equation identified, there are at least two shared stochastic trends. Hence we can only claim partial convergence of the nominal exchange rate. Next consider the real exchange rate. Five countries are included in the analysis. The highest number of cointegrating equations obtained is two (Table 6) at the 5% significance level, suggesting at least three shared stochastic trends. The real exchange rate has not followed one common trend for the EAC countries. So again we can only claim partial convergence with respect to this variable. For the third variable, the monetary base, four countries are included and the number of cointegrating equations identified (Table 7) at the 5% level is at most two. This suggests at least two shared stochastic trends. This implies as of now there are at least two independent monetary policy trends followed by these countries. For the real gdp, five countries are included in the analysis. The highest number of cointegrating equations obtained is three (Table 8) at the 5% significance level, suggesting at least two shared stochastic trends.

For all the four variables analyzed (nominal exchange rate, real exchange rate, monetary base, and real gdp), the empirical results from all the five submodels considered suggest only partial convergence of policies of the EAC. These results imply there are some EAC countries that follow policies that are independent of the policies that are followed by other EAC countries. From a policy perspective the lack of complete long-run equilibrium suggests the EAC countries will need to make significant adjustments to align their policies for the currency union to be viable. A direct implication of these results is that the EAC countries need a period of monetary policy coordination prior to monetary union. The results puts into serious question the suggested date of 2012 as it is unlikely to provide adequate time for effective policy coordination for member countries. A clearly defined convergence period, with clear targets to be achieved by all member states would need to be a part of any negotiated framework to monetary union. The EAC currently does not have an autonomous supranational monetary institution that can be tasked with the implementation of the coordination phase. Therefore there is need for the creation of such an institution (call it an East African Monetary Institute - EAMI) would be necessary at the start of this phase. The EAMI's task would be to encourage cooperation between the national central banks of the member states of the EAC and oversee the convergence process. Such an institution could be the precursor to the East African Central Bank.

The EMU experience suggests that the integrity of fiscal policy is also crucial to the overall long term success of monetary union. Several member countries have failed to live up to the agreed upon fiscal policy restrictions. As Kočenda *et al.* (2008) notes, monetary unions do not necessarily encourage fiscal convergence for its members. This failure could undermine the credibility of macroeconomic polices in Europe. Neck and Holzmann (2006) have suggested that the detrimental effects of high and increasing public debt threaten the stability of EMU. Hence this experience suggests the EAC would need, in addition to monetary coordination, a fiscal coordination program prior to monetary union and the ability to enforce these restrictions post-monetary union to ensure fiscal integrity is maintained.

4. Conclusions

This paper applies multivariate cointegration analysis to provide empirical evidence on the state of convergence for the five EAC member countries with respect to four variables; the nominal and real exchange rates, the monetary base, as well as the real gdp. The motivation for this investigation is the stated objective of the five-member EAC to fast track the establishment of the proposed monetary union. This is despite the fact that no specific monetary or fiscal policy coordination program is currently in place to promote convergence. However, with the common market negotiations drawing to a successful conclusion, the focus is now beginning to shift to the monetary union stage. To

help policy-makers set up a realistic time frame for the monetary union process, one important question that needs to be answered at the start of this phase is the current state of convergence of the EAC countries' policies.

Using cointegration techniques we test the existence of long-run relationships that tie together variables in each criterion across the EAC countries. The results we find support a gradual approach caution against a fast-track EAC monetary union process. The empirical results for all the four variables from all the five submodels considered indicate only partial convergence of the EAC policies. These results imply there are some EAC countries that follow policies that are independent of the policies that are followed by other EAC countries. Hence the EAC countries need to make significant adjustments to align their monetary policies for the currency union to be viable. Given the relatively small endogeneity effects suggested by literature (such as Carmignani (2009) and Tapsoba (2009)), prudence would suggest that the EAC countries allow for a period of monetary policy coordination prior to monetary union to promote further convergence and improve the chances of a credible and sustainable monetary union.

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Notes

Note 1. The EAC comprises 5 countries (Kenya, Tanzania, Uganda, Rwanda and Burundi).

Note 2. The common market protocol was signed November 20, 2009 at the 11th ordinary summit of heads of state in Arusha. This is expected to be ratified and implemented in 2010. [Online] available: http://www.eac.int/component/content/342.html?task=view (Accessed November 21, 2009).

Note 3. This would seem an ambitious target date and though there is a likelihood it may not be achieved, it may be construed as an indicator of the political will to pursue this agenda.

Note 4. Only 11.17% of Burundi exports go to EAC countries. The corresponding numbers for the other EAC countries are 23.69% for Kenya, 2.23% for Rwanda, 4.42% for Tanzania, and 17.44% for Uganda. Source: Calculated from Direction of Trade Statistics (IMF, 2009). These numbers are an average for 2007 and 2008.

Note 5. Consultations on the proposed establishment of the East African Monetary Union (EAMU) got underway September 2009 with various stakeholders in Kigali, Rwanda. [Online] available: http://www.eac.int/component/content/308.html?task=view (Accessed September 20, 2009).

Note 6. All nominal exchange rates, real rates, and monetary base are expressed in natural logs.

Note 7. This is termed trend (none) in Stata10 program. The other submodels that follow are termed restricted constant, unrestricted constant, restricted trend, and unrestricted trend for models 1*, 1, 2*, and 2 respectively in stata.

Table 1. Augmented Dickey Fuller unit root tests

Country	Nominal Exchange Rate		Real Exchange Rate		Inflation Rate		Monetary Base		Real GDP	
	Level	First difference[a)]	Level	First difference	Level	First difference	Level	First difference	Level	First difference
Burundi	-3.31 (0.02)[b)]	-5.48 (0.00)	-2.68 (0.08)	-5.80 (0.00)	-6.39 (0.00)[c)]	-12.42 (0.00)	-1.06 (0.73)	-8.47 (0.00)	-1.11 (0.71)	-3.52 (0.01)
Kenya	-2.56 (0.10)	-5.31 (0.00)	0.38 (0.98)	-5.80 (0.00)	-5.63 (0.00)	-8.00 (0.00)	-0.17 (0.94)	-7.60 (0.00)	-1.42 (0.58)	-3.14 (0.02)
Rwanda	-2.28 (0.18)	-2.86 (0.05)	-1.31 (0.63)	-3.46 (0.01)	-4.84 (0.00)	-8.39 (0.00)	[d)]----	-----	-0.91 (0.78)	-3.21 (0.02)
Tanzania	-1.75 (0.41)	-6.15 (0.00)	-1.40 (0.58)	-6.22 (0.00)	-6.55 (0.00)	-8.36 (0.00)	-0.19 (0.94)	-6.66 (0.00)	0.07 (0.96)	-3.50 (0.01)
Uganda	-3.02 (0.03)	-3.63 (0.01)	-2.42 (0.14)	-3.79 (0.00)	-5.71 (0.00)	-11.36 (0.00)	0.68 (0.99)	-6.15 (0.00)	-0.10 (0.95)	-5.22 (0.00)

Note: [a)] This column indicates the first difference of the variable. [b)] The first entry is the ADF statistic, while the entry in parentheses is the associated p-value. The nominal exchange rate for Burundi and Uganda are stationary, I(0), in levels at the 5% significance level. [c)] The inflation variable is I(0) in levels for all the countries at the 1% significance level. [d)] Adequate monetary base data is not available for Rwanda.

Table 2. Test of cointegration for nominal exchange rate

Null hypothesis: r	Maximum eigenvalue test			Trace test		
	λ_{max} statistic	5% critical value	1% critical value	λ_{trace} statistic	5% critical value	1% critical value
0	22.52[*1]	20.97	25.52	34.41[*1]	29.68	35.65
1	7.98[*5a)]	14.07	18.63	11.89[*5]	15.41	20.04
2	3.91	3.76	6.65	3.91	3.76	6.65

Note: These results are based model 1 and 2 lags. [*5a)] The null hypothesis of no cointegration, $r = 0$, is rejected while the null hypothesis of zero or one, $r \leq 1$, cannot be rejected against the alternative of, $r = 2$, at the 5% level.

Table 3. Test of cointegration for real exchange rate

Null hypothesis: r	Maximum eigenvalue test			Trace test		
	λ_{max} statistic	5% critical value	1% critical value	λ_{trace} statistic	5% critical value	1% critical value
0	41.64	36.41	41.58	88.10	77.74	85.78
1	16.57[*1, 5a)]	30.33	35.68	46.45[*1, 5]	54.64	61.21
2	13.74	23.78	28.83	29.88	34.55	40.49
3	9.35	16.87	21.47	16.14	18.17	23.46
4	6.78	3.74	6.40	6.78	3.74	6.40

Note: These results are based on model 2 and 1 lag. [*1, 5a)] The null hypothesis of no cointegration, $r = 0$, is rejected while the null hypothesis of zero or one, $r \leq 1$, cannot be rejected against the alternative of, $r = 2$, at the 5% and 1% level.

Table 4. Test of cointegration for monetary base

Null hypothesis: r	Maximum eigenvalue test			Trace test		
	λ_{max} statistic	5% critical value	1% critical value	λ_{trace} statistic	5% critical value	1% critical value
0	40.50	31.46	36.65	102.50	62.99	70.05
1	40.12	25.54	30.34	62.00	42.44	48.45
2	11.76[*1, 5a)]	18.96	23.65	21.88[*1, 5]	25.32	30.45
3	10.12	12.52	16.26	10.12	12.25	16.26

Note: These results are based on model 2* and 4 lags. [*1, 5a)] The null hypothesis of $r \leq 2$ cannot be rejected against the alternative, $r = 3$, at the 5% and 1% level.

Table 5. Test of cointegration of nominal exchange rate under different restrictions

Submodel	Maximum eigenvalue test (λ_{max})		Trace test (λ_{trace})	
	1% level	5% level	1% level	5% level
Model 0. Trend (None)	0	1	0	1
Model 1*. Trend (rconstant)	0	1	1	1
•Model 1. Trend (constant)	0	1	0	1
Model 2*. Trend (rtrend)	0	0	0	0
Model 2. Trend (trend)	0	0	0	1

Note: •The LR tests suggest this is the best sub-model. The results shown here are based on two lags indicated by the AIC and HQIC tests as optimal. Tests of cointegration are carried out for only three countries (Kenya, Rwanda, and Tanzania). Burundi and Uganda are not included because the ADF tests indicate the variable is I(0) in levels.

Table 6. Test of cointegration of real exchange variable under different restrictions

Sub-model	Maximum eigenvalue test (λ_{max})		Trace test (λ_{trace})	
	1% level	5% level	1% level	5% level
Model 0. Trend (None)	1	1	2	2
Model 1*. Trend (rconstant)	1	1	1	2
Model 1. Trend (constant)	1	1	1	2
Model 2*. Trend (rtrend)	1	1	1	1
•Model 2. Trend (trend)	1	1	1	1

Note: •The LR tests suggest this is the best sub-model. The results shown here are based on one lag indicated by the AIC and HQIC tests as optimal.

Table 7. Test of cointegration of monetary base variable under different restrictions

Sub-model	Maximum eigenvalue test (λ_{max})		Trace test (λ_{trace})	
	1% level	5% level	1% level	5% level
Model 0. Trend (None)	2	2	2	2
Model 1*. Trend (rconstant)	2	2	2	2
Model 1. Trend (constant)	2	2	2	2
•Model 2*. Trend (rtrend)	2	2	2	2
Model 2. Trend (trend)	1	1	1	2

Note: •The LR tests suggest this is the best sub-model. The results shown here are based on four lags indicated by the AIC and HQIC as optimal. Cointegration test is carried out for only four countries. Rwanda is excluded for lack of data.

Table 8. Test of cointegration of real gdp under different restrictions

Sub-model	Maximum eigenvalue test (λ_{max})		Trace test (λ_{trace})	
	1% level	5% level	1% level	5% level
Model 0. Trend (None)	2	3	2	3
Model 1*. Trend (rconstant)	2	3	3	3
•Model 1. Trend (constant)	1	1	1	1
Model 2*. Trend (rtrend)	0	1	0	1
Model 2. Trend (trend)	1	1	1	1

Note: •The LR tests suggest this is the best sub-model. The results shown here are based on two lags.

Relationship between Financial Sector Development and Sustainable Economic Development: Time Series Analysis from Pakistan

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Abstract

The study empirically investigated the contribution of financial sector in sustainable economic development of Pakistan. Annual data were used from the period of 1973 to 2007. Main objectives were to analyze the long run relationship between financial sector development and sustainable economic development along with direction of causality between both. Auto Regressive Distributed Lag (ARDL) bound testing technique for cointegration was applied to estimate the long run relationship. A stable long run relationship was found between financial sector indicators and the sustainable economic development. Error Correction coefficient was statistically significant. It was concluded that financial sector had positive impact on the sustainable economic development in short run as well as in the long run. Causality test revealed that financial sector development was the basis for economic development.

Keywords: Sustainable economic development, Financial sector, Cointegration

JEL: E44, N25, O16

1. Introduction

In the past decade the financial sector had gone under large transformation in many countries of the world. Deregulation, privatization and openness had brought revolution in this sector. This resulted in many findings related to importance of financial sector developments in prompting the economic development of a nation.(Note 1)

Here comes a question that either this development in financial sector has caused sustainable development in developing countries; or the pace of development is going to initiate the development in financial sector.

It is true that a well-developed, efficient, organized and viable financial system is a necessary condition for the economic development in any economy. The financial sector occupied a crucial place in performing the development activities and acted as a catalyst to economic growth. Countries with developed banking sector and dynamic stock markets grew faster over the period compared with the countries had lagged financial system(Levine, 1997).The effects of technological changes had expanded firm's financial demand and these changes had increased requirements for financial intermediaries. Financial Intermediaries allocated funds to those projects where the marginal productivity of capital was maximum, thus financial sector caused the economic growth by increasing the productivity of capital. Development of the banking sector and the stock market were highly correlated with the economic development and both sectors exerted an important impact on development of a country (Beck et al.2000). Further, the financial sector played a very important role in mobilizing and better utilization of saving (Ang, 2008). Financial sector utilized these resources to increase capital formation through the provision of a wide range of financial tools to meet different requirements of borrowers and lenders.

The financial sector of Pakistan also witnessed revolutionary changes. A broad based program of reforms was launched since 1990s but the pace of these reforms increased manifold since 2000. The banking sector in Pakistan had been transformed from a sluggish state- owned sector to a dynamic private sector. The State Bank of Pakistan took a number of steps to further enhance the pace of this transformation process of the development of financial sector in the country.

Substantial literature existed on the debate of the financial sector development contribution towards economic development. Historically, Bagehot (1873) and Schumpeter (1912) highlighted the role of the financial sector in economic development. Levine and Zervos (1998) and King and Levine (1993) analyzed the contribution of financial sector development on output growth in cross-countries analysis. Stock market liquidity and banking sector development indicators showed positive correlation with economic growth in both short run and long run scenario in most countries of the study. Arestis et al. (2001), Shan et al. (2002), and Abu-Bader et al. (2005) explored the link between financial sector development and economic growth Bank-based model contributed more to output growth in long run than the stock market based model. Causality results showed finance led growth. Loayza and Ranciere

(2002), Andries et al. (2003), Seetanah (2007), Jalil and Ma (2008) and Khan et al. (2005) used Autoregressive distributed lag (ARDL) technique was used to estimate the short run and long run effects of financial sector development on economic growth. A positive long-run effect was found of financial intermediation on output growth. Ang (2008) attempted to analyze the role of financial sector development and liberalization on the income inequalities in India. Khan and Qayyum (2004) and Shahbaz et al. (2008) investigated the impact of trade and financial development on economic growth in Pakistan. With Bound testing approach of cointegration; it was found that financial sector indicators and real interest rate had a positive and significant effect on economic growth. Previous studies used GDP, real GDP per capita or GNP as the proxies for economic growth but these studies ignored the debt burden and exports. This paper will use external debt to exports ratio as the proxy of sustainable economic development and examine the contribution of financial sector development towards the economic development of the country and also the direction of causality between them.

The paper is structured as follows: In the next section the main findings of the existing literature are given, section 2 is for description of research methodology and data used. In section 3 the empirical findings are provided and finally, the main findings of the study are summarized in concluding section.

2. Data and Research Methodology

The most important and critical requirement for the research is the provision of an accurate and consistent data along with an appropriate methodology. Therefore, the use of systematic and most suitable technique in conducting any empirical study was imperative. Basic hypotheses, data selection, model specification, variables description and procedures were considered the basic ingredients of methodology. All these key-components of methodology are discussed in this section.

2.1Data and Data sources

The annual time series data were used over the period of (1973-2007). The data were taken from International Financial Statistics (IFS), World Development Report, World Bank, Pakistan Economic Survey different issues, Handbook of Statistics on Pakistan Economy (2005), State Bank of Pakistan (SBP). World Development Indicators (WDI), Global Development finances.

