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A DETAILED ANALYSIS OF THE PRODUCTIVITY PERFORMANCE OF THE CANADIAN FOREST PRODUCTS SECTOR SINCE 2000

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A Detailed Analysis of the Productivity Performance of the Canadian Forest Products Sector

Abstract

The forest products sector in Canada has faced hard times since 2000. In terms of productivity growth, the sector as a whole has performed poorly relative to the total-economy average. Labour productivity in the sector grew by 0.38 per cent per year between 2000 and 2007, below the economy-wide average of 0.98 per cent per year over the same period. This sub-par performance is entirely attributable to the paper manufacturing subsector, where labour productivity has collapsed since 2000. The other two subsectors within the forest products sector – forestry and logging and wood product manufacturing – experienced above average productivity growth over the 2000-2007 period, but much of this improvement has come from cuts in inputs (labour and capital) that have exceeded cuts in real output. This is an unsustainable source of productivity growth in the long run.

A Detailed Analysis of the Productivity Performance of the Canadian Forest Products Sector

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A Detailed Analysis of the Productivity Performance of the Canadian Forest Products Sector

Executive Summary

The forest products sector in Canada has faced hard times since 2000. Between 2000 and 2007, the sector's real output decreased by 1.34 per cent per year and total profits across the sector fell precipitously. The long-run decline of the sector as an employer of Canadian workers and a contributor to Canada's GDP continued. In response to this crisis, firms in the forest products sector have made efforts to lower costs through improvements in productivity. These efforts have not proved successful for the sector as a whole. Annual growth in labour productivity in the forest products sector averaged 0.38 per cent over the 2000-2007 period, even lower than the economy-wide average of 0.98 per cent.

This sub-par productivity performance is entirely attributable to the paper manufacturing subsector, where growth of labour and multifactor productivity sharply declined after 2000. The other two subsectors within the forest products sector – forestry and logging and wood product manufacturing – performed better. Forestry and logging, in particular, had strong growth in labour, capital, and multifactor productivity. However, much of this improvement came from cuts in inputs that exceeded cuts in real output. Given that the three subsectors exhibited different productivity trends over the period, each subsector requires its own set of explanations.

Forestry and Logging

The forestry and logging subsector saw strong productivity growth between 2000 and 2007: 2.42 per cent per year in labour productivity, a marked improvement over its annual growth rate of 0.38 per cent between 1989 and 2000. In all three measures of productivity growth – labour, capital, and multifactor – the forestry and logging subsector outperformed the total economy. This was the result of declining real GDP coupled with reductions in hours worked and real capital stock. Capital intensity grew as labour hours fell faster than the capital stock; this, along with strong multifactor productivity growth, led to the subsector's strong labour productivity performance. At the same time, capital productivity increased as the capital stock declined faster than output.

Forestry and logging faces challenges. Cutting inputs faster than output falls is not a sustainable long-run source of productivity growth. Although the subsector's R&D is of high quality, R&D spending by forestry and logging firms is far below the total-economy average and has not been increasing in recent years. The subsector's relatively low capital depreciation rate, combined with its negative net investment since 2000, suggests that the sector is using much old capital equipment that does not embody the latest technological innovations. Finally, forestry and logging has had to deal with significant environmental changes, in part as a result of climate change. In the short run, the costs of these changes will likely reduce productivity growth.

Wood Product Manufacturing

The wood products manufacturing subsector accounts for the largest share of the output in the forest products sector. Wood product manufacturing saw above average labour productivity growth between 2000 and 2007: 1.48 per cent per year, essentially equal to its average rate of 1.39 per cent in the 1990s. This was driven by strong growth in capital intensity, which itself was a result of labour hours falling more quickly than the capital stock as in the forestry and logging subsector. Unlike forestry and logging, however, the wood products manufacturing subsector also experienced a slowdown in multifactor productivity growth. Capital productivity in wood products manufacturing decreased over the 2000-2007 period as output fell slightly faster than the capital stock.