2.1.1. Description of the variables

The selection of key variables to indicate the level of financial sector development is a very difficult task. There were so many alternative indicators that could affect the financial sector development. Numerous indicators are used in various studies related to the topic of financial development and economic growth. Three indicators are selected from the banking sector and one proxy is developed to capture stock market development.The first indicator is the Ratio of M2 minus Currency in Circulation to Nominal GDP (*MG*). M2 to GDP ratio was used as an indicator of banking sector development (see Levine (1997), Asteriou (2003), Shan (2005), and Masih (2008)). This ratio reflects an extensive use of currency out side the banking system rather than an increase in bank deposits. Owing to this reason this measure appears to be less indicative of the financial dealings and transaction of the banking system. Now-a-days researchers are using the ratio of M2 minus currency in circulation to nominal GDP as financial sector development Abu-Bader et al. (2005), Dematriads and Hussen (1996), and Khan et al. (2005). M2 means total currency in circulation in the economy i.e. currency in the tills of scheduled banks, bank deposits with SBP, scheduled banks demand deposits and scheduled banks time deposits .

The second indicator of banking sector development is the ratio of domestic credit to private sector to nominal GDP (*DCPS*). This indicator measures the quality and quantity of the investment financed by the banking sector many researchers used this indicator as a proxy for financial sector development (see King and Levine (1993), Levine (1999), Abu-Bader,et al. (2005), Beck et al, Shandre, et al. (2004) Mazur and Alexander (2001), Shan (2005), Erdal and Hyougsoo (2007), Acaravci et al. (2007). Third indicator of the banking sector development is the assets with the central bank to GDP ratio (ASBG). Central bank assets are gold, approved foreign exchange and special drawing rights. It further reveals the strength of financial system of a country. Average market capitalization to GDP ratio (*AMC*) is used as the indicator of development of stock exchange market. Thus ratio of total value of stock market over the nominal GDP shows the country's financial and investment policy behavior (Beck et al.1999). Sustainable economic development is measured by the ratio of external debt to exports ratio (*EDX*). This indicator represents the degree of indebtedness of the country and its exports performance. Higher the ratio, greater the share of the GDP allocated to current repayments and a burden on future generations, As a result, the economy's current and future development possibilities will be affected. High indebtedness ratio could curtail social sector spending in the long run. The impact of the reduced spending in social sectors would affect poverty, health and education.

Labels assigned to all the variables used in the study are shown in the table 1.

2.1.2 Test for Stationarity Check

Stationarity is a key concept used in econometric theory for the time series data as regressions between two non-stationary variables produce bogus results according to (Griffith et al. 2001). Most time series show the increasing or decreasing tendency over the time. Any estimation between series depicting specific inclinations may turn out to have considerable results with high R^2, but may not be authentic (Granger and Newbold, 1974). To

avoid all these problems of the spurious regression results; Dickey Fuller and Augmented Dickey Fuller test (1986) are used for stationarity check of all the variables.

2.1.3 Test for Cointegration

The concept of cointegration was first given by Granger (1981). If the linear combination of two non- stationary I (1) series, Y and X, such that the residuals of the regression are stationary, errors have tendency to disappear and return to zero i.e. are I (0), then the variables are co integrated.

$$Y_t = \beta_0 + \beta_1 X_t + u_t \quad \ldots\ldots\ldots\ldots (1)$$

$$u_t = Y_t - \beta_0 - \beta_1 X_t \quad \ldots\ldots\ldots\ldots (2)$$

$$u_t = I(0) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Auto regressive distributed (ARDL) bounds testing approach is applied to examine the cointegration relationship between financial sector development and economic development.

$$EDX_t = b_0 + b_1 MG_t + b_2 AMC_t + b_3 ASBG_t + b_4 DCPS_t + e_t \quad \ldots\ldots\ldots (4)$$

Following double log form is used to estimate the cointegration relationship between financial sector development and sustainable development (loyaza, 2002).

$$LnEDX_t = b_0 + b_1 LnMG_t + b_2 LnAMC_t + b_3 LnASBG_t + b_4 LnDCPS_t + e_t \quad \ldots\ldots (5)$$

2.2. Estimation Procedure

The study uses Auto Regressive Distributed Lag (ARDL) bound testing approach to cointegration developed by Pesaran (2001). ARDL has many advantages over Johansen cointegration approach. It can be applied when the variables are of different order of integration, Variables may be I (0), I (1) or mutually co integrated (Pesaran and Pesaran, 1997). This approach performs better than Engle Granger or Johansen cointegration technique in small sample size. In ARDL approach all the variables are considered as endogenous variables.

To find out the cointegration relationship between financial sector indicators and the economic development the following unrestricted error correction version of the ARDL model is used. The auto regressive distributed lag approach to cointegration is a general to specific approach. Numbers of iterations are made and lag length is selected that provided appropriate estimates.

$$DLnEDX_{it} = b_0 + \sum_{i=1}^{p} b_{1i} DLnEDX_{t-i} + \sum_{i=1}^{p} b_{2i} DLnMG_{t-i} + \sum_{i=1}^{p} b_{3i} DLnAMC_{t-i} + \sum_{i=1}^{p} b_{4i} DLnDCPS_{t-i} + \sum_{i=1}^{p} b_{5i} DLnASBG_{t-i} + l_1 LnEDX_{t-1} + l_2 LnMG_{t-1} + l_3 LnAMC_{t-1} + l_4 LnDCPS_{t-1} + l_5 LnASBG_{t-1} + m_t \quad \ldots\ldots (6)$$

In equation (6), the terms with the summation signs represent the error correction dynamics (short run dynamics of the model), and the terms with λ sign represent the long run relationship. While βo is the drift component and μ_t the white noise error term.

The null hypothesis indicating the non existence of long run relationship is used as follows

$$Ho: \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 0 \quad \ldots\ldots\ldots (7)$$

The alternative hypothesis shows the existence of the long run relationship among the variables.

$$H_1: \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq 0 \quad \ldots\ldots (8)$$

The null hypothesis is estimated through the help of F statistics. Two asymptotic critical value bands are provided by Pesaran et al (2001) when the variables are I(0) or I(1) . The assumption considered by the lower boundary is that variables in the model are I(0) and the upper boundary assumes that all the variables in the model were I(1). If some concerned variables are I (2) or beyond, then the computed F statistics provided by Pesaran et al. (2001) becomes invalid.

The ARDL approach starts with conducting the bounds test for the null hypothesis of no co integration. The F-statistic is compared with the critical value tabulated by Pesaran et al. (2001). If computed F- statistic exceeds the upper critical value the null hypothesis of no long run relationship can be rejected regardless of whether the order of integration of the variables is I(0) or I(1). Similarly if calculated F- statistic is below the lower critical value, the null hypothesis is failed to reject. If calculated F- statistic is between these two bounds the results would be inconclusive. When the long run relationship is established among the variables then there is an error correction representation.

So the following error correction model is estimated.

$$DLnEDX_t = b_0 + \sum_{i=1}^{p} b_{1i} DLnEDX_{t-i} + \sum_{i=1}^{p} b_{2i} DLnMG_{t-i} + \sum_{i=1}^{p} b_{3i} DLnAMC_{t-i} + \sum_{i=1}^{p} b_{4i} DLnDCPS_{t-i} + \sum_{i=1}^{p} b_{5i} DLnASBG_{t-i} + aECM_{t-1} + m_t \ldots\ldots\ldots(9)$$

The error correction model results indicate the speed of adjustment back to long run disequilibria after a short run shocks. The ECM integrates the short-run coefficient with the long-run coefficient with out losing long-run information

2.2.1. Test for Granger Causality

There are two variables y_t and M_t affecting each other with distributed lags; the relationship between these variables can be captured by a VAR model

There are four possibilities that (a) y_t causes M_t (b) M_t causes y_t (c) there is a bi-directional feedback (causality among the variables) (d) the two variables are independent.

2.2.2 Test for Stability Check

The goodness of fit of the ARDL model is verified through the stability tests namely Cumulative Sum of Recursive Residuals (CUSUM) and Cumulative Sum of Squared Recursive Residuals (CUSUMSQ.). The diagnostic test examined the serial correlation, functional form, normality and heteroscedasticity.

3. Results and Discussion

The relationship between time series variables could be estimated by cointegration test. Prior to conducting the cointegration analysis, it is essential to check the Stationarity for each variable in the model. The presence of unit root in time series data usually provides fake regression results (Griffith et al, 2001). Thus, the first step in any time series empirical analysis is to test for presence of unit root to avoid the problem of inaccurate estimates. A series is stationary when the mean and variance is constant and Covariance is time independent. In order to check stationarity, Dickey Fuller and Augmented Dickey Fuller tests (1986) are used. Unit root tests are applied on the original data series and results of the tests are reported in the table 2.

The results of the unit root tests shows that all the variables are non-stationary at level. Tabulated value of all the variables is less negative then the critical values. It shows the existence of unit root i.e. the variables are non-stationary at level. Further the unit root tests were applied on the first differenced time series. The results in the table 3 show that all the variables attained stationarity at first difference. The calculated values of coefficients are more negative then the critical value developed by McKinnon (1991).

3.1. ***Cointegration tests***

The null hypothesis of no cointegration is estimated through ARDL approach. The F- statistic is compared with the critical value tabulated by Pesaran et al (2001). The results of variable addition test show that the value of F statistics i.e. 5.635 at 5 percent level of significance exceeded the critical bounds (2.649 to 3.805) developed by Pesaran et al. (1997) with an unrestricted intercept and no trend at 95 percent level. So the null hypothesis of no long run relationship is failed to accept (rejected). The rejection of null hypothesis shows the clear long run relationship between the variables of financial sector development and sustainable economic development (EDX).

The co-integrating vectors are generated through application of bounds tests on equation 9. Independent variables are used as dependent variables turn by turn and the value of F statistics is calculated.

$$\Delta LnEDX_t = \beta_0 + \sum_{i=1}^{2} \beta_{1i} \Delta LnEDX_{t-i} + \sum_{i=1}^{2} \beta_{2i} \Delta LnMG_{t-i} + \sum_{i=1}^{2} \beta_{3i} \Delta LnAMC_{t-i} + \sum_{i=1}^{2} \beta_{4i} \Delta LnDCPS_{t-i} + \sum_{i=1}^{2} \beta_{5i} \Delta LnASBG_{t-i} + \lambda_1 LnEDX_{t-1} + \lambda_2 LnMG_{t-1} + \lambda_3 LnAMC_{t-1} + \lambda_4 LnDCPS_{t-1} + \lambda_5 LnASBG_{t-1} + \mu_t \ldots\ldots\ldots(10)$$

The results of table 4 indicate the existence of a long run relationship between the variable of financial sector and external debt to exports ratio. Therefore ARDL approach to co integration was applied to estimate the long run coefficients and error correction model. ARDL (3,1,0,1,1) model is estimated and lags are selected based on Schwarz Bayesian Criterion. Dependent variable is log of external debt to exports ratio (LnEDX)

The results indicate that all the variables are significant at 5 percent level of significance but average market capitalization to GDP ratio (AMC) is found insignificant. The sign of credit to private sector to GDP ratio (DCPS) and assets with the State Bank to GDP ratio (ASGB) are negative and consistent with the economic theory;

indicating the inverse relationship between financial sector development and external debt to exports ratio. An increase in M2 minus currency in circulation indicates that M2 minus currency in circulation was increasing at rapid rate as compared to increase in GDP. It meant people are spending less and saving more to have more financial assets. It leads to saving paradox that is more saving, less investment. The sign of average market capitalization is also negative, consistent with economic theory but insignificant. It is concluded that banking sector is more affective to reduce the ratio of external debt to exports ratio in Pakistan. This model also highlighted the importance of credit to private sector, which had a robust effect on reducing the ratio of external debt to exports ratio. But stock exchange markets show no significant role to reduce external debt to exports ratio. The results are consistent with Roble (1997).

3.2. Error Correction Mechanism

The value of error correction coefficient is -0.756, statistically significant at the 5 percent levels confirms a high speed of adjustment back to long run disequilibrium i.e. with the feedback coefficient of 0.756. Only the coefficient of assets with the State Bank to GDP ratio is significant with negative sign. It shows that assets with the State Bank had inverse relationship with external debt to exports ratio. Whereas the lagged values of external debt to exports ratio are accumulating the external debt to exports ratio in short run.

3.3. Granger Causality Tests

Pair wise Granger Causality Test was applied and the results of the test were given in the following table. The results indicate unidirectional causality between external debt to exports ratio and the ratio of credit to private sector to GDP. Uni-directional causality is also observed between assets with the State Bank of Pakistan to GDP ratio and external debt to exports ratio at 5 percent level of significance. The results of causality test highlighted the importance of credit to private sector and assets with the State Bank, showing

a robust effect on economic development.

Stability of the Model

The Cumulative Sum of Recursive Residuals (CUSUM) and Cumulative Sum of Squared Recursive Residuals (CUSUMSQ) stability tests are applied to confirm the stability of the variables in the model. Graphs of CUSUM and CUSUMSQ are within 5 percent of critical bands. It indicates the structural stability of the variables of the model (Oskooee and Wing, 2002). The plots of Both CUSUM and CUSUMSQ given in Fig 1 & Fig 2 confirm the stability of the model.

Conclusion

The study evaluates the role of financial sector in sustainable economic development of Pakistan. The main objectives of the study are to analyze the long run relationship between financial sector development and sustainable economic development and also to determine the direction of causality between financial sector indicators and sustainable economic development. Dickey Fuller and Augmented Dickey Fuller unit root tests are used to check the stationarity of each variable in the model. All the variables are found I (1). Auto Regressive Distributed Lag (ARDL) bounds testing technique to cointegration, developed by Pesaran et al. (2001) is applied to estimate the long run relationship between financial sector development and sustainable economic development. A stable cointegration relationship is found among the variables and Error Correction coefficient is also found statistically significant. It indicates that there is a stable long run relationship between financial sector and economic development.Short run results indicate that the lagged values of external debt to exports ratio with direct relationship are accumulating the external debt to exports ratio. Uni-directional causality exists between external debt to exports ratio and credit to private sector to GDP ratio and also between assets with the State Bank to GDP ratio and external debt to exports ratio. The study also applied the stability tests, Cumulative Sum of Recursive Residuals (CUSUM) and Cumulative Sum of Squared Recursive Residuals (CUSUMSQ) for the structural stability of the variables in the model and found that the model is stable.

Policy Recommendations

On the basis of estimated results the study concludes that credit to private sector has a significant impact on sustainable economic development in long run. Therefore priority should be given to private sector in credit disbursement decisions to further enhance the pace of sustainable economic development. The ratio of M2 minus currency in circulation to GDP shows a negative impact on economic development. Savings are essential to economic development, but these savings should be converted into productive investment to get the fruits of development. It was also found that the assets with the State Bank of Pakistan had a significant role to reduce the ratio of external debt to exports. The study suggested that a well-developed financial sector is essential to economic development. Liberal policies should be adopted for the development of financial sector in Pakistan to have the sustainable development of the economy..

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Notes

Note 1. Among them are Bagehot(1873),Schumpeter(1912), Levine (1997), Beck,et al.(2000) Arestis et al.(2001), Shan et al. (2005), and Abu-Bader and Abu-Qarn (2007).

Table 1. Labels Assigned to Variables of the Study

Label	**Name of the variable**
LnMG	Log of M2 minus currency in circulation to GDP ratio.
LnAMC	Log of Average Market Capitalization to GDP ratio.
LnDCPS	Log of domestic credit to private sector to GDP ratio.
LnASBG	Log of assets with the State Bank of Pakistan to GDP ratio.
LnEDX	Log of external debt to exports ratio.

Table 2. Results of the Unit Root Test at level

	Test with a constant & no trend		Test with a constant & trend	
Variables	DF	ADF	DF	ADF
LnMG	-0.796	-0.783	-2.092	-2.224
LnAMCG	0.996	0.197	-2.307	-2.234
LnASBG	-1.080	-1.040	-2.199	-2.243
LnDCPS	-2.114	-2.740	-2.265	-2.873
LnEDX	-1.279	-2.23	-1.362	-2.312
Critical value	-2.953		-3.551	

At 5 percent level of significance.

Table 3. Results of the Unit Root Test at first Difference level

	Test with a constant and no trend		**Test with a constant and trend**	
Variables	DF	ADF	DF	ADF
DLnMG	-5.497*	-4.389*	-5.448*	-4.356*
DLnAMCG	-5.680*	-3.625*	-5.708*	-3.654*
DLnASBG	-5.493*	-4.082*	-5.346*	-3.913*
DLnDCPS	-5.769*	-5.514*	-5.686*	-5.380*
DLnEDX	-3.681*	-2.974*	-3.616*	-3.913*
Critical value	-2.956		-3.556	

Note: * indicated the stationarity of the variables at 5% level of significance.

Table 4. Results of the Bounds Tests on Changing the Positions of Independent and Dependent Variables.

Dependent variable	**Independent variable**	**Value of F statistics**	**Lags order**
LnMG	LnEDX, LnAMC, LnDCPS, LnASBG	4.2477*	3
LnAMC	LnEDX, LnMG, LnDCPS, LnASBG	1.1560	2
LnDCPS	LnEDX, LnMG, LnAMC, LnASBG	3.6131	1
LnASBG	LnEDX, LnMG, LnDCPS, LnAMC	3.8173*	2

Note: * represented the co integration relationship.

Table 5. Results of Long run Relationship between Sustainable Development (external debt to exports ratio) and Financial Sector Development

Independent variable	Coefficient	Standard Error	T-Ratio
LnMG	0.642*	0.164	3.901
LnAMC	-0.024	0.039	-0.627
LnDCPS	-0.620*	0.294	-2.105
LnASBG	-0.283*	0.054	-5.185
INPT	7.299	0.975	7.483

Note: * indicated 5 percent level of significance.

Table 6. Short term Dynamics between Sustainable Development and Financial sector development through Error Correction Model
log of external debt to exports ratio is used as dependent variable

Independent Variables	Coefficient	Standard Error	T-Ratio
DLnEDX1	0.230	0.152	1.518
dLnEDX2	0.591*	0.181	3.273
dLnMG	-0.248	0.215	-1.152
dLnAMC	-0.018	0.030	-0.616
dLnDCPS	-0.015	0.239	-0.063
dLnASBG	-0.097*	0.038	-2.563
dINPT	5.523	1.184	4.6643
ecm(-1)	-0.756*	0.133	-5.697
R-Squared	0.762		
DW-statistic	2.223		

Note: * indicated 5 percent level of significance.

Table 7. Granger Causality between Sustainable Development and Financial Sector development
log of external debt to exports ratio is used as dependent variable

Direction of Causality			**F-Statistic**	**Probability**
LnMG	NO	LnEDX	1.033	0.318
LnEDX	NO	LnMG	1.6352	0.211
LnAMC	NO	LnEDX	0.1052	0.748
LnEDX	NO	LnAMC	1.794	0.190
LnDCPS	NO	LnEDX	0.495	0.488
LnEDX	⟶	LnDCPS	13.694*	0.001
LnASBG	⟶	LnEDX	3.954*	0.056
LnEDX	NO	LnASBG	0.697	0.410

Note: * indicates 5 percent level of significance.

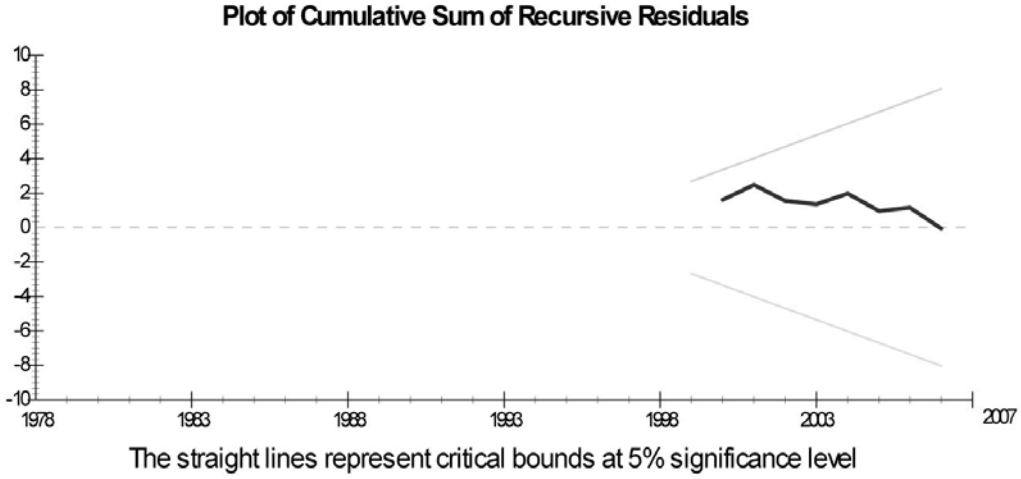

Figure 1. Plot of CUSM recursive residuals showing stability of Model

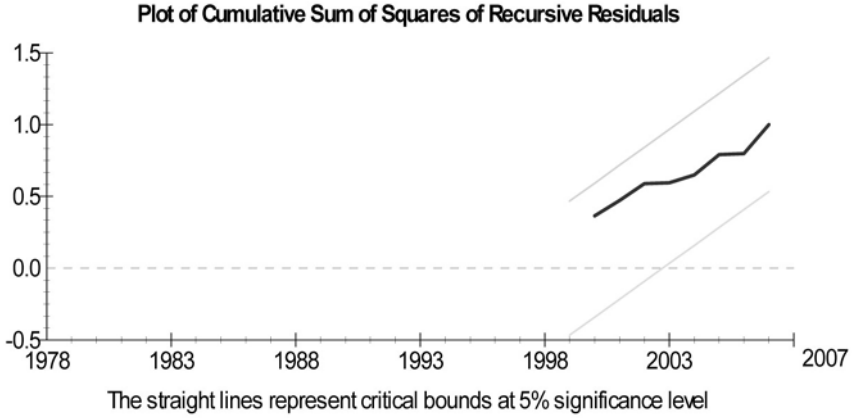

Figure 2. Plot of CUSMSQ Recursive residuals showing stability of Model

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Stability of Demand for Money in India: Evidence from Monetary and Liquidity Aggregates

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Abstract
The determinants and stability of money demand functions, as per new definitions of monetary aggregates, has been analyzed in this paper. Quarterly Data from 1996Q2 to 2009Q2, for various monetary aggregates, interest rates, exchange rates, stock prices and GDP is in use. The cointegration tests, error correction mechanism, Granger causality and CUSUM tests has been applied for empirical analysis. The estimated results disclose the existence long-run and short-run relationship among the variables. Unidirectional Granger causality found from GDP and Stock Prices to monetary, new monetary as well as liquidity aggregates. Also similar result repeated from interest rates to money demand functions. The CUSUM and CUSUMQ tests support the existence of stability of each money demand functions. All the three variables, except exchange rate, affect the money demand of both types of specification.

Keywords: Monetary, New monetary, Liquidity aggregates, Cointegration, Stability tests, Causal tests

1. Introduction

Stability of demand for money is vital for choosing the appropriate instruments and intermediate targets of monetary policy. Essentially, it's a prerequisite for use of monetary aggregate as an intermediate target. Money demand stability implies that the quantity of money can be predictable related to various macroeconomics variables (Judd and Scadding (1982) and Friedman (1987)). In fact various macroeconomic variables such as, fiscal policy, interest rates, exchange rate, stock market, consumption expenditure, savings, investment, Import, export, etc can significantly affect the money demand. Understanding such linkages will facilitate the central bank to design the appropriate money demand function and, thus accordingly formulate and implement the appropriate monetary policy to achieve the desired objective of price stability with growth.

The issue of determinants and stability of money demand function in a transition economy has received budding interest among academician and policy makers. Stability of money demand functions is essential for stable economic growth. Several empirical studies examining the money demand function across economies are found in the macro-monetary literature. Some of the prominent studies are, Tobin (1958), Chow (1966), Goldfeld (1973), Judd and Scadding (1982), Roley (1985), McCallum and GoodFriend(1987), Laidler (1990), Goldfeld and Sichel(1990), Taylor (1991) and many more . These studies made significant contributions towards determinants and stability of money demand function. More empirical studies found across economies recently e.g. Hafer and Jansen (1991), Miller (1991), McNown and Wallace (1992) and Mehra (1993) for the USA. The paper of Lütkepohl and Wolters (1999), Coenen and Vega (2001), Brand and Cassola (2000), Holtemöller (2004b) discusses for Euro area. Arize and Shwiff (1993), Miyao (1996) and Bahmani-Oskooee (2001) examined the demand for money in the context of Japan. The studies of Drake and Chrystal (1994) for the UK; Haug and Lucas (1996) for Canada; Lim (1993) for Australia, whereas Orden and Fisher (1993) for New Zealand; Brissimis and Leventakis (1981), Bahami-Oskooee and Economiodu (2005) among few for Greece; Hsing(2007) for Croatia are pioneering in the field of demand for money. No unanimous results found in terms of specification, determinants and stability of money demand function. For example, Taylor (1991) recognized that for a high inflationary country, inflation expectation was the main determinant of money demand function than the low inflationary country.

Various aspect of money demand functions have been extensively studied in Indian context. The earlier studies of Biswas (1962), Singh (1970), Avadhani (1971), Gupta (1970, 71), Ahluwalia (1979) widely differs regarding income and interest rate as the determinant of money demand. Vasudevan (1977), Arif (1996), provides useful survey of some of the earlier studies. Applying various statistical and econometric techniques Deadman and Ghatak (1981), Sampath and Hussian (1981), Bhole (1985) and Rangarajan (1988), Nag and Upadhyay (1993) focused attention on the choice of monetary aggregates as dependent variable. Jadav (1994) established the long-run real income elasticity of broad money and semi elasticity with respect to own real rate of return. Recently Joshi and Saggar (1995), Arif (1996), Mohanty and Mitra (1999), Das and Mandal (2000) found stability of money demand functions. On the other hand, Bhoi (1995), Pradhan and Subramanian (2003) observed that financial deregulation and liberalization in the 1990s affect the empirical stability of broad money. The real GDP significantly affects money demand not interest rates, Kulkarni and Erickson (2000), thus supporting monetarists' argument of no role of interest rate in money demand. Padhan (2006), examined the money demand (M1, M3) function under liquidity adjustment facility and found that money demand functions are sensitive to real income, interest rates and to some extent exchange rates.

In India, the monetary policy formulation and implementation, which was entirely governed by the policies of Reserve Bank of India (RBI) during pre 1990's has become market driven in the post 1990's scenario. However, last

two decade the economy is witnessed by several socio-economic-political crises, e.g. spill over effect of Asian Financial turmoil of 1997, Indo-Pak Kargil War, the devaluation of rupees against US dollar, US sub prime crisis spill over effect, global recession, the stock market crash, spiral increase in inflation, general elections, internal rebellion of various activists groups and many more. This has complicated the task for RBI to conduct and implement monetary policy in a challenging environment and cope up with the pace of transition from an administered system to a market based process. Choosing the appropriate intermediate target, instruments and operating procedures of monetary policy has become tedious. Since mid 80's monetary target is still the intermediate target of monetary policy even though RBI has adopted multiple indicator approach ever since mid 90's. An effective and transparent monetary policy requires a strong relationship between output, income, prices, interest rates etc. and other macroeconomic variables. Therefore such transitions and challenges raise concerns over the determinants and stability of the money demand.

To summaries, most of these studies applied either narrow money (M_1) or broad money (M_3) as measures of monetary aggregates and mixed evidence found on stability. Recently, RBI working group on money supply (1998) came up with alternative monetary aggregates such as L_1, L_2, L_3, NM_1, NM_2, and NM_3 (Note 1). Although, broad money (M_3) is widely used for policy analysis, other monetary aggregates are quite relevant for the economy, as they provide unique information. To our mind, none of the study considered such empirical specification of money demand functions. There is also paucity of study to examine the impact of factors such as stock price, exchange rates in affecting money demand functions. Instead of using proxy variable (IIP) the study uses actual quarterly GDP data for income and two different interest rates (call money rate i.e. market determined interest rate and 91Day Treasury bill rate i.e. policy rate). In view of this, the objective of the paper is to study determinants and stability of money demand applying various monetary (old and new) and liquidity aggregates in this context of India.

The rest of the paper is divided into following sections. The Section 2 specifies model specification and methods of estimation of money demand function. Section 3 discusses the empirical results and section 4 concludes.

2. Model Specifications and Methods of Estimation

While formulating the demand for money we have started with the traditional quantity theory of money expressed as MV = Py (Note 2). As suggested by Friedman (1987) including various determinants of money demand the QTM, a simple money demand function, can be stated as $(M/P)^d = f(y, r, E, S)$, where M is money stock, P is general price level, V is velocity of circulation of money, y is real income, r is interest rate, E is exchange rate, S is stock price. The exchange rate and stock price is included as additional determinants of demand for money. The rationality is that foreign exchange and stocks constitutes a part of portfolio of economic agents. Depreciation in exchange rate may result in further depreciation of the currency, which will force individuals to hold money as foreign currency to avoid possible losses. Similarly, expectations of currency depreciations may reduce money demand either due to substitution effect or wealth effect, Arango and Nadiari (1981). On the other hand stock price could be another variable affecting money demand functions possibly due to wealth effect and substitution effect Friedman (1988). For example, any increase in stock price might increase the nominal wealth; as returns on investment increases. This might induce people to hold more money and hence demand for money balances increases. Similarly, as stock price increases people might reshuffle the portfolio and prefer to hold large chunk of other attractive and lucrative equities in the portfolios. It indicates that net affect of stock price could be either +ve or –ve. Thus the demand for real money balances as a function of real income, interest rate, real stock price, real exchange rate can be specified as (Note 3)

$$(M/P)_t^d = \beta_0 + \beta_1 (Y/p)_t + \beta_2 r_t + \beta_3 E_t + \beta_4 S_t + \varepsilon_t \quad \text{----} \quad (1)$$

Where, M is nominal money supply at time t., P is the price level(WPI), Y is nominal income, r_t is short term interest rate and E_t is the real exchange rate, S_t is the real stock price at time t. In the equation, $(M/P)_t^d$ represents the real money balance and $(Y/p)_t$ is the real income at time t. Theoretically, demand for money is directly related with real income and indirectly with interest rates. But the sign of the exchange rate and stock price in uncertain. So by convention, the values of the coefficient of income (β_1) should be positive and interest rate (β_2) is negative but for exchange rate (β_3) and stock price (β_4) it could be either negative or positive. It calls for empirical estimation of money demand functions and tests its stability.

The equation (1) can be estimated by multiple linear regression models, although regression model does not explain the dynamic relationship among the specified variables. The relationship could also be spurious. The cointegration test of Johansen-Juselius (1990) possibly avoids the problem by allowing feedback relationship and provides the long-run equilibrium relationship among variables.

The equation 1 can be expressed as a vector of variables, where each variable might be dynamically interrelated. Their long-run and short-run equilibrium relationship can be examined using cointegration and error correction model respectively. Technically speaking the money demand equation can be considered as a cointegrating equation. The estimation of Johansen –Juselius cointegration equation is based on Vector auto regression model estimated through maximum likelihood estimation procedure (Note 4). Johansen (1988, 1991), Johansen's-Juselius (1990, 1992) methodology is design to determine the number of cointegrating vector in the VAR system. The methods specify two test statistics in order to test the number of cointegrating vectors. Those are λ max (the maximum eigen value statistics) and λ trace statistics. The first step of testing cointegration is to tests whether the series are

stationary or not i.e. I (1) or I (0). Then apply the cointegration for non-stationary series i.e the series at levels if the variables are I (1). We can test the integration of the series by applying Phillips –Peron, PP (1988) and KPSS (1992) tests. Once the series are cointegrated they follow equilibrium pattern in the long run. However, in the short-run they might depart from each other resulting in dis-equilibrium. This can be explained through corresponding error correction model by including stationary residuals from the cointegrating vectors and include its one period lagged values (ECt-1) in an error correction model.

The ECM can be specified as,

$$\Delta M_t = \beta 0 + \sum_{j=1}^{n} \beta_{1j} \Delta M_{t-j} + \sum_{j=0}^{n} \beta_{2j} \Delta y_{t-j} + \sum_{j=0}^{n} \beta_{3j} \Delta r_{t-j} + \sum_{j=0}^{n} \beta_{4j} \Delta E_{t-j} + \sum_{j=0}^{n} \beta_{5j} \Delta S_{t-j} + \lambda EC_{t-1} + u_t \ldots\ldots\ldots\ldots\ldots (2)$$

Where, λ is the coefficient of error correction term. It denotes the speed of convergence towards equilibrium and provides the direction of equilibrium. The expected sign of the coefficient is negative. It means if the model is out of equilibrium, then demand for real money balance come forward from below to restore the equilibrium in the next period. If λ is not statistically significant, implying that the coefficient is equivalent to zero, hence the dependent variable adjusts to the changes in independent variables in the same period during short run.

We have applied the Granger causality tests to evaluate the temporal causality. Granger causality test says that if the variables are cointegrated then there exists a necessarily causal relationship among them at least in one direction. The causality can be tested using F statistics. Under the null hypothesis of no causality (e.g. from Y to X), if calculated F statistics is greater than critical F statistics with appropriate degrees of freedom and significance level, then reject the null hypothesis against alternative hypothesis.

Finally, we have applied CUSUM and CUSUMQ tests, proposed by Brown et. al. (1975) to tests the stability of the long-run and short-run coefficients. If the plot of CUSUM or CUSUMQ stays with in the 5% significance level, then the coefficients estimates are said to be stable (Note 5).