Paper Manufacturing

Paper manufacturing presents the most interesting and puzzling trends. Labour productivity declined by 1.93 per cent per year over the 2000-2007 period, a dramatic decline from its annual growth rate of 3.55 per cent in the 1990s. On one level, the reason for this pattern is straightforward. From 1989 to 2000, paper manufacturing responded to higher prices by increasing real output. At the same time, the subsector was able to reduce capital stock and hours worked. The result was a significant improvement in productivity. After 2000, prices and output fell. Paper manufacturing cut back capital stock even more aggressively than in the 1990s and maintained the pace of capital productivity growth. For some reason, however, the subsector was unwilling or unable to cut back as aggressively on hours worked. As a result capital intensity, and therefore, labour productivity, declined. Why did paper manufactures not reduce hours worked when they cut output? One potential explanation may lie in government policies that encourage firms to maintain inefficient capacity so as to maintain workers' jobs.

Where to Now?

The Canadian forest products sector currently faces great challenges but also great opportunities. In recent years productivity growth has varied significantly across the subsectors that constitute the forest products sector. It has generally been strong in forestry and logging and wood product manufacturing, but much of the productivity improvement has come from cuts in inputs (labour and capital) that have exceeded cuts in real output. Clearly, this pattern can only be sustained temporarily since there will eventually be no more labour or capital to cut. Meanwhile, the paper manufacturing industry is undergoing a more serious productivity crisis.

Investment in research and development, education and training, and new machinery and equipment is key to improving productivity in the long run. And improving productivity is the only sustainable way to ensure the long-term viability of the sector. At the same time, investment in Canada's forest products sector will only occur if the likely return is higher than elsewhere in the world economy. The federal and provincial governments must assist the sector in adjusting to the changing global environment while softening the adverse affects of such adjustment on communities and individuals.

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A Detailed Analysis of the Productivity Performance of the Canadian Forest Products Sector[1,2]

I. Introduction

The forest products sector in Canada has faced hard times since 2000. Between 2000 and 2007, the sector's real output decreased by 1.34 per cent per year and total profits across the sector fell precipitously. The long-run decline of the sector as an employer of Canadian workers and a contributor to Canada's GDP continued. In response to this crisis, firms in the forest products sector have made efforts to lower costs through improvements in productivity. These efforts have not proved successful for the sector as a whole. Annual growth in labour productivity in the forest products sector averaged 0.38 per cent over the 2000-2007 period, even lower than the economy-wide average of 0.98 per cent annual growth in labour productivity.

However, productivity performance has not been uniform within the forest products sector. The forestry and logging subsector achieved growth of 2.42 per cent per year in labour productivity over the 2000-2007 period, a marked improvement over its annual growth rate of 0.38 per cent between 1989 and 2000. This performance reflected reductions in hours worked that more than kept pace with reductions in real output resulting from declining demand. Wood product manufacturing also experienced labour productivity growth above the economy-wide average; productivity growth in that subsector was 1.48 per cent per year between 2000 and 2007, essentially equal to its average rate of 1.39 per cent in the 1990s. This subsector was able to adjust quickly to declining demand by reducing hours worked. In the paper manufacturing subsector, labour productivity declined by 1.93 per cent per year over the 2000-2007 period, a dramatic decline from its annual growth rate of 3.55 per cent in the 1990s. The decline reflected a shrinking market and barriers to reducing hours worked.

This report provides a detailed analysis of the productivity trends in the Canadian forest products sector since 2000. The remainder of the report is organized as follows. Section two discusses definitions, concepts, and measurement issues related to productivity analysis, as well as data sources. Section three outlines trends in labour, capital, and multifactor productivity in the three industries that make up the Canadian forest products sector. The fourth section provides comparisons between the forest sectors of Canada and other countries, with emphasis on important competitors Finland, Sweden, and the United States. Section five identifies factors that influence productivity growth in the forest products sector and discusses the role these factors have played in the recent evolution of productivity in the sector in Canada. Section six summarizes and concludes.

[1] The Centre for the Study of Living Standards (CSLS) would like to thank the Forest Products Association of Canada for financial support for this project and Jean-Francois Arsenault and Alexander Murray for contributions to the report.
[2] A comprehensive set of data tables for this report are posted at the CSLS web site: http://www.csls.ca.

II. Definitions, Concepts, Measurement Issues, and Data Sources

This section discusses definitions and concepts relevant for productivity analysis in the forest products sector. It then addresses general issues in productivity measurement and outlines the data sources utilized in this report.

A. Definitions

Statistics Canada classifies establishments[3] according to the North American Industry Classification System (NAICS). NAICS classifies establishments into industries based on the similarity of their production processes. NAICS has a hierarchical structure that divides the economy into 20 sectors, identified by 2-digit codes. Below the sector level, establishments are classified into 3-digit subsectors, 4-digit industry groups, and 5-digit industries. At all levels the first two digits always indicate the sector, the third digit the subsector, the fourth digit the industry group, and the fifth digit the industry.