3. Data and Empirical Analysis

3.1 Data

Various alternative definitions of monetary aggregates such as narrow money (M1), broad money (M3) and liquidity aggregates L_1, L_2, new monetary aggregates (NM_3) is applied for empirical analysis(Note 6).

Weighted average call money rate (henceforth CMR) Mumbai and 91 Day Treasury bill rate (henceforth TBR) are considered for interest rates and Real effective exchange rate (reert) trade based (36- country weights) is for exchange rate. For stock price, CNXNifty is considered. Real income is measured by GDP at constant price. The empirical analysis is carried out applying quarterly data from 1996 Q2 to 2009 Q2. The period has been chosen based on availability of the quarterly data; collected from the Handbook of Statistics on Indian Economy. The quarterly data for CMR and TBR which is not available are extrapolated from monthly data. The real values are generated by deflating the nominal variable with the wholesale price index (WPI). After estimating the variable in real term, all the variables are expressed by natural logarithms.

3.2 Descriptive Statistics and Correlations

Preliminary understating of data structure can be analyzed through descriptive statistics and correlations coefficients. The results of summary statistics for all variables expressed in natural logarithms are given in table 1. The results reveal that except 91 day Treasury bill rate (TBR) and CNXNifty other variables follow normal distribution as represented by JB test and corresponding probability values. The null hypothesis of normal distribution for both the variables is rejected at 1% and 10 % significance level. Since the sample size is very small i.e. 53 only, so such type of conclusion is irrelevant. Skewness and Kurtosis support the same conclusion, whose value for a normal distribution are 0 and 3 respectively. Except TBR and CNXNifty other variables are normally distributed. When the variable is normally distributed, it does not follow random walk process and hence become easy to establish the relationship between such variables.

The variability of various monetary aggregates is similar. The coefficient of variations is lowest for TBR indicating that it's less volatile. The correlation coefficient of GDP and Stock price with money aggregates are highly correlated. Interest rate is moderately correlated with the monetary aggregates. Informally, the money demand functions are highly correlated with the income, interest rate and stock market. The sign of the correlation coefficient are obtained as per expectations. Although correlation coefficient between exchange rate and monetary aggregates are very less, it does not provide cause and effect relationship between variables. The demand function can be estimated through regression analysis.

3.3 Regression Analysis

The money demand equation 1 can be estimated through multiple linear regression model. We have estimated 10 different regression equations for 5 different alternative combinations of monetary aggregates using 2 types of interest rates separately. It's because the model suffers from multicollinearity problem as the correlation coefficient between CMR and TBR is very high i.e 0.858 and VIF is 3.788. The results are reported in table 2. The regression model is estimated with Newey-West HAC standard error and covariance with lag truncation equal to 3 to avoid the possibility of unknown heteroscedasticity and autocorrelation problem. The regression results using CMR and TBR separately are reported in panel A and B respectively. In both the panel, income and interest rates significantly affect money demand function irrespective of model specification. The coefficients of income are statistically significant at 1% significance level applying t test. Except for M_3 (which is significant at 5% significance level) in panel A, the

coefficient of interest rate are statistically significant at 1% significance level. The results are consistent with Keynesian theory of demand for money as the sign of the coefficient; real income and interest rate are consistent and statistically significant. On the other hand, coefficient of stock price is statistically significant at 1% significance level only for M_1 money demand function and none other. But exchange rate is not statistically significant in either case. Hence both the variables do not statistically significantly affect money demand. The obtained coefficients are elasticity of money with respect to respective variables. For example the income elasticity of M_3 is equal to 1.32, i.e. more elastic. The regression results are robust due to high R^2, Significant F statistics, no autocorrelation and no heteroscedasticity problem. Of course, the limitation is that multiple regression model does not explain dynamic relationship among variables. The cointegration techniques e.g. Johansen-Juselius (1990) applied here can overcome such problem (Note 7).

3.4 Stationary of the Series

If any linear combination of two or more non-stationary series is stationary then the series are said to be cointegrated. The application of cointegration needs prior checking of stationary properties. Phillips-Perron (PP, 1988) and Kwiatkowsk, Phillips, Schmidt, and Shin (KPSS, 1992) unit root tests are applied. The former test addresses the issue of possible serial correlation in the regression model and tests the hypothesis. The later is a confirmatory test. The results are reported in table 3 at level and first difference of the variables. The models are estimated including a constant (C) and with constant & trend (C & T) term in the regression equations separately. For PP and KPSS tests the brackets represent the bandwidth of Newey- West using Bartlett kernel. For PP tests p values are in the parenthesis.

The PP tests assume the null hypothesis of unit root against the alternative of stationary. On the other hand KPSS is a confirmatory test, which assumes the null hypothesis of stationary against the alternative of non-stationary. For all variables at level the null hypothesis is accepted. However, for the variables at first difference, we reject the null hypothesis of unit root at 1% significance level for by both the PP and KPSS test of alternative model specification. Thus variables are stationary at first difference and non-stationary at level. Hence we can apply cointegration tests at level data.

3.5 Cointegration Results

The next step is to apply the multivariate cointegration test of Johansen (1988, 1991) and Johansen's-Juselius (1990, 1992), estimated through maximum likelihood estimation procedure. Two tests statistics such as λ trace and λ maximum eigen value is used to determine the number of cointegration vector. For n variable cases if at least one (r=1) cointegrating vector is present, it is sufficient to conclude that the variables are cointegrated. The number of cointegrating vector is estimated through VAR model for which it is necessary to specify the number of lag length in the autoregressive process. We have started with 1 lag and maximum of 8 is taken in the process. The lag length of 4 is chosen based on Akaike Information Criteria, Schwarz Bayesian Criteria and log likelihood ratio tests, which is theoretically and practically justified. The robustness of the model has also been checked using ARCH, LM, JB, Heteroscedasticity tests (Note 8).

Once optimal lag length is determined then next step is to apply cointegration test. The obtained results are reported in table 4. Panel A specify the cointegration equation with constant term, whereas panel B specify model with the linear deterministic trend term. In both the cases, we have estimated 10 cointegrating equations with two different interest rates. In panel A , irrespective of money demand specification with any interest rates, the null hypothesis of zero cointegrating vector (r=0) is rejected against the alternative of at least one cointegrating vector at 5% significance level. The same result is repeated in panel B also. For both the model we found minimum one cointegrating vector. Further, testing more number of cointegrating vectors, we might obtain different results, as shown in the table. This is evident from both trace and eigen value statistics. For example, the null hypothesis of r=2 cointegrating vector is rejected and alternative of 3 cointegrating vector is accepted for M_1 money demand function with constant term. Similarly for NM_3 money demand function with trend, the null hypothesis of r=1 cointegrating vector is rejected at 5% significance level and alternative of $r > 2$ is accepted. The result strongly supports the presence of one cointegrating vector for both the demand functions. Therefore, we can conclude that cointegration exists between variables and hence in the long-run they are related.

3.6 Error Correction Mechanism

If the variables are cointegrated, it need not necessarily mean that in the short-run they are always in equilibrium. This departure from the equilibrium relationship in the short-run is explained through error correction term. The error correction term is obtained from the residuals terms of cointegrating equations and plugged into the cointegrating equation with lagged term in first difference. The specified error correction model 2 is estimated using OLS methods. The results are reported in table 6. The details of ECM results are not provided here except the coefficient of Error correction term due to space consumption and may be available upon request. It means except M_3 money demand equation the sign of coefficient of error correction term is negative which is as per expectations. It implies that the specified money demand function adjust from below to restore the equilibrium in the immediate next period. Since other coefficients are statistically insignificant, implying that they are equivalent to zero. So the money demand function reacts to the changes in independent variables with the same period to restore equilibrium. However, if ECM term is negative, then monetary aggregates comes from above to restore equilibrium. The result

indicates that all the variables are related in the short run and therefore the short-run causality can be explained through Granger causality tests.

3.7 Granger Causality Tests

The bivariate Granger causality test is applied for testing causality. According to Engel-Granger (1987), if the variables are cointegrated, then they are necessarily causally related at least in one direction. Granger causality applied for stationary series only, so we have estimated this for variables with first difference. The bivariate Granger causality tests results are reported in table 6. Accordingly the null hypothesis of GDP does not Granger cause monetary aggregates have been rejected for all types of money demand functions at various significance level, as reported by F statistics and corresponding P values. It implies that real income Granger causes money demand but not the reverse except for L2. Except L2 unidirectional causality found from real income to real money balances. Bi-directional relationships exist for real income and real L2 money balance. There is also unidirectional causality from real money to both the interest rates. It implies that call money rate reacts (also TBR) for any change in money demand not the reverse. Unidirectional causality found from stock price to money demand functions as the null hypothesis is rejected at various significance level. No causal relationship notices in either direction between exchange rate and real money balances. The result is consistent with regression results, also justified as per the magnitude and sign of coefficients are concerned.

3.8 Stability Tests

Once variables are cointegrated and causal relationship established, then stability of the demand for money can be tested applying CUSUM and CUSUMQ tests. From cointegrating equation we can obtain residuals. Considering the coefficients of residual with one period lagged term, we estimate an error correction model (with appropriate lagged term, here it is 4) and then apply both CUSUM and CUSUMQ test on the residual of error correction term. The equation 2 specifies ECM and can be estimated by OLS method. Then apply the CUSUM and CUSUMQ tests on the residual. If graphical plot of the CUSUM and CUSUMQ stays within 5% significance level, then coefficient estimators are said to be stable. The estimated result for each money demand specification with both CMR and TBR are represented in both Panel A and B respectively. From fig 1 it is clear that graphical plot of the CUSUM and CUSUMQ stays with in critical band of 5% for M_1, L_1, and L_2 demand for money. It indicates that the demand for money is stable. However although CUSUMQ tests for M_3 and NM_3 money demand are slightly out side the band (during mid 2006 to 2007) most of the cumulative sum of recursive residual squares are with in 5% confidence limit. It indicates that both M_3 and NM_3 demand for money is also relatively stable.

3.9 Money Demand Functions

The estimated money demand functions through regression analysis are reported in table 2. The estimated demand functions suggest existence of a stable relationship between real money balances with real income, real interest rate, and to some extent real exchange rate and stock price. From the equations we can find the elasticity of demand for real money balances. The income elasticity of demand with respect to M_1, M_3, L_1, L_2 and NM_3 is 1.014, 1.32, 1.39, 1.387, and 1.397 respectively. The positive sign is consistent with the theory because as income increases the demand for money increases. The interest (CMR) elasticity of money demand with respect is M_1, M_3, L_1, L_2 and NM_3 is -0,118, -0.127, -0.143,-0.140 and -0.145 respectively, which is also consistent with theory. The elasticity of money demand for M_1, M_3, L_1, L_2 and NM_3 with respect to exchange rate is 0.006, 0.188, 0.284, 0.288 and 0.173 respectively. Similarly the elasticity of money demand for M_1, M_3, L_1, L_2 and NM_3 with respect to stock price is 0.165, 0.038, 0.046, 0.046 and 0.083 respectively. Elasticity of money demand with respect to real income is elastic but inelastic for interest rate, exchange rate and stock price. The results are consistent with theories of demand for money.

4. Conclusion

The paper started with a discussions on the specification, estimation and stability of the demand for money with respect to various monetary (old and new) and liquidity aggregates. The money demand function specified including exchange rate and stock price in addition to income and interest rates. For empirical testing of the same it uses quarterly data. All the series expressed in natural logarithms are stationary at first difference. The cointegration result shows the presence of more than one cointegrating vector for all types of money demand functions, supporting the long-run equilibrium relationship among variables. Similarly ECM also supports the short-run dynamic properties of money demand functions. Unidirectional causality found from GDP and Stock Prices to monetary, new monetary and liquidity aggregates through Granger causality test. Similarly unidirectional causality is also noticed from interest rates to money demand functions. The CUSUM and CUSUMQ tests show that all the alternative specification of money demand functions is stable. The paper also concludes that except exchange rate, all the other variables significantly affect the money demand function.

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Notes

Note 1. M1 = Currency with the Public + Demand Deposits with the Banking System + 'Other' Deposits with the RBI.

M2=M1 + Savings Deposits of Post office Savings Bank

M3 = M2 + Term Deposits of residents with a contractual maturity of over one year with the Banking System + Call/Term borrowings from 'Non-depository' Financial Corporations by the Banking System

NM2 = currency and residents' short-term bank deposits which would stand in between narrow money (M1) (which includes only the non-interest bearing monetary liabilities of the banking sector) and broad money (M3) (an all encompassing measure that includes long-term time deposits). NM3= Currency with the public + Demand Deposits with Banks + Time Deposits with Banks- FCNR (b) and RIB deposits + 'Other' Deposits with RBI +Other borrowings by Banks.

L1= M3 + all Post Office Deposits with the Post Office Savings Banks(Excluding National Savings Certificate)

L2= L1+ Term Deposits with FIs + Term Borrowing by FIs + CDs issued by FIs
L3= L2 + Public Deposits with NBFCs
Note 2.According to the standard text books, real income determines the demand for money in the classical sense as money is demanded for transaction purpose, whereas for Keynesian it is real income and interest rate as people demand money for transaction, precautionary and speculative purpose. On the other hand, Friedman has given a list of factors affecting money demand such as stock, bonds, etc. which generated wealth. Similar exchange rate also determines the demand for money because of substitution as well as wealth effect.
Note 3. According to Rangarajan (1985),it is possible to build into such a formulation the lagged impact of the factors that influence the money holding
Note 4. Since this is widely applied technique, we are not discussing the details of it. Once can refer a stranded text book on Time series Econometrics. In our earlier version of the paper Padhan (2006) we have discuses about this procedure elaborately.
Note 5. The significance level is portrayed by two straight lines whose equations are given in Brown et.al (1975)
Note 6. NM2 and L2 are not considered due to lack of required data.
Note 7. Gonzalo (1994) analyzed the statistical performance of three cointegration tests such as, Engel-Granger, the Stock and Watson tests, and Johansen's test and found that Johansen's is found to be superiors to the other tests under consideration.
Note 8. The results can be obtained from the author upon request.

Table 1. Descriptive Statistics and Correlations

Descriptive Statistics	M_1	M_3	L_1	L_2	NM_3	GDP	CMR	TBR	REERT	CNXNifty
Mean	3.45	3.990	4.002	4.004	3.977	5.541	0.813	0.820	1.994	0.999
Std. Dev.	0.149	0.176	0.180	0.179	0.185	0.116	0.134	0.146	0.0161	0.178
Skewness	0.270	0.066	0.054	0.054	0.115	0.149	0.206	-1.419	-0.662	0.702
Kurtosis	1.827	2.003	1.915	1.922	1.928	2.093	2.929	7.994	3.389	2.411
Jarque-Bera	3.680	2.232	2.624	2.590	2.655	2.012	0.388	72.875	4.202	5.126
P Values	0.159	0.328	0.269	0.274	0.265	0.366	0.824	0.000	0.122	0.077
Coeff. Variation	0.043	0.043	0.045	0.045	0.046	0.022	0.165	0.002	0.008	0.178
Correlations										
M_1	1.000	0.991	0.992	0.992	0.995	0.963	-0.344	-0.499	0.135	0.797
M_3	0.991	1.000	0.999	0.999	0.999	0.959	-0.355	-0.526	0.120	0.730
L_1	0.992	0.999	1.000	1.000	0.999	0.963	-0.364	-0.532	0.130	0.736
L_2	0.992	0.999	1.000	1.000	0.999	0.963	-0.363	-0.532	0.131	0.737
NM_3	0.995	0.999	0.999	0.999	1.000	0.961	-0.358	-0.524	0.126	0.748
GDP	0.963	0.959	0.963	0.963	0.961	1.000	-0.281	-0.468	0.095	0.753
CMR	-0.344	-0.355	-0.364	-0.363	-0.358	-0.281	1.000	0.858	-0.070	-0.090
TBR	-0.499	-0.526	-0.532	-0.532	-0.524	-0.468	0.858	1.000	0.028	-0.144
REERTB	0.135	0.120	0.130	0.131	0.126	0.095	-0.070	0.028	1.000	0.263
CNXNifty	0.797	0.730	0.736	0.737	0.748	0.753	-0.090	-0.144	0.263	1.000

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Table 2. Regression Results: (Newey West HAC Standard Error and Covariance (lag truncation=3))

Dep.Var	Panel A: Independent Variables					Panel B Independent Variables				
	C	GDP	CMR	REERT	CNXNifty	C	GDP	TBR	REERT	CNXNifty
M_1	-2.25*	1.014*	-0.12*	0.006	0.1649*	-2.08*	0.953*	-0.12*	0.0874	0.186*
	(-4.33)	(17.01)	(-3.94)	(0.030)	(4.700)	(-3.53)	(12.63)	(-2.92)	(0.375)	(4.673)
	(0.000)	(0.000)	(0.000)	(0.976)	(0.000)	(0.00)	(0.000)	(0.005	(0.709)	(0.000)
	R^2=0.949 Adj R^2=0.945 DW=1.158 F=224.645 P=0.000					R^2=0.946, Adj R^2=0.945, DW=1.58, F=226.15 P=0.000				
M_3	-3.93*	1.32*	-0.13**	0.188	0.0383	-3.70*	1.298*	-0.14**	0.275	0.065
	(-4.73)	(14.11)	(-2.63)	(0.656))	(0.737)	(-4.68)	(12.11)	(-3.02)	(0.908)	(1.222)
	(0.000)	(0.000)	(0.011)	(0.515)	(0.464)	(0.000	(0.000)	(0.004)	(0.368)	(0.228)
	R^2=0.929 Adj R^2=0.922 DW=1.497 F=156.136 P=0.000					R^2=0.930, Adj R^2=0.92 DW= 1.49, F=159.43 P=0.000				
L_1	-4.24*	1.39*	-0.14*	0.284	0.046	-4.01*	1.318*	-0.16*	0.038	0.075
	(-5.44)	(14.57)	(3.033)	(1.127)	(0.981)	(-4.94)	(12.10)	(-2.911)	(1.323)	(1.465)
	(0.000	(0.000)	(0.004)	(0.265)	(0.333	(0.000	(0.000)	(0.005)	(0.192)	(0.149)
	R^2=0.938 Adj R^2=0.933 DW=1.604 F=183.21 P=0.000					R^2=0.939 Adj R^2=0.934 DW= 1.59, F=186.74 P=0.000				
L_2	-4.194	1.387	-0.140	0.288	0.0459	-3.94*	1.308*	-0.16*	0.384	0.073
	(-5.41)	(-2.99)	(-2.99)	(0.684)	(0.784)	(-4.96)	(12.07)	(-2.93)	(1.343)	(1.469)
	(0.000)	(0.000)	(0.004)	(0.497)	(0.437)	(0.00)	(0.000)	(0.005)	(0.186)	(0.148)
	R^2=0.938 Adj R^2=0.933 DW= 1.599 F=182.014 P=0.000					R^2=0.939, Adj R^2=0.934 DW= 1.59 F=186.028 P=0.000				
NM_3	-4.07*	1.397*	-0.14*	0.173	0.083	-3.84*	1.316*	-0.14*	0.272	0.111**
	(-5.17)	(14.52)	(-3.05)	(0.623)	(1.664)	(-4.80)	(11.86)	(-2.90)	(0.887)	(2.076)
	(0.000)	(0.000)	(0.004)	(0.536)	(0.103)	(0.00)	(0.000)	(0.006)	(0.379)	(0.043
	R^2=0.938 Adj R^2=0.931 DW=1.548 F=175.469 P=0.000					R^2=0.9386Adj R^2=0.934 DW= 1.55 F=178.150 P=0.000				

*, **, ** Denotes 1%,5% and 10% significance level respectively. Obtained 't' statistics and p values are given the parenthesis respectively.

Table 3. Unit Root Tests

Variable	PP Test Level		PP Test First Difference		KPSS Test Level		KPSS Test First Difference	
	C	C & T	C	C & T	C	C & T	C	C & T
M_1	2.770 (14)	-2.98 (18)	-9.279 (17)	-13.46 (15)	0.980 (5)	0.231	0.421 (05) *	0.137 (14) *
	(1.00)	(0.148)	(0.000) *	(0.000) *		(13)		
M_3	1.364 (12)	-1.138 (7)	-3.946 (80)	-5.951(21)	0.989 (5)	0.123 (5)	0.246 (10) *	0.131 (12) *
	(0.999)	(0.912)	(0.000) *	(0.000) *				
L_1	1.623 (19)	-3.12 (10)	-9.269 (25)	-9.541(24)	0.994 (5)	0.144 (3)	0.283 (20) *	0.173 (19) *
	(0.999)	(0.113)	(0.000) *	(0.000) *				
L_2	1.582 (19)	-3.101 (9)	-9.366 (26)	-9.461(24)	0.994 (5)	0.148 (3)	0.278 (20) *	0.108 (19) *
	(0.999)	(0.117)	(0.000)	(0.000)				
NM_3	4.544 (44)	-1.62 (12)	-7.451 (50)	-7.45 (50)	0.991 (5)	0.187 (8)	0.407 (46) *	0.500(81) *
	(1.000)	(0.771)	(0.000) *	(0.000) *				
GDP	-0.789 (12)	-6.33 (25)	-17.68 (11)	-16.88 (11)	0.983 (5)	0.500	0.372 (11) *	0.636 (11) *
	(0.814)	(0.000) *	(0.000) *	(0.000)		(52)		
CMR	-3.478 (1)	-3.765 (1)	-11.44(18)	-12.06 (20)	0.407 (4)	0.102 (4)	0.097 (9) *	0.095 (9) *
	(0.013)	(0.007)	(0.000) *	(0.000) *				
TBR	-0.939 (1)	-1.633 (1)	-3.806 (0)	-3.584 (1)	0.344 (5)	0.096 (4)	0.177 (1) *	0.132 (1) *
	(0.707)	(0.766)	(0.005) *	(0.04) *				
REERT	-2.218 (2)	-1.973 (2)	-5.332 (1)	-5.661 (1)	0.162 (4)	0.948 (4)	0.163 (1) *	0.086 (0) *
	(0.203)	(0.602)	(0.000) *	(0.000) *				
CNXNIFTY	-0.962 (1)	-2.02(0)	-5.004 (3)	-4.91 (15)	0.642 (3)	0.174 (5)	0.9395 (2) *	0.062 (2) *
	(0.759)	(0.577)	(0.001) *	(0.0009) *				

*, **, ** Denotes 1%,5% and 10% significance level respectively stands for with constants and C & T for with constant and trend. For PP tests and KPSS the brackets represent the bandwidth Newey- West using Bartlett kernel. For PP tests p values in the parenthesis. The critical values for KPSS LM statistics is at level with constant term is at 1%, 5%, 10% significance level are 0.739, 0.463 and 0.347 respectively and for constant and trend term it is 0.216, 0.146 and 0.119. Similar

Table 4. Johansen Juselius Cointegration Tests

Cointg. Equation	Hypothesis: Trace Stat.	Hypothesis: Max Stat.	Panel A (with Constant)				Panel B (With Trend)			
			λ Trace Stat.	P value	λ Max Stat.	P Value	λ Trace Stat.	p Value	λ Max Stat.	p Value
M_1, GDP, CMR, REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	127.530*	0.000	50.327*	0.000	141.624*	0.000	46.544*	0.005
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	17.003*	0.001	41.319*	0.000	93.250*	0.000	44.764	0.071
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	95.684*	0.044	18.162	0.171	50.946*	0.006	23.915	0.088
	Ho:r≤3, H_1:r>3	Ho:r=3, H_1:r=4	17.321	0.114	146.7	0.078	23.041	0.053	15.171	0.154
M_1, GDP, TBR, REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	141.230*	0.000	61.795*	0.000	155.957*	0.000	66.025*	0.000
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	79.435*	0.000	42.244*	0.000	89.938*	0.001	43.927*	0.001
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	32.191*	0.030	19.302	0.132	46.008*	0.003	21.401*	0.021
	Ho:r≤3, H_1:r>3	Ho:r=3, H_1:r=4	18.086	0.097	13.396	0.140	25.547*	0.035	14.023	0.251
	Ho:r≤4, H_1:r>4	Ho:r=4, H_1:r=5	4.492	0.344	4.492	0.344	12.543*	0.024	11.523*	0.002
M_3, GDP, CMR, REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	105.580*	0.000	37.776*	0.002	130.037*	0.000	42.981*	0.014
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	67.784*	0.001	31.312*	0.021	87.875*	0.000	32.907*	0.040
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	36.272*	0.038	16.759	0.244	34.909*	0.002	29.409*	0.016
	Ho:r≤3, H_1:r>3	Ho:r=3, H_1:r=4	19.42	0.063	14.171	0.091	25.507	0.054	14.119	0.246
M_3, GDP, TBR , REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	170.182*	0.000	81.628*	0.000	124.004*	0.000	44.367*	0.002
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	88.956*	0.000	35.866*	0.005	79.052*	0.000	35.812*	0.003
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	33.089*	0.000	28.118*	0.007	43.844*	0.007	25.231*	0.025
	Ho:r≤3, H_1:r>3	Ho:r=3, H_1:r=4	24.970*	0.010	18.374*	0.019	20.610*	0.007	18.069*	0.011
	Ho:r≤4, H_1:r>4	Ho:r=4, H_1:r=5	6.446	0.959	6.446	0.159	2.541	0.119	2.541	0.119
L_1, GDP, CMR, REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	136.924*	0.000	61.426	0.000*	136.973*	0.000	61.428*	0.000
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	75.493*	0.000	31.846*	0.018	75.495*	0.02	31.848*	0.018
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	43.646*	0.022	19.721	0.110	43.646*	0.005	19.721	0.110
	Ho:r≤3, H_1:r>3	Ho:r=3, H_1:r=4	23.923	0.075	13.861	0.101	23.925*	0.015	13.860	0.101
	Ho:r≤4, H_1:r>4	Ho:r=4, H_1:r=5	4.004	0.067	9.064	0.054	10.064	0.136	10.004	0.135
L_1, GDP, TBR, REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	100.386*	0.000	36.734*	0.024	114.820*	0.000	44.478*	0.008
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	63.832*	0.005	28.872*	0.050	70.340*	0.012	32.788*	0.041
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	35.275*	0.049	20.931	0.075	32.337	0.181	16.820	0.473
	Ho:r≤3, H_1:r>3	Ho:r=3, H_1:r=4	14.804	0.769	8.354	0.806	21.237	0.190	16.216	0.240
L_2, GDP, CMR, REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	92.701*	0.002	33.479*	0.041	113.839*	0.000	40.183*	0.030
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	59.221*	0.016	29.0146*	0.043	73.638	0.076	32.186*	0.045
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	30.057	0.161	13.341	0.472	211.472	0.069	22.165	0.141
L_2, GDP, TBR, REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	99.293*	0.004	36.04*	0.035	114.894*	0.002	44.863*	0.000
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	63.184*	0.006	22.590*	0.050	70.030*	0.014	31.863	0.537
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	35.593	0.545	20.456	0.080	38.167	0.138	17.903	0.384
	Ho:r≤3, H_1:r>3	Ho:r=3, H_1:r=4	15.156	0.212	8.753	0.054	20.167	0.213	13.519	0.288
NM_3, GDP, CMR, REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	104.860*	0.001	41.669*	0.006	24.384*	0.000	45.677*	0.006
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	62.190*	0.036	26.631*	0.046	78.708*	0.001	29.686	0.097
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	36.209*	0.036	17.681	0.185	49.012*	0.011	24.521	0.073
	Ho:r≤3, H_1:r>3	Ho:r=3, H_1:r=4	18.829	0.077	13.348	0.125	24.550	0.728	13.257	0.307
NM_3, GDP, TBR, REERT, CNXNifty	Ho:r=0, H_1:r>0	Ho:r=0, H_1:r=1	131.128*	0.000	64.994*	0.000	110.277*	0.000	40.246*	0.027
	Ho:r≤1,H_1:r>1	Ho:r=1,H_1:r=2	66.134*	0.003	27.743*	0.048	70.0264*	0.001	27.013*	0.012
	Ho:r≤2, H_1:r>2	Ho:r=2, H_1:r=3	38.381	0.022	24.201	0.027	32.953*	0.004	23.323	0.024
	Ho:r≤3, H_1:r>3	Ho:r=3, H_1:r=4	14.179	0.277	9.086	0.425	14.629	0.067	12.142	0.105

*, **, ** Denotes 1%,5% and 10% significance level respectively. Critical Values are used from Osterwald-Lenum (1992).

Table 5. Error Correction Models:

ECM Equations	Interest rate Variables	Coefficient of ECM(-1)	T Statistics	P values
M_1	CMR	-0.405	-0.973	0.342
M_1	TBR	-0.182	-0.377	0.709
M_3	CMR	0.003	0.008	0.993
M_3	TBR	0.377	0.791	0.438
L_1	CMR	-0.083	-0.404	0.647
L_1	TBR	-1.173	-1.77	0.162
L_2	CMR	-0.855	-1.216	0.237
L_2	TBR	-0.289	-0.625	0.538
NM3	CMR	-0.342	-0.797	0.434
NM_3	TBR	-0.002	-0.009	0.996

*, **, ** Denotes 1%,5% and 10% significance level respectively.

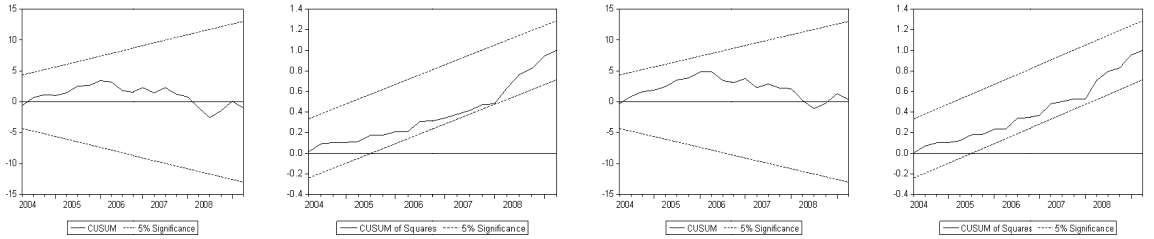
Table 6. Granger Causality Tests

Hypothesis e. g. H_0: Y does not Granger cause X. ; H_1: Y Granger cause X , Lag=4:							
Direction of Causality (Y→X)	F Statistics	P value	Causality Exists	Direction of Causality (Y→X)	F Statistics	P Value	Causality Exists
RGDP→ M_1	2.53***	0.055	Y	L_1→TBR	4.243*	0.006	Y
M_1→GDP	1.211	0.322	N	EERTB→ L_1	0.838	0.510	N
CMR→M_1	1.894	0.131	N	L_1→REERTB	0.251	0.907	N
M_1 →CMR	5.457*	0.001	Y	CNXNIFTY→L_1	2.397***	0.067	Y
TBR→ M_1	1.872	0.135	N	L_1→-CNXNIFTY	0.792	0.537	N
M_1-TBR	4.835**	0.003	Y	GDP→ L_2	8.247*	0.000	Y
REERTB→ M_1	0.510	0.729	N	L_2→ GDP	2.272**	0.079	Y
M_1 → REERTB	0.077	0.989	N	CMR→ L_2	0.966	0.437	N
CNXNIFTY-→ M_1	5.037*	0.002	Y	L_2 →CMR	3.340**	0.019	Y
M_1 → CNXNIFTY	3.152**	0.024	Y	TBR → L_2	1.526	0.213	N
GDP → M_3	2.361***	0.070	Y	L_2→ TBR	4.121*	0.007	Y
M_3→GDP	1.579	0.199	N	REERTB → L_2	0.950	0.445	N
CMR→– M_3	1.390	0.255	N	L_2 →REERTB	0.284	0.887	N
M_3 →CMR	5.171*	0.002	Y	CNXNIFTY→ L_2	2.353***	0.071	Y
TBR→ M_3	0.842	0.5073	N	L_2→CNXNIFTY	0.803	0.531	N
M_3→TBR	5.229*	0.002	Y	GDP → NM_3	3.335**	0.019	Y
REERTB→ M_3	0.486	0.746	N	NM_3 → GDP	1.508	0.219	N
M_3 →REERTB	0.138	0.967	N	CMR → NM_3	1.220	0.318	N
CNXNIFTY → M_3	2.419***	0.065	Y	NM_3 →CMR	5.611*	0.001	Y
M_3→CNXNIFTY	1.863	0.136	N	TBR →NM_3	0.544	0.704	N
DP→L_1	8.271*	0.000	Y	NM_3→ TBR	5.462*	0.001	Y
L_1→ GDP	2.276**	0.078	Y	REERTB→- NM_3	0.591	0.671	N
CMR→ L_1	0.899	0.474	N	NM_3 → REERTB	0.042	0.996	N
L_1 - CMR	3.396**	0.018	Y	CNXNIFTY →NM_3	2.401***	0.066	Y
TBR → L_1	1.267	0.299	N	NM_3→ CNXNIFTY	2.035	0.108	N