Exhibit 1: The Forest Products Sector, Subsectors and Industry Groups by North American Industry Classification System

113 Forestry and Logging
- 1131 Timber Tract Operations
- 1132 Forest Nurseries and Gathering of Forest Products
- 1133 Logging

321 Wood Product Manufacturing
- 3211 Sawmills and Wood Preservation
- 3212 Veneer, Plywood and Engineered Wood Product Manufacturing
- 3219 Other Wood Product Manufacturing

322 Paper Manufacturing
- 3221 Pulp, Paper and Paperboard Mills
- 3222 Converted Paper Product Manufacturing

Source: Statistics Canada, 2007.
Note: See Appendix I for a complete description of the industries that make up the forest products sector.

[3] "The establishment is the level at which all accounting data required to measure production are available. The establishment, as a statistical unit, is defined as the most homogeneous unit of production for which the business maintains accounting records from which it is possible to assemble all the data elements required to compile the full structure of the gross value of production (total sales or shipments, and inventories), the cost of materials and services, and labour and capital used in production. Provided that the necessary accounts are available, the statistical structure replicates the operating structure of the business. In delineating the establishment, however, producing units may be grouped. An establishment comprises at least one location but it can also be composed of many. Establishments may also be referred to as profit centres." (Statistics Canada, 2007)

The forest products sector is not one of the 20 sectors in the NAICS classification. However, three subsectors, forestry and logging, wood product manufacturing, and paper manufacturing, can be grouped into an aggregate defined by this report as the forest products sector (Exhibit 1).[4]

Forestry and logging (NAICS code 113) is a subsector composed of establishments involved in growing and harvesting timber over a production cycle of 10 years or more. The length of the production cycle distinguishes the forestry and logging subsector from the crop production subsector, where output might be similar, but production cycles are shorter. For example, the production of Christmas trees is classified as crop production, part of agriculture, because the production cycle is less than 10 years. Statistics Canada (2007) also notes that, except when undertaken on a very small scale, forestry and logging involves unique machinery and equipment, reflecting the unique production process of the subsector. The subsector also includes the gathering of forest products such as moss and bark.

Wood product manufacturing (NAICS code 321) is a subsector that includes establishments engaged in sawing logs into lumber, preserving wood products, and making products that improve the natural characteristics of wood (for instance, plywood, veneer, reconstituted wood panels, and engineered wood). Another industry in this subsector is millwork, wherein establishments use wood-working machinery like planers, jointers, lathes and routers to shape wood.

Paper manufacturing (NAICS code 322) includes the manufacture of pulp, paper, and various paper products through cutting and shaping. Examples of products include boxes, stationery products, sanitary products, egg cartons, and paper bags.

It is important to acknowledge that the forest products sector as defined here is very heterogeneous in terms of production processes. As a result, aggregate measures of productivity for the forest products sector should be interpreted with caution. The

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[4] There are three notable exclusions from the forest products sector as defined in this report. The "support activities for forestry" industry group (NAICS code 1153), which includes forest fire fighting services, log hauling in the bush (i.e., within the logging limits), forestry pest control services, reforestation services, timber cruising, and timber valuation, is excluded due to lack of data. Also for lack of data, the forest products trucking industries are excluded (NAICS codes 484223 (local) and 484233 (long-distance)). These industries include establishments engaged in the trucking of logs, timber, and pulpwood to mills and the trucking of lumber and woodchips. To the extent that these industries have changed in size (measured by either employment or output) or have experienced changes in productivity that differ from the rest of the forest products sector, their exclusion could have an impact on the analysis presented in this report.

Of these three excluded industries, the only available data are for employment and hours worked in support activities for forestry. These data do not suggest that trends in employment or hours worked in this industry group differed significantly from trends in the forestry and logging subsector since 2000, although prior to that there was some divergence (see Appendix Tables 3b and 4c). Between 1997 and 2007, employment in support activities for forestry has averaged 23,000 people across Canada, around half the level of the forestry and logging subsector, making this industry group a very important segment of what many people would consider "forestry." Unfortunately, there is little that can be done about this limitation in the available data. Readers should bear in mind the exclusion of this industry group from the remainder of this report.

heterogeneity of the forest products sector partly explains why it is not one of the 20 sectors of the economy defined by NAICS.