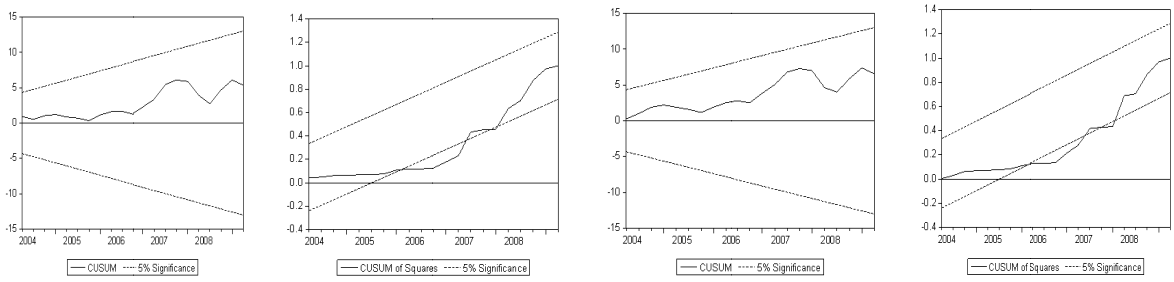
*, **, ** Denotes 1%,5% and 10% significance level respectively. Y for Yes , N for No

Panel A: with CMR **Panel B: with TBR**

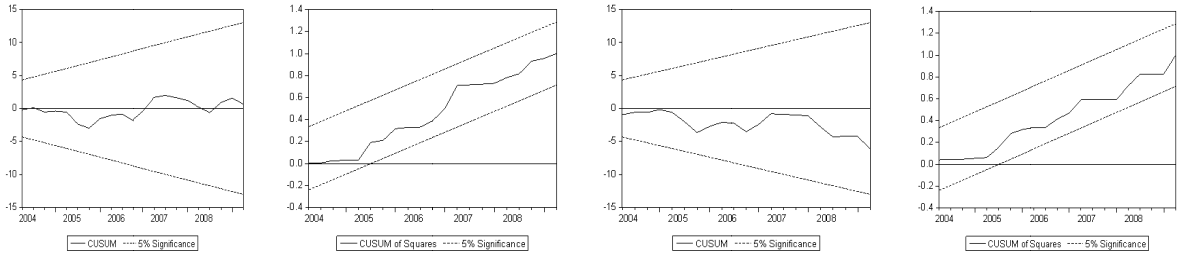
1. M_1



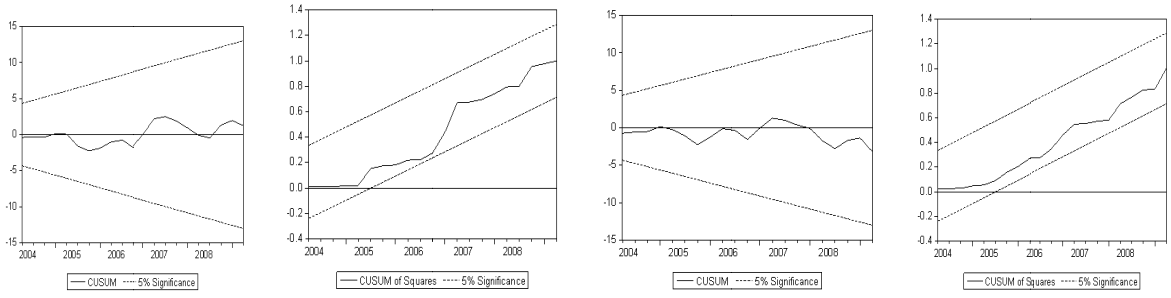
2. M_3



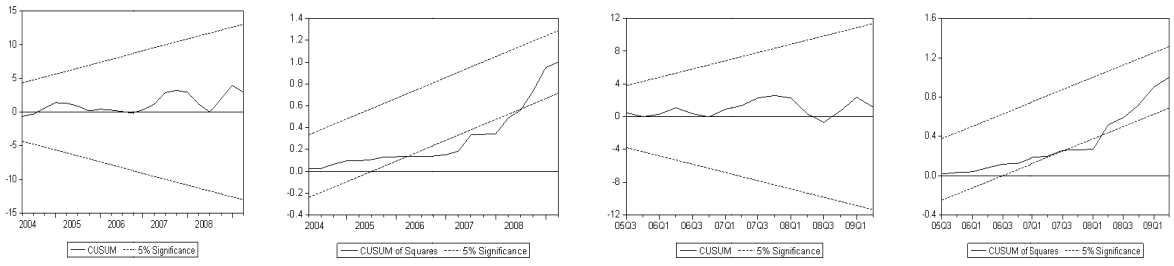
3. L_1



4. L_2



5. NM_3



The straight line represent critical bound at 5% significance level

Figure 1. CUSUM and CUSUMQ Test: Plot of cumulative sum of and square of recursive residual

Inter-Bank Call Rate Volatility and the Global Financial Crisis: The Nigerian Case

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Abstract

This paper investigated the volatility of interbank call rates in Nigeria using GARCH (1, 1), EGARCH (1, 1), TS-GARCH (1, 1) and PARCH (1, 1) models in the light of the stock market crash and global financial crisis. Using data over the period, June 11, 2007 and May 20, 2009, volatility persistence and asymmetric properties are investigated for the Nigerian interbank call money market. The result shows that volatility is persistent. The hypothesis of asymmetry and leverage effect is rejected. It is found that the Nigerian interbank call money market returns show high persistence in the volatility but it shows clustering properties. The result shows the stock market crash and global financial crisis have impact on interbank call rate return but not on its volatility. The stock market crash and global financial crisis could have accounted for the sudden change in variance. The augmented TS-GARCH (1, 1) model is found to be the best model.

Keywords: Interbank call rate, Stock market crash, Global Financial crisis, Volatility persistence, GARCH

***JEL**: G01, G11, G12, G14, G21*

1. Introduction

The deregulation of the Nigerian financial environment following the introduction of the Structural Adjustment Programme (SAP) in Nigeria in September 1986 led to the increasing competition in the Nigerian banking industry, and the interbank market. The interbank market is the market for unsecured wholesale short term funds between banks. Bank lends and borrows in this market to smooth out its liquidity position so as to comply with statutory requirement placed on them. The major proportion of the dealing in this market is for very short term funds, i.e., overnight funds, and up to 3 months. However, some inter bank loans are for longer periods (up to one year). Interest rates are quoted for overnight or call money, 7 days' notice of withdrawal, 30 days, 60 days, 90 days, 180 days, 270 days and 360 days.

The volatility of interbank call or overnight rates has been of concern to investors, analysts, brokers, dealers and regulators as the overnight or call funds constitute the bulk of the activities in the Nigerian money market. Market participants determine the interbank call rate according to their perceptions of the current and future liquidity condition in the market. Thus this rate reflects the supply and demand behavior of bank reserves, and gives important signals to the Central bank of Nigeria (CBN) to understand the market pressure. The interbank call rate also has a close link with other interest rates in the financial market and the foreign exchange rate. Interbank call rate volatility which represents the variability of interbank call rate changes which could be perceived as a measure of uncertainty of the interbank call rate shows how much economic behaviors are not able to perceive the directionality of the actual or future volatility of interbank call rate. Central banks conduct monetary policy in such a way that the interbank call rate does not deviate much from the central bank's monetary policy rate.

Financial assets volatility of has been of growing area of research (see Longmore and Robinson (2004) among others). The variance or standard deviation and the vector autoregressive (VAR) methods are two of the common means of measuring asset volatility (see Bailey et al. (1986, 1987), Chowdhury (1993), and Arize etal. (2000)). The use of variance or standard deviation as a measure of volatility is unconditional and does not recognize that there are interesting patterns in asset volatility; e.g., time-varying and clustering properties. Researchers have introduced various models to explain and predict these patterns in volatility. .Engle (1982) introduced the autoregressive conditional heteroskedasticity (ARCH) to model volatility. Engle (1982) modeled the heteroskedasticity by relating the conditional variance of the disturbance term to the linear combination of the squared disturbances in the recent past. Bollerslev (1986) generalized the ARCH model by modeling the conditional variance to depend on its lagged values as well as squared lagged values of disturbance, which is called generalized autoregressive conditional heteroskedasticity (GARCH). Since the work of Engle (1982) and Bollerslev (1986), various variants of GARCH model have been developed to model volatility. Some of the models include IGARCH originally proposed by Engle and Bollerslev (1986), GARCH-in-Mean (GARCH-M) model introduced by Engle, Lilien and Robins (1987),the standard deviation GARCH model introduced by Taylor (1986) and Schwert (1989), the EGARCH or Exponential GARCH model proposed by Nelson (1991), TARCH or Threshold ARCH and Threshold GARCH were introduced independently by Zakoïan (1994) and Glosten, Jaganathan, and Runkle (1993), the Power ARCH model generalized by Ding, Zhuanxin, C. W. J. Granger, and R. F. Engle (1993) among others.

The modeling and forecasting of interbank call rates and their volatility has important implications for many issues in economics and finance. Unlike other financial markets, few work have been done on interest rates volatility (e.g. Cyree and Winters, 2001; Edward and Susmel, 2003; Palombini, 2003; Joshi, 2004; Shahiduzzaman and Naser, 2008).

Palombini (2003) used the GARCH model to construct and estimate the daily and hourly volatility on the Italian money market. Shahiduzzaman and Naser (2008) used the GARCH model to investigate the pattern of volatility in the overnight money market rate (call money rate) in Bangladesh. Their results show that volatility shocks are quite persistent as the sum of ARCH and GARCH coefficients are close to one.

The interbank call rate volatility has implications for many issues in the arena of finance and economics. Such issues include impact of interbank call rate volatility on derivative pricing, other money market rates, repurchase agreement, reverse repo, open buy back, exchange rate determination in the foreign exchange market, bank's cost of funds, lending rates, and stock market and government policy decisions.

The recapitalization of the banking industry in Nigeria in July 2004 and the Insurance industry in September 2005 boosted the number of securities on Nigerian stock market increasing public awareness and confidence about the Stock market. The banking industry boosted the trading activity on the stock market through margin lending to various investors. The margin lending rate, like other interest rates, is closely linked to interbank call rates. However, since April 1, 2008, investors have been worried about the falling stock prices on the Nigerian stock market. The falling prices on the stock market could have affected interbank call money rate volatility.

The global financial crisis of 2008, an ongoing major financial crisis, could have affected interbank call rate volatility. The crisis which was triggered by the subprime mortgage crisis in the United States became prominently visible in September 2008 with the failure, merger, or conservatorship of several large United States-based financial firms exposed to packaged subprime loans and credit default swaps issued to insure these loans and their issuers (Wikipedia, 2009). The crisis rapidly evolved into a global credit crisis, deflation and sharp reductions in shipping and commerce, resulting in a number of bank failures in Europe and sharp reductions in the value of equities (stock) and commodities worldwide(Wikipedia, 2009). In the United States, 15 banks failed in 2008, while several others were rescued through government intervention or acquisitions by other banks (Wikipedia, 2009). The financial crisis created risks to the broader economy which made central banks around the world to cut interest rates and various governments implement economic stimulus packages to stimulate economic growth and inspire confidence in the financial markets. The financial crisis dramatically affected the global stock markets. Many of the world's stock exchanges experienced the worst declines in their history, with drops of around 10% in most indices (Wikipedia, 2009). In the US, the Dow Jones industrial average fell 3.6%, not falling as much as other markets. The economic crisis caused countries to temporarily close their markets (Wikipedia, 2009).

The purpose of this paper is to model daily interbank call rate volatility in Nigeria using GARCH model in the light of stock market crash and the global financial crisis. The paper will investigate the volatility persistence in Nigeria using daily interbank call rate data. The rest of this paper is organised as follows: Section two discusses an overview of the Nigerian foreign exchange market while Section three discusses the literature review. Section four discusses methodology while the results are presented in Section five. Concluding remarks are presented in Section six.

2. Overview of the Nigerian Money Market

The Nigerian money markets consist of the Government Securities market, non-government Securities market, the Discount market; the Foreign Exchange market; and the Inter bank market. The government securities include treasury bills, treasury certificates, CBN bills and Eligible development stocks. Non-government securities include certificates of deposit, commercial paper, banker's acceptances and tenured deposits. The discount market promotes market in treasury bills and other eligible bills used in open market operation. The foreign exchange market is the market for buying and selling of foreign currencies. The interbank market is a market for buying and selling of unsecured wholesale short term funds, money market securities and foreign currencies between banks. The market also includes markets for repurchase agreement, reverse repo and open buyback. The major proportion of the dealing in the Nigerian interbank market is for very short term funds, i.e., overnight funds, and up to 3 months. However, some inter bank loans are for longer periods (up to one year). Interest rates are quoted for overnight money, 7 days' notice of withdrawal, 30 days, 60 days, 90 days, 180 days, 270 days and 360 days.

The inter-bank market is regulated by the Money Market Association of Nigeria (a self-regulating organisation). At the interbank market, the interest rate charged in the largest market is the Nigerian Inter-Bank Offer Rate or NIBOR, which is used by individual banks to establish their own base rate and interest rates for 'wholesale' lending to large borrowers. Lending by banks to their own customers might be at a certain rate above their base rate (retail lending) or a certain rate above the NIBOR (wholesale lending).

Prior to the deregulation of the Nigerian economy in September 1986, there were 40 banks with 1,397 branches operating in Nigeria, consisting of 28 commercial banks with 1,367 branches and 12 merchant banks with 30 branches (Olowe, 1996). The introduction of structural adjustment programme in Nigeria led to the deregulation of licensing of banks and interest rate in 1987. Prior to 1987, the level and structure of interest rates were administratively determined by the Central Bank of Nigeria. Both deposit and lending rates were fixed by the CBN based on policy decisions. There was also little activity in the interbank market during this period. However, in August 1987, within the general framework of deregulating the economy following the introduction of structural adjustment programme in 1986 to enhance competition and allocation of resources, the CBN introduced a market-based interest rate policy. The deregulation of interest rates allowed banks to determine their deposit and

lending rates according to market condition through negotiation with their customers. As at the end of 1993, the number of commercial banks has increased to 66 with 2,353 branches while the number of merchant banks has increased to 54 with 126 branches (Central Bank of Nigeria, 1994). By 1998, however, the number of banks in operation declined to 89 as a result of the liquidation of over 30 terminally distressed banks. Other types of financial institutions also increased substantially. Apart from commercial and merchant banks, new banking institutions and other financial intermediaries have sprung up. As at the end of 1993, there were 252 primary mortgage institutions, 879 community banks, 271 Peoples bank branches, 5 development banks, 752 finance companies and 3 discount houses operating in Nigeria (Central Bank of Nigeria, 1994). The increased competition in the Nigerian financial system led to increase in activities in the Nigerian interbank market.

In June 1993, the CBN commenced open market operations (OMO) using existing government securities (treasury bills and certificates, and development stocks). The operations are coordinated with discount window and reserve requirement policies. To facilitate OMO and promote the growth, efficiency and development of the Nigerian money market, discount houses are now being licensed by the CBN. As at the end of 1993, 3 discount houses have been licensed (Central Bank of Nigeria, 1994).

The licensing of discount houses further promoted the activities in the interbank market. The introduction of universal banking in Nigeria in 2001 further enhanced the activities in the interbank market.

The Central Bank of Nigeria (CBN) on July 6, 2004, proposed reforms of the banking sector in Nigeria. The key element of the reforms is the increase in minimum capitalization for all licensed banks from N2 billion (approximately $15million) to N25billion (approximately $250million). This led to the emergence of 25 strong banking groups by December 31, 2005 (Olowe, 2009). In September 2005, the Federal Government of Nigeria announced new capital requirements for insurance companies in Nigeria. The share capital for Life business was increased to N2 billion while the share capital of Non-Life, Reinsurance and composite companies were increased to N3 billion, N10 billion and N5 billion respectively. As at February 2007, licensed, insurance companies consist of 7 Life insurance companies, 23 General insurance companies, 11 composite companies and 1 Reinsurance company (Olowe, 2009). The introduction of the new capital requirements for banks in 2004 and insurance companies in 2005 increase number of securities on the Nigerian stock market and increase the volume of trading activities on the stock market through increase in public awareness about the stock market. The banking industry further enhanced securities trading through provision of margin lending to various investors. The margin lending further enhanced the activities in the interbank market.

Figure 1 shows the trend in the call rates and open buy back (OBB) rates from June 11, 2007 to May 20, 2009. This period coincided with the completion of the recapitalization exercise in the banking and insurance industry. The call rates appear to show more fluctuations. It will be of interest to investigate the volatility of interbank call rates.