This heterogeneity also demonstrates the limitations of a classification system like NAICS that classifies establishment on the basis of similarity of production process alone. The concept of the forest products sector is based on inputs (from forests) and outputs (wood and paper products), not production processes. The fact that many forest products companies are vertically integrated adds to this disconnect, since they are likely operating in all of the subsectors that this report combines to make up the forest products sector.

The problem in analyzing aggregate productivity trends for the forest products sector is that very different forces might be driving productivity in the different subsectors. Both wood product manufacturing and paper manufacturing are part of the manufacturing sector (NAICS codes 31-33) because they physically or chemically transform materials or substances into new products. Forestry and logging is part of the agriculture, forestry, fishing and hunting sector (NAICS code 11) and involves completely different processes. As an example of how productivity may be affected differently, imagine that government imposes new regulations on logging. Such regulations might have a significant productivity impact on the forestry and logging subsector, but may have no impact on the wood product manufacturing subsector. Because of these definitional issues, interpreting productivity in the aggregate forest products sector can be challenging. In order to avoid misinterpretation, this report will analyze not only the aggregate forest products sector but also each of the three constituent subsectors.

B. Productivity Concepts[5]

Productivity is the key factor that determines living standards in the long run. Without growth in the amount each worker can produce, there would be no increase in real wages and incomes (CSLS, 2004). It is therefore productivity growth that drives long-run increases in living standards, as measured by real GDP per capita. When discussing productivity, there are two important factors to consider. The first is whether productivity is measured using partial productivity or multifactor productivity. The second is whether productivity is measured in current or constant dollars.

There is a fundamental distinction between partial and multifactor productivty (MFP).[6] Partial productivity refers to the relationship between output and a single input, such as labour or capital. This report provides estimates of both labour productivity (the most commonly used measure of productivity) and capital productivity. It is important to note that growth in labour productivity is not attributed solely to changes in labour effort. Other factors that affect labour productivity include capital accumulation, technical

[5] This section draws on CSLS (2003), CSLS (2004), and Sharpe (2007).
[6] Multifactor productivity (MFP) is also referred to as total factor productivity (TFP). The difference is purely semantic. MFP is an attempt to capture the growth in value added or gross output that is not captured by growth in labour, capital, and other inputs (CSLS, 2005 and Sharpe and Arsenault, 2009).

change, and the amount of capital each worker has to work with. MFP attempts to measure how efficiently all factors of production are used in the production process. MFP growth is measured as the difference between output growth and combined input growth, and thus captures the residual effects of elements of the production process such as improvements in workforce skills, compositional shifts, improvements in technology and organization, and increasing returns to scale.

Productivity can be expressed either in growth rates or in levels. Economists most often focus on productivity growth rates, which are based on constant-price measures of output and productivity to reflect increases in the real volume of output produced per hour worked or per unit of capital stock. In contrast, business analysts often focus on productivity levels expressed in current dollars as these estimates capture changes in relative prices. Current- and constant-dollar productivity levels can sometimes move in opposite directions because of relative price swings. This sort of price information may be important for some business purposes, but in the economic analysis of a sector's productivity, it is proper to consider productivity as a real concept rather than a nominal one. This report therefore makes use of constant-dollar productivity measures.

C. Data

Statistics Canada does not officially produce an aggregate measure of labour productivity for the forest products sector, but it is possible to construct such a measure from official data. In this report, we construct productivity estimates for the forest products sector and its constituent subsectors using official Statistics Canada estimates of real GDP, labour inputs, and capital stock. Statistics Canada does produce official time series on productivity in the industries that make up the forest products sector, but our estimates have two advantages over those official data. First, the official estimates are available only in index form; they can be used to analyze growth rates, but not levels. Second, the official estimates are available only up to the year 2004. Our productivity estimates allow for the analysis of both growth rates and levels up to the year 2007.