3. Literature Review

The variance or standard deviation and the vector autoregressive (VAR) methods are two of the common means of measuring asset volatility (see Bailey et al. (1986, 1987), Chowdhury (1993), and Arize etal. (2000)). The use of variance or standard deviation as a measure of volatility is unconditional and does not recognize that there are interesting patterns in asset volatility; e.g., time-varying and clustering properties. Researchers have introduced various models to explain and predict these patterns in volatility. .Engle (1982) introduced the autoregressive conditional heteroskedasticity (ARCH) to model volatility. Engle (1982) modeled the heteroskedasticity by relating the conditional variance of the disturbance term to the linear combination of the squared disturbances in the recent past. Bollerslev (1986) generalized the ARCH model by modeling the conditional variance to depend on its lagged values as well as squared lagged values of disturbance, which is called generalized autoregressive conditional heteroskedasticity (GARCH). This simple and useful GARCH is the dominant model applied to financial time series analysis by the parsimony principle. GARCH (1, 1) model can be summarized as follows:

$$s_t = b_0 + \varepsilon_t \varepsilon_t \,/\, j_{t-1} \sim N(0, \sigma_t^2) \tag{1}$$

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 \tag{2}$$

where, σ^2 is conditional variance of ε_t and $\omega > 0$, $\alpha \geq 0$, $\beta \geq 0$. Equation (2) shows that the conditional variance is explained by past shocks or volatility (ARCH term) and past variances (the GARCH term). Equation (2) will be stationary if the persistent of volatility shocks, $\sum_{i=1}^{p} \alpha_i + \sum_{j=1}^{q} \beta_j$ is lesser than 1 and in the case it comes much closer to 1, volatility shocks will be much more persistent. As the sum of α and β becomes close to unity, shocks die out rather slowly (see Bollerslev (1986)). To complete the basic ARCH specification, we require an assumption about the conditional distribution of the error term. There are three assumptions commonly employed when working with ARCH models: normal (Gaussian) distribution, Student's *t*-distribution, and General Error Distribution. Bollerslev (1986, 1987), Engle and Bollerslev (1986) suggest that GARCH(1,1) is adequate in modeling conditional variance.

The GARCH model has a distinctive advantage in that it can track the fat tail of asset returns or the volatility clustering phenomenon very efficiently (Yoon and Lee, 2008). The normality assumption for the error term in (1) is adopted for most research papers using ARCH. However, other distributional assumptions such as Student's *t*-distribution and General error distribution can also be assumed. Bollerslev (1987) claimed that for some data the fat-tailed property can be approximated more accurately by a conditional Students-distribution.

A weakness of the GARCH model is that the conditional variance is merely dependent on the magnitude of the previous error term and is not related to its sign. It does not account for skewness or asymmetry associated with a distribution. Thus, GARCH model can not reflect leverage effects, a kind of asymmetric information effects that have more crucial impact on volatility when negative shocks happen than positive shocks do (Yoon and Lee, 2008).

Because of this weakness of GARCH model, a number of extensions of the GARCH (p, q) model have been developed to explicitly account for the skewness or asymmetry. The popular models of asymmetric volatility includes, the exponential GARCH (EGARCH) model, Glosten, Jogannathan, and Rankle (1992) GJR-GARCH model, asymmetric power ARCH (APARCH), Zakoian (1994) threshold ARCH (TARCH). The TS-GARCH advanced by Taylor (1986) and Schwert (1990), Ding, Zhuanxin, C. W. J. Granger, and R. F. Engle (1993) generalized power ARCH model, the generalized version of Higgins and Bera (1992) non-linear ARCH (NGARCH) among others.

The TS-GARCH model developed by Taylor (1986) and Schwert (1990) is a popular model used to capture the information content in the thick tails, which is common in the return distribution of speculative prices. The specification of this model is based on standard deviations and is as follows:

$$\sigma_t = \omega + \sum_{i=1}^{p} \alpha_i \left|\varepsilon_{t-i}\right| + \sum_{j=1}^{q} \beta_j \sigma_{t-j} \tag{3}$$

The exponential GARCH (EGARCH) model advanced by Nelson (1991) is the earliest extension of the GARCH model that incorporates asymmetric effects in returns from speculative prices. The EGARCH model is defined as follows:

$$\log(\sigma_t^2) = \omega + \sum_{i=1}^{p} \alpha_i \left| \frac{\varepsilon_{t-i}}{\sigma_{t-i}} - \sqrt{\frac{2}{\pi}} \right| + \sum_{j=1}^{q} \beta_j \log(\sigma_{t-j}^2) + \sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{t-k}}{\sigma_{t-k}} \tag{4}$$

where ω, α_i, β_i and γ_k are constant parameters. The EGARCH (p, q) model, unlike the GARCH (p, q) model, indicates that the conditional variance is an exponential function, thereby removing the need for restrictions on the parameters to ensure positive conditional variance. The asymmetric effect of past shocks is captured by the γ coefficient, which is usually negative, that is, cetteris paribus positive shocks generate less volatility than negative shocks (Longmore and Robinson, 2004). The leverage effect can be tested if $\gamma < 0$. If $\gamma \neq 0$, the news impact is asymmetric.

The asymmetry power ARCH (APARCH) model of Ding, Granger and Engle (1993) also allows for asymmetric effects of shocks on the conditional volatility. Unlike other GARCH models, in the APARCH model, the power parameter of the standard deviation can be estimated rather than imposed, and the optional γ parameters are added to capture asymmetry of up to order r. The APARCH (p, q) model is given as:

$$\sigma_t^{\delta} = \omega + \sum_{i=1}^{p} \alpha_i \left(\left|\varepsilon_{t-i}\right| - \gamma_i \varepsilon_{t-i}\right)^{\delta} + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^{\delta} \tag{5}$$

where $\delta > 0$, $\left|\gamma_i\right| \leq 1$ for i =1, …, r, $\gamma_i = 0$ for all I > r, and $r \leq p$

If $\gamma \neq 0$, the news impact is asymmetric.

The introduction and estimation of the power term in the APARCH model is an attempt to account for the true distribution underlying volatility. The idea behind the introduction of a power term arose from the fact that, the assumption of normality in modeling financial data, which restricts *d* to either 1 or 2, is often unrealistic due to significant skewness and kurtosis(Longmore and Robinson, 2004).. Allowing *d* to take the form of a free parameter to be estimated removes this arbitrary restriction.

Various family of GARCH models have been applied in the modeling of the volatility of interbank call rates in various countries. Taylor (1987) and more recently West and Chow (1995) examined the forecast ability of interbank call rate volatility using a number of models including ARCH using five U.S. bilateral interbank call rate series. They found that generalized ARCH (GARCH) models were preferable at a one week horizon, whilst for less frequent data, no clear victor was evident. Yoon and Lee (2008) used GARCH (1,1), TARCH (1,1) and EGARCH (1,1) models to estimate the volatility and asymmetry of the daily Won/Dollar interbank call rate over the period, March 2, 1998 to

June 30, 2006. Their results show that strong volatility persistence, asymmetry and leverage effect, which explain that volatility shock has an effect on the uncertainty of the interbank call rate.

Unlike other financial markets, few work have been done on interest rates volatility (e.g. Campbell, Lo, & MacKinlay, 1997; Cyree and Winters, 2001; Palombini, 2003; Joshi, 2004; Shahiduzzaman and Naser, 2008). The earlier empirical work focused attention on investigating the time series properties of interest rate level at a daily frequency (e.g. Campbell, 1987; Hamilton, 1996) or focuses on the "liquidity effect", i.e. changes in interest rates triggered by a variation in monetary base, and the related "martingale hypothesis" (e.g. Hamilton, 1997; Bartolini, Bertola and Prati, 2000). Palombini (2003) used the GARCH model to construct and estimate the daily and hourly volatility on the Italian money market.

Shahiduzzaman and Naser (2008) used the GARCH model to investigate the pattern of volatility in the overnight money market rate (call money rate) in Bangladesh. Their results show that volatility shocks are quite persistent as the sum of ARCH and GARCH coefficients are close to one.

Little or no work has been done on modeling interbank call rate volatility in Nigeria particularly using GARCH models. This study will model the volatility of interbank call rates in Nigeria using daily data in the light of stock market crash and. global financial crisis.

4. Methodology

4.1The Data

The time series data used in this analysis consists of the daily interbank call rate from June 11, 2007 to May 20, 2009 downloaded from the website of the Central Bank of Nigeria. As in previous work on interest rate volatility, the focus will on first difference (see, for example, Gray, 1996; Ghysels & Ng, 1998; and Edwards and Susmel, 2003). Concentrating on changes in interest rates avoids the problems associated with series that have a large, possibly unit root. Thus, in this study, the return on interbank call rate series is defined as:

$$r_t = I_t - I_{t-1} \quad (6)$$

Where r_t represents return on interbank call rate series at time t;

I_t represent interbank call rate at time t.

I_{t-1} represent interbank call rate at time t-1.

The r_t of Equation (1) will be used in investigating the volatility of interbank call rate in Nigeria over the period, June 11, 2007 to May 20, 2009.

However, since April 1, 2008, investors have been worried about the falling stock prices on the Nigerian stock market. The falling prices on the stock market could have affected interbank call money rate volatility.

Since April 1, 2008, investors have been worried about the falling stock prices on the Nigerian stock market. The stock index fell from 63016.56 on April 1, 2008 to 27108.4 on January 16, 2009. The falling prices on the stock market could have affected interbank call money rate volatility. To account for the stock market crash (SMC) in this paper, a dummy variable is set equal to 0 for the period before April 1, 2008 and 1 thereafter.

The global financial crisis of 2008 , an ongoing major financial crisis , was triggered by the subprime mortgage crisis in the United States which became prominently visible in September 2008 with the failure, merger, or conservatorship of several large United States-based financial firms exposed to packaged subprime loans and credit default swaps issued to insure these loans and their issuers (Wikipedia, 2009). On September 7, 2008, the United States government took over two United States Government sponsored enterprises Fannie Mae (Federal National Mortgage Association) and Freddie Mac (Federal Home Loan Mortgage Corporation) into conservatorship run by the United States Federal Housing Finance Agency. The two enterprises as at then owned or guaranteed about half of the U.S.'s $12 trillion mortgage market. This causes panic because almost every home mortgage lender and Wall Street bank relied on them to facilitate the mortgage market and investors worldwide owned $5.2 trillion of debt securities backed by them (Wikipedia, 2009). Later in that month Lehman Brothers and several other financial institutions failed in the United States. This crisis rapidly evolved to global crisis. In this study, September 7, 2008 is taken as the date of commencement of the global financial crisis. To account for global financial crisis (GFC) in this paper, a dummy variable is set equal to 0 for the period before September 7, 2008 and 1 thereafter.

4.2 Properties of the Data

The summary statistics of the interbank call rate return series is given in Table 1. The mean return is 0.0002 while the standard deviation is 0.0173. The skewness for the interbank call rate return series is -1.1346. This shows that the distribution, on average, is negatively skewed relative to the normal distribution (0 for the normal distribution). The skewness indicates a non-symmetric series. The kurtosis is much larger than 3, the kurtosis for a normal distribution. Skewness indicates non-normality, while the excess kurtosis suggests that distribution of the return series is leptokurtic, signaling the necessity of a peaked distribution to describe this series. This suggests that for the interbank call rate return series, large market surprises of either sign are more likely to be observed, at least unconditionally. The Ljung-Box test Q statistics for the interbank call rate return series are, on average, insignificant at the 5% for all reported lags confirming the absence of autocorrelation in interbank call rate return series.

Jarque-Bera normality test rejects the hypothesis of normality for the interbank call rate return series. Figure 2 shows the quantile-quantile plots of the interbank call rate returns for the period. Figure 2 shows that the distribution of the interbank call rate returns series show a strong departure from normality.

The usual method of testing for testing for conditional homoscedasticity by calculating the autocorrelation of the squared return series might not be appropriate here in view of the non-normality of the interbank call rate return series (see Mckenzie (1997)). According to Mckenzie (1997), volatility clustering is by no means unique to the squared returns of an assets price. In general, the absolute changes in an assets price will exhibit volatility clustering and the inclusion of any power term acts so as to emphasise the periods of relative tranquility and volatility by highlighting the outliers in that series. It is possible to specify any power term to complete this task from a myriad of options inclusive of any positive value (Mckenzie, 1997). The common use of a squared term is most likely a reflection of the normality assumption made regarding the data. If a data series is normally distributed, then we are able to completely characterise its distribution by its first two moments. As such, it may be appropriate to focus on a squared term. However, if we accept that the data has a non-normal error distribution, then one must transcend into the realm of the higher moments of skewness and kurtosis to adequately describe the data. In this instance, the intuitive appeal of a squared term is lost and other power transformations may be more appropriate (Mckenzie, 1997). Following, Mckenzie (1997), the test for conditional homoscedasticity was carried out by calculating the autocorrelation of power transformed interbank call rate return series using powers of 0.25 and 0.5. The Ljung-Box $Q^{0.25}$ and $Q^{0.5}$ statistics for the interbank call rate return series are significant at the 5% for all reported lags confirming the presence of heteroscedasticity in the data.

Table 2 shows the results of unit root test for the interbank call rate return series. The Augmented Dickey-Fuller test and Phillips-Perron test statistics for the interbank call rate return series are less than their critical values at the 1%, 5% and 10% level. This shows that the interbank call rate return series has no unit root. Thus, there is no need to difference the data.

In summary, the analysis of the interbank call rate return indicates that the empirical distribution of returns in the call money market is non-normal, with very thick tails. The leptokurtosis reflects the fact that the market is characterised by very frequent medium or large changes. These changes occur with greater frequency than what is predicted by the normal distribution. The empirical distribution confirms the presence of a non-constant variance or volatility clustering. Volatility clustering is apparent in Figure 3. This implies that volatility shocks today influence the expectation of volatility many periods in the future.

4.3 Models used in the Study

In the light of volatility clustering in the empirical distribution of interbank call rate return series, this study will attempt to model the volatility of daily interbank call rate return in Nigeria using the GARCH, EGARCH, TS-GARCH and PARCH models in the light of stock market crash and the global financial crisis. The various families of GARCH models will be used so that the sensitivity of the results to the various GARCH models can be assessed. The best model will be the one that has maximum log-likelihood and/or lowest Akaike information Criterion or Schwarz Criterion or Hannan-Quinn criterion. The GARCH (1,1) model will first be applied in investigating the volatility of the interbank call rate return series. Then, the GARCH(1,1), EGARCH(1,1), TS-GARCH(1,1) and PARCH(1,1) models will be augmented to account for sudden change in variance in the volatility equation.

Thus, the mean and variance equations of the GARCH (1,1) model are given as :

$$R_t = b_0 + b_1 SMC + b_2 GFC \quad \varepsilon_t / j_{t-1} \sim GED(0, \sigma_t^2, r) \tag{7}$$

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \tag{8}$$

where v_t is the degree of freedom

To account for the shift in variance as a result of the stock market crash and global financial crisis, the GARCH(1,1) model is re-estimated with the mean equation (7) while the variance equation is augmented as follows:

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 + \Theta_1 SMC + \Theta_2 GFC \tag{9}$$

To enable comparison with other models and to allow for possible asymmetric and leverage effects, the GARCH model of Equation (8) accounting for the shift in variance as a result of the stock market crash and global financial crisis is restimated using is using other volatility models as follows:

$$\text{EGARCH(1,1):} \quad \log(\sigma_t^2) = \omega + \alpha\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}} - \sqrt{\frac{2}{\pi}}\right| + \beta\log(\sigma_{t-1}^2) + \gamma\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| + \Theta_1 SMC + \Theta_2 GFC \tag{10}$$

$$\text{TS-GARCH(1,1):} \quad \sigma_t = \omega + \alpha\left|\varepsilon_{t-1}\right| + \beta\sigma_{t-1} + \Theta_1 SMC + \Theta_2 GFC \tag{11}$$

$$\text{PARCH}(1,1): \sigma_t^{\delta} = \omega + \alpha(|\varepsilon_{t-1}| - \gamma\varepsilon_{t-1})^{\delta} + \beta\sigma_{t-1}^{\delta} + \Theta_1 SMC + \Theta_2 GFC \quad (12)$$

The mean equation is the same as in Equation (8). The volatility parameters to be estimated include ω, α and β. As the interbank call rate return series shows a strong departure from normality, all the models will be estimated with Generalised Error Distribution as the conditional distribution for errors. The estimation will be done in such a way as to achieve convergence.

5. The Results

The results of estimating the GARCH models as stated in Section 4.3 are presented in Table 4. In the mean equation, the coefficient b_1 and b_2 representing coefficients of the stock market crash and global financial crisis respectively, are all statistically significant at the 5% level in the GARCH (1,1) model and all the augmented models. This implies that the stock market crash and global financial crisis have impact on interbank call rate returns.

The variance equation in Table 4 shows that the coefficients are positive and statistically significant at the 5% level in the GARCH (1, 1) model and all the augmented models except augmented GARCH (1, 1) model. However, the coefficient in the augmented GARCH (1, 1) model is significant at the 10% level. This confirms that the ARCH effects are very pronounced implying the presence of volatility clustering. Conditional volatility tends to rise (fall) when the absolute value of the standardized residuals is larger (smaller) (Leon, 2007).

Table 3 shows that the β coefficients (the GARCH parameter) are statistically significant in the GARCH(1,1) model and all the augmented models. The sum of the

α and β coefficients in the in the GARCH(1,1) model, augmented GARCH(1,1) model and augmented TS-GARCH(1,1) model are 0.9886, 0.8977 and 0.8625 respectively. This appears to show that there is high persistence in volatility as the sum of α and β are, on average, close to 1 in the GARCH(1,1) model, augmented GARCH(1,1) model and augmented TS-GARCH(1,1) model. In the augmented EGARCH(1,1) models of Table 4, β is 0.6169 showing persistent volatility in the EGARCH model. In the augmented PARCH models of Tables 4, α+β +(γ/2) is 0.8679 which is also close to 1. This also appears to show that the shocks to volatility are very high under the PARCH model.

Table 4 shows that the coefficients γ, the asymmetry and leverage effects, is positive and statistically insignificant at the 5% level in the augmented EGARCH model; and negative and statistically insignificant in the augmented PARCH model. However, leverage effect will only exist if $\gamma > 0$ in the PARCH model and $\gamma < 0$ in the EGARCH. In view of the signs and statistically insignificance of γ in the EGARCH and PARCH models, the hypothesis of asymmetry and leverage effect is rejected for the augmented EGARCH (1, 1) and augmented PARCH (1, 1) models.

The stock market crash and global financial crisis could have accounted for sudden changes in variance. The augmented GARCH models where the stock market crash and global financial crisis variables are added to variance equation indicates that Θ_1 and Θ_2 representing coefficients of the stock market crash and global financial crisis respectively are all statistically insignificant at the 5% level. The volatility persistence in the augmented is higher than that of the full sample. This appears to indicate that the stock market crash and global financial crisis could have accounted for the sudden change in variance.

The estimated coefficients of the GED parameter are significant at the 5-percent level in the GARCH(1,1) model and all the augmented models implying the appropriateness of Generalised error distribution.

5.1 Diagnostic Checks

Table 4 shows the results of the diagnostic checks on the estimated GARCH(1,1) model and all the augmented models. Table 5 shows that the Ljung-Box Q-test statistics of the standardized residuals for the remaining serial correlation in the mean equation shows that autocorrelation of standardized residuals are statistically insignificant at the 5% level in the GARCH(1,1) model and all the augmented models confirming the absence of serial correlation in the standardized residuals. This shows that the mean equations are well specified. The Ljung-Box Q^2-statistics of the squared standardized residuals in Table 5 are all insignificant at the 5% level in the GARCH(1,1) model and all the augmented models confirming the absence of ARCH in the variance equation. The ARCH-LM test statistics in Table 5 for the GARCH(1,1) model and all the augmented models further showed that the standardized residuals did not exhibit additional ARCH effect. This shows that the variance equations are well specified in the GARCH(1,1) model and all the augmented models. The Jarque-Bera statistics still shows that the standardized residuals are not normally distributed. In sum, all the models are adequate for forecasting purposes. The volatilities for the GARCH(1,1) model, augmented GARCH(1,1) model, augmented EGARCH(1,1) model, augmented TS-GARCH(1,1) model and the augmented PARCH(1,1) models are plotted in Figures 4,5,6,7 and 8 respectively showing their conditional standard deviation.

6. Conclusion

This paper investigated the volatility of daily interbank call rates in Nigeria using GARCH (1,1), EGARCH(1,1), TS-GARCH(1,1) and PARCH(1,1) models in the light of stock market crash and global financial crisis. Volatility persistence and asymmetric properties are investigated for the Nigerian interbank call money market. The result also

shows that volatility is persistent. The hypothesis of asymmetry and leverage effect is rejected. It is found that the Nigerian interbank call money market returns show high persistence in the volatility but it shows clustering properties. The result shows the stock market crash and global financial crisis have impact on interbank call rate return but not on its volatility. The stock market crash and global financial crisis could have accounted for the sudden change in variance. The augmented TS-GARCH(1,1) model is found to be the best model.

The high volatility persistence could be due to liquidity crisis caused by the stock market crash and global financial crisis. It appears the stock market of emerging markets is integrated with the global financial market. The financial crisis in the developed markets could have affected the emerging markets. It is suspected that the sub mortgage crisis in the United States which causes liquidity crisis could have put up pressure on foreign investors in the Nigerian and other emerging stock market to sell off their shares so as to provide the needed cash to address their financial problems. The continuous sale of shares by foreign investors causes the stock prices to fall in the Nigerian stock market. The fall in stock prices resulted in the loss of investor's confidence leading to further decline as many banks that granted credit facilities for stock trading recall their loans. In the process many banks suffered huge losses as a result of the margin loans they granted for stock trading. The huge losses suffered by banks along with withdrawal of foreign investments in the country exerted pressure on liquidity of banks, thus, putting pressure on the interbank call money market. Another possible cause of high volatility in the interbank call money market is the continuous sourcing of funds by banks to enable them bid for foreign exchange at the foreign exchange market. There is a need for regulators in the emerging markets to evolve policy towards the stability and restoration of investor's confidence in the Nigerian stock market. Governments should possibly aid the promotion of market makers towards warehousing shares and creating the market for securities trading. This will go a long way in reducing losses of banks. The Central Bank of Nigeria should continue to monitor all foreign exchange bidding by banks to ensure that they are genuine demand for foreign exchange by users of foreign exchange. Proper monitoring of purchase and sale of foreign exchange by banks will reduce pressure on bank's liquidity.

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Appendix

Table 1. Summary Statistics and Autocorrelation of the Interbank call rate return series over the period, June 11, 2007 – May 20, 2009

	Call Rate Return Series
Mean	0.0002
Median	0.0015
Maximum	0.0804
Minimum	-0.1130
Std. Dev.	0.0173
Skewness	-1.1346
Kurtosis	9.9898
Jarque-Bera	945.1178
Probability	(0.0000)*
Observations	420
Ljung-Box Q Statistics	
Q(1)	2.8060
	(0.0940)
Q(5)	4.6295
	(0.4630)
Q(10)	14.1740
	(0.1650)
Q(20)	22.3040
	(0.3240)

Notes:p values are in parentheses.

*indicates significance at the 5% level

Table 2. Autocorrelation of the Interbank Call Rate Return Series over the period, June 11, 2007 - May 20, 2009

	Lags			
	5	10	15	Q20
Ljung-Box $Q^{0.25}$ Statistics	17.5880	23.9350	30.2930	37.4940
	(0.0040)*	(0.0080)*	(0.0110)*	(0.0100)*
Ljung-Box $Q^{0.5}$ Statistics	13.5550	19.2740	26.3530	36.6180
	(0.0190)*	(0.0370)*	(0.0340)*	(0.0130)*

Notes:p values are in parentheses.*indicates significance at the 5% level

Table 3. Unit Root Test of the Interbank Call Rate Return Series over the period, June 11, 2007 - May 20, 2009

	Statistic	**Critical Values**		
		1% level	5% level	10% level
Augmented Dickey-Fuller test	-22.1819	-2.5705	-1.9416	-1.6162
Philips-Perron test	-22.7040	-2.5705	-1.9416	-1.6162

Notes: The appropriate lags are automatically selected employing Akaike information Criterion

Table 4. Parameter Estimates of the EGARCH-in-Mean Models January 2, 2002 – March 13, 2009

	GARCH (1,1)	**AUGMENTED MODELS**			
		GARCH	**EGARCH**	**TS-GARCH**	**PARCH**
Mean Equation					
b_0	0.0007	0.0007	0.0008	0.0008	0.0008
	(0.0014)*	(0.0094)*	(0.0002)*	(0.0006)*	(0.0002)*
b_1	0.0014	0.0014	0.0013	0.0013	0.0013
	(0.0017)*	(0.0000)*	(0.0000)*	(0.0001)*	(0.0000)*
b_2	0.0019	0.0018	0.0018	0.0021	0.0017
	(0.0006)*	(0.0007)*	(0.0001)*	(0.0003)*	(0.0037)*
Variance Equation					
ω	0.0000	0.0000	-3.7486	0.0031	0.0001
	(0.1275)	(0.1064)	(0.0129)*	(0.0262)*	(0.8217)
α	0.1696	0.1583	0.5405	0.3396	0.2016
	(0.0228)*	(0.0564)**	(0.0022)*	(0.0034)*	(0.0435)*
β	0.8190	0.7394	0.6169	0.5229	0.7461
	(0.0000)*	(0.0000)*	(0.0002)*	(0.0005)*	(0.0000)*
γ			0.1159		-0.1596
			(0.3734)		(0.4931)
δ					1.6337
					(0.0768)**
Θ_1		0.0000	0.1768	0.0010	0.0001
		(0.1887)	(0.2821)	(0.2552)	(0.7965)
Θ_2		0.0000	0.4124	0.0027	0.0002
		(0.1564)	(0.0905)	(0.1167)	(0.7396)
GED	0.6022	0.6470	0.6309	0.6452	0.6538
	(0.0000)*	(0.0000)*	(0.0000)*	(0.0000)*	(0.0000)*
Persistence	0.9886	0.8977	0.6169	0.8625	0.8679
LL	1236	1240	1242	1243	1241
AIC	-5.8485	-5.8614	-5.8667	-5.8738	-5.8551
SC	-5.7812	-5.7749	-5.7705	-5.7873	-5.7493
HQC	-5.8219	-5.8272	-5.8286	-5.8396	-5.8133
N	420	420	420	420	420

Notes: Standard errors are in parentheses.*indicates significant at the 5% level.
LL, AIC, SC, HQC and N are the maximum log-likelihood, Akaike information Criterion, Schwarz Criterion, Hannan-Quinn criterion and Number of observations respectively

Table 5. Autocorrelation of Standardized Residuals, Autocorrelation of Squared Standardized Residuals and ARCH LM test for the GARCH Models over the period January 2, 2002 – March 13, 2009

	GARCH (1,1)	AUGMENTED MODELS			
		GARCH	EGARCH	TS-GARCH	PGARCH
Ljung-Box Q Statistics					
Q(1)	0.5973	1.3464	0.6123	0.7235	1.0376
	(0.4400)	(0.2460)	(0.4340)	(0.3950)	(0.3080)
Q(10)	8.1419	9.0336	10.2990	10.3020	8.7914
	(0.6150)	(0.5290)	(0.4150)	(0.4140)	(0.5520)
Q(15)	12.8900	15.3050	16.0360	16.3490	15.5130
	(0.6110)	(0.4300)	(0.3800)	(0.3590)	(0.4150)
Q(20)	18.3360	18.3570	19.0340	19.6100	18.7610
	(0.5650)	(0.5640)	(0.5200)	(0.4830)	(0.5370)
Ljung-Box Q^2 Statistics					
$Q^2(1)$	0.4202	0.0784	0.5734	0.4723	0.0707
	(0.5170)	(0.7800)	(0.4490)	(0.4920)	(0.7900)
$Q^2(10)$	9.1241	13.4850	13.1270	14.2380	12.0880
	(0.5200)	(0.1980)	(0.2170)	(0.1620)	(0.2790)
$Q^2(15)$	13.3340	22.8490	18.5500	21.2110	21.3040
	(0.5770)	(0.0870)	(0.2350)	(0.1300)	(0.1270)
$Q^2(20)$	13.9790	24.1650	21.2850	23.8860	23.0090
	(0.8320)	(0.2350)	(0.3810)	(0.2470)	(0.2880)
ARCH-LM (1)	0.4148	0.0773	0.5663	0.4664	0.0698
	(0.5199)	(0.7811)	(0.4521)	(0.4950)	(0.7918)
ARCH-LM (5)	0.6571	0.4569	0.3577	0.4492	0.4664
	(0.6562)	(0.8083)	(0.8772)	(0.8138)	(0.8013)
ARCH-LM (10)	0.8639	1.2779	1.3178	1.4003	1.1414
	(0.5673)	(0.2407)	(0.2184)	(0.1776)	(0.3297)
ARCH-LM (15)	0.8318	1.5124	1.2624	1.4060	1.3853
	(0.6420)	(0.0974)	(0.2231)	(0.1408)	(0.1508)
ARCH-LM (20)	0.6535	1.2205	1.0919	1.1838	1.1266
	(0.8708)	(0.2333)	(0.3552)	(0.2646)	(0.3191)
Jarque-Berra	1149.6990	1128.2690	954.7517	978.1423	1234.5780
	(0.0000)*	(0.0000)*	(0.0000)*	(0.0000)*	(0.0000)*

Note: p values are in parentheses

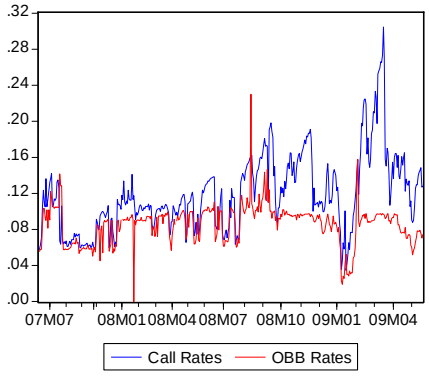

Figure 1. Trend in the call rates and open buy back (OBB) rates from June 11, 2007 to May 20, 2009

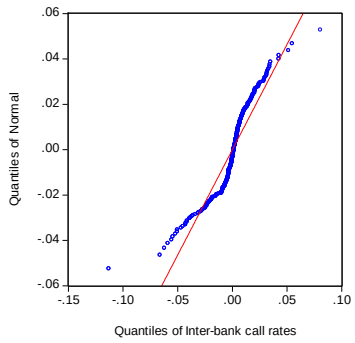

Figure 2. Quantile-Quantile Plot of Interbank call rate return series Based on the Full Sample (January 2, 2002 – March 13, 2009)

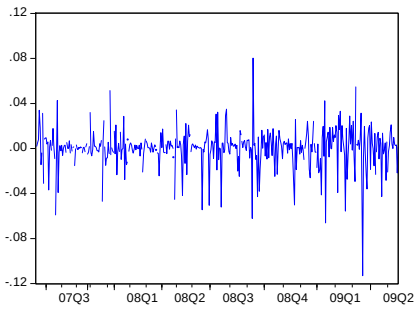

Figure 3. First-difference of daily inter bank call rates, June 11, 2007 – May 20, 2009

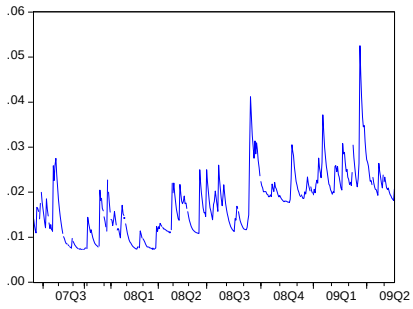

Figure 4. GARCH (1,1) Conditional Standard Deviation For the Interbank call rate return series

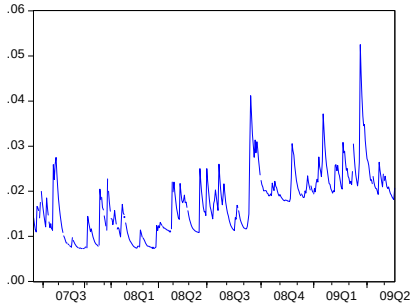

Figure 5. Augmented GARCH (1,1) Conditional Standard Deviation For the Interbank call rate return series

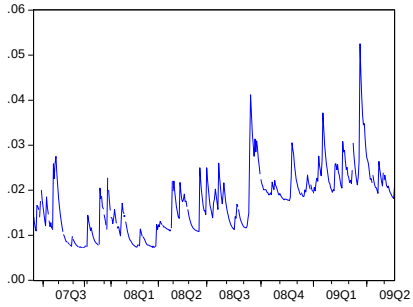

Figure 6. Augmented EGARCH (1,1) Conditional Standard Deviation For the Interbank call rate return series

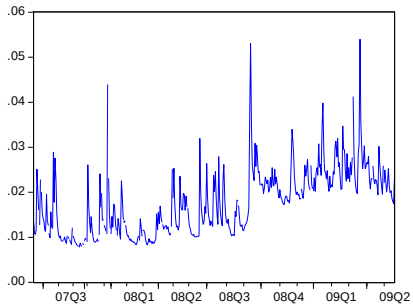

Figure 7. Augmented EGARCH (1,1) Conditional Standard Deviation For the Interbank call rate return series

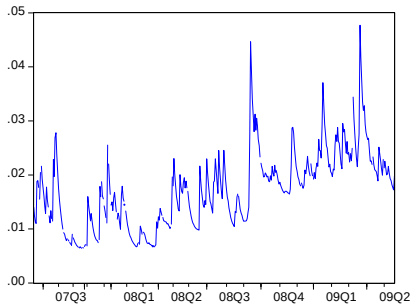

Figure 8. Augmented TS-GARCH (1,1) Conditional Standard Deviation For the Interbank call rate return series

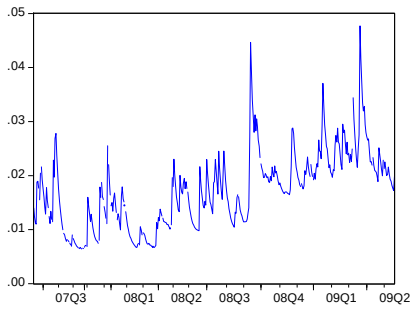

Figure 9. Augmented PARCH (1,1) Conditional Standard Deviation For the Interbank call rate return series

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