The analysis in this report focuses on the 2000-2007 period so as to emphasize recent trends. The 1989-2000 period is also analyzed for comparison.[7] The choice of time periods is motivated by the fact that they are both cyclically neutral. Growth rates calculated over these periods minimize the effects of short-term fluctuations driven by the business cycle; they better reflect long-term trends, which are more relevant in productivity analysis.[8]

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[7] Estimates could be constructed back to 1986; real GDP estimates for the forestry and logging subsector, a key segment of the forest products sector, are available from 1986. Estimates of labour productivity for the other subsectors that make up the forest products sector, wood product manufacturing and paper manufacturing, are available from 1981 onward. We start the analysis in 1989 so as to have cyclically-neutral time periods; see the discussion above. Incidentally, this is also the reason we include 2000 in both time periods: to have two periods that run peak-to-peak over the business cycle. Results would not be qualitatively different if we used, for instance, 1989-1999 and 2000-2007.

[8] Real output data for 2008 became available after the completion of this report. These data show an acceleration of the negative trend that has been observed in recent years. Real output in the forest products sector declined by 13.8 per cent in 2008 alone, compared to declines of 8.5 per cent in 2007 and 5.3 per cent in 2006, and an increase of 1.0 per cent in 2005. Data on labour hours are not yet available for 2008, so labour productivity estimates cannot be computed.

Statistics Canada publishes two sets of data on hours worked that could be used to construct productivity estimates for the forest products sector. There is a series from the Labour Force Survey (LFS) and a series from the Canadian Productivity Accounts (CPA). The CPA hours worked series is more accurate, because Statistics Canada makes adjustments to ensure that it is consistent with the output series that are also used in the CPA. This is particularly true when data is disaggregated by industry. However, LFS provides more up-to-date (to 2008 instead of 2007) and detailed data. Given that the most recent period under analysis is the cyclically neutral 2000-2007 period, and that the level of industry disaggregation available in the CPA is sufficient, we do not use LFS estimates in our analysis.

Data for the international productivity comparisons has been retrieved from the productivity database maintained by the Groningen Growth and Development Centre in the Netherlands. Based on official data, this database contains productivity estimates for the subsectors that make up the forest products sector. These estimates are available for most countries of interest for the period 1979-2003.

For details regarding the specific data series used in this report, look to the appendix tables.

D. Measurement Issues

The quality of productivity estimates can be no better than the quality of the data on which they are based. Productivity estimates are constructed from data on current dollar output, price deflators, capital input, and labour input.

i. Current Dollar Output

Since the forest products sector produces output that is sold in the market there is no ambiguity concerning the appropriate measure of the sector's output as there often is in non-market industries such as health care and national defence. In addition, the output of the sector can be measured in physical terms, such as board feet of lumber or tons of a particular quality of newsprint. Price data is also relatively reliable due to the physical nature of the sector's output.

Statistics Canada rates the quality of input and GDP data from the input-output tables for each NAICS industry. The latest input-output tables are available for 2003-2004 (Statistics Canada, 2008).[9] For the forestry and logging subsector, GDP data were rated B, or reliable, while in both wood product manufacturing and paper manufacturing

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In any case, 2008 data would disrupt the cyclical neutrality of the time periods under analysis in this report. Any significant changes in productivity resulting from the economic downturn of 2008 and 2009 are likely to be short-term phenomena that will be reversed by economic recovery.

[9] The highest quality rating of "A" or "most reliable" was assigned to data sets with the largest sample size and smallest under-coverage requiring indirect estimation of missing data. A rating of "B" or "reliable" was assigned to data sets that had some, but not all, of the attributes of an "A" rating. The lowest quality rating "C" or "acceptable" wass assigned to data sets that required significant indirect estimation techniques and relied on source data from small samples.

they were rated A, or most reliable. Given these ratings, this report assumes that output data for the forestry products sector are generally reliable.

ii. Price Deflators

Productivity growth over time is a real or physical concept; it captures the amount of output that is produced per unit of input. For example, labour productivity is meant to capture how many chairs per hour can be produced by one worker in a chair factory. However, current-dollar output measures are affected by the fact that prices may change over time for reasons that have nothing to do with the production process (for example, general price inflation). Since measures of productivity (output per unit of input) should not reflect such price changes, it is necessary to adjust the nominal output data by a price deflator to ensure that the productivity estimates are measured in constant prices.

A subtle point related to prices and productivity is the issue of output quality. Prices and quality change over time, and indeed, some price changes are driven by quality changes. It is necessary to disentangle quality-driven price changes from pure price changes such as general inflation. To continue with the chair factory example, suppose that the quality of the chair produced increased by 10 per cent and so did the price, with no change in the number of hours of work necessary to produce it. Statisticians will consider that the real price of chairs has remained constant (that is, the price increase was entirely due to an increase in quality), and productivity will have increased by 10 per cent. In this case, the entire increase in current dollar output (number of chairs times the price per chair) will be accounted for by productivity increases. If, however, the 10 per cent price increase was not accompanied by a change in quality, productivity will remain unchanged even though the revenue obtained for each door chair increased 10 per cent. In the latter case, the entire increase in current dollar output is accounted for by pure price changes. It is this sort of change in current-dollar output that is eliminated through the use of a price deflator.

iii. Capital Input

The quality and quantity of capital that firms use in the production process is a key determinant of productivity. Capital is a stock, but can be approximated over long time periods with data on investment. This report makes use of both capital stock and investment data. Gross real investment estimates shed light on how much new capital is entering a sector, whereas net real investment data (net of depreciation) show whether a sector's capital stock is growing or shrinking.

iv. Labour Input

In the CPA, Statistics Canada estimates hours worked by first estimating average annual hours per job and the number of jobs by province, industry, and class of workers. The volume of hours worked is then obtained by multiplying these two estimates (Maynard, 2005). Firms (that is, establishments) are surveyed using the Survey of Employment, Payroll and Hours (SEPH), while households are surveyed using the

Labour Force Survey (LFS).[10] Because the coverage of the LFS is more comprehensive (e.g. it includes self-employed workers), the CPA uses this source as the main indicator of the number of jobs in the economy. However, Statistics Canada believes that the SEPH provides a more accurate classification of jobs according to industry, because firms responding to the SEPH tend to be more knowledgeable about their industry classification than workers responding to the LFS. As a result, SEPH data are used to allocate hours worked to specific industries.

[10] LFS excludes the Armed Forces, Indian Reserves, and, in the past, the Territories. The CPA hours worked estimates make adjustments for these exclusions.

III. Productivity Trends in the Forest Products Sector in Canada

This part of the report is divided into two sections. The first reviews trends in the forest products sector at the national level, for the aggregate forest products sector and the three subsectors. The second section explores productivity trends in the forest products sector by province. The focus of this report is on the years since 2000, but data from earlier periods are also discussed so as to provide context. Each section includes a concluding sub-section that highlights key findings.

A. Forest Products Sector Productivity Trends at the National Level

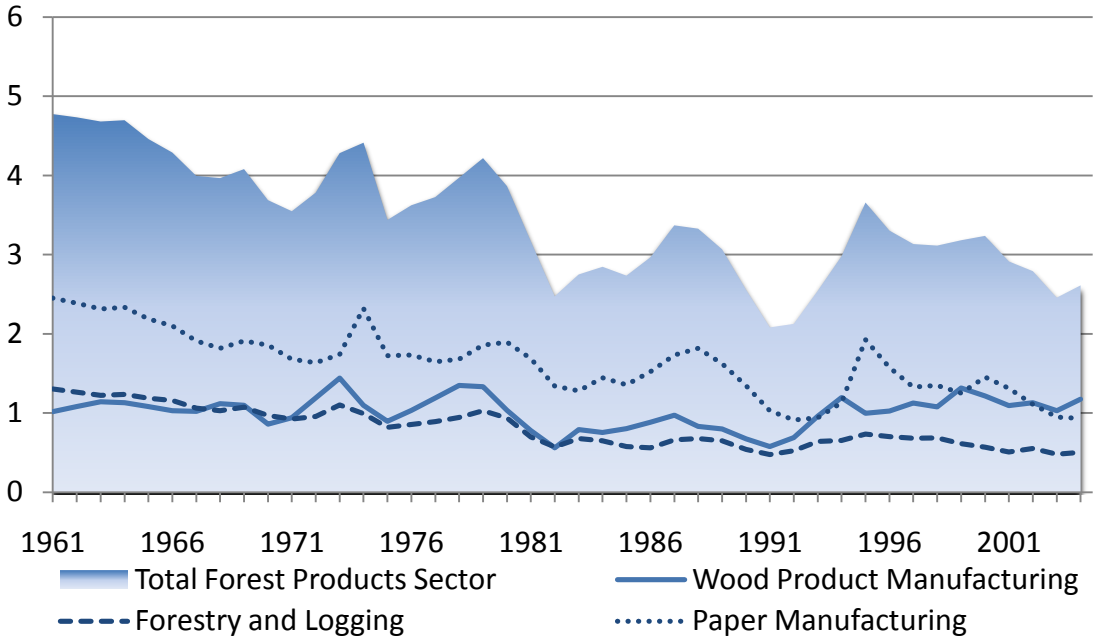
This section explores productivity trends in the forest products sectors and in each of its three constituent subsectors: forestry and logging, wood product manufacturing, and paper manufacturing. First, we outline long-run trends in nominal output to provide context for the remainder of this report. We then examine each of the elements of productivity estimates: real output, labour input, and capital input. Then, trends in labour productivity, capital productivity, and multifactor productivity are explored. Finally, key findings are summarized.

i. Nominal Output (GDP)

The forest products sector in Canada is in long-term decline in terms of its share of total economy GDP. Chart 1 shows the share of nominal GDP produced in the forest products sector and its constituent subsectors as a share of nominal GDP produced by the entire Canadian economy. As will be seen in the next section, this does not mean that output has fallen in an absolute sense; rather, it indicates that the rest of the Canadian economy has grown at a faster pace than the forest products sector.

As a whole, the forest products sector has seen its share of Canadian GDP fall from 4.8 per cent in 1961 to 2.6 per cent in 2004. Both forestry and logging and paper manufacturing have seen their shares of total economy GDP fall by more than half since 1961. In that year, paper manufacturing produced 2.5 per cent of GDP; in 2004 the subsector produced only 0.9 per cent of GDP. In forestry and logging the fall was from 1.3 per cent to 0.5 per cent of GDP. Only wood product manufacturing has increased its share of GDP; it grew from 1.0 per cent of GDP in 1961 to 1.2 per cent in 2004. All three subsectors experienced deep declines in their share of Canadian GDP in the early 1980s and, after mild recoveries, further declines in the early 1990s. These patterns reflected poor overall economic conditions, which affected the forest products sector more than other sectors.

Chart 1: Nominal GDP, Forest Product Sector as a Share of Total Economy, Per Cent, 1961-2004



Source: Appendix Table 1c

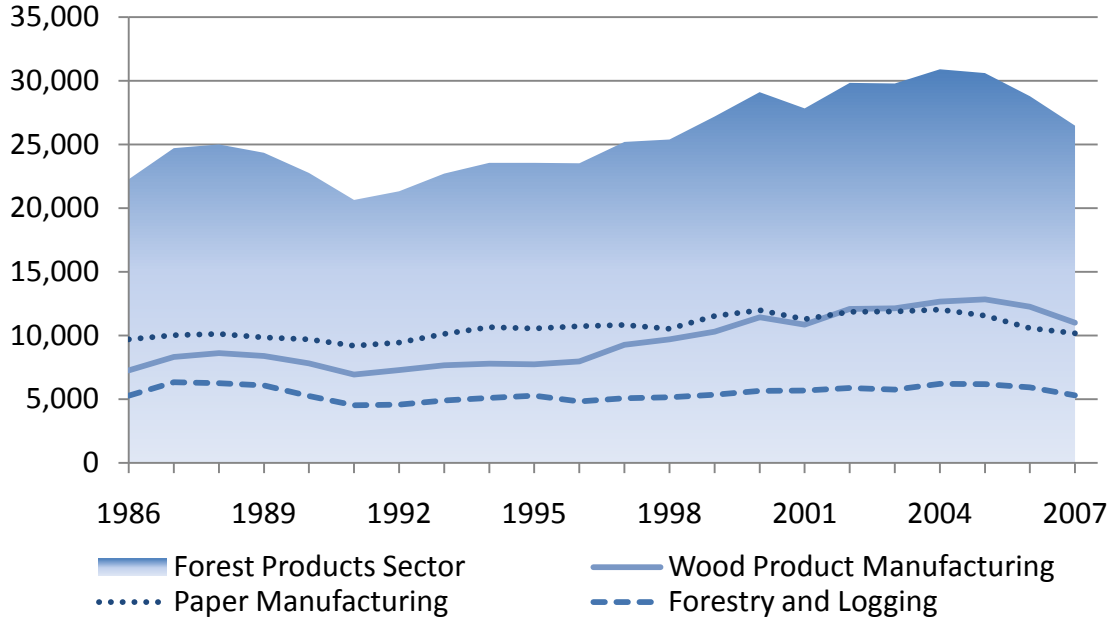
ii. Real Output (GDP)

The real output of the forest products sector has grown more slowly than the economy as a whole over the past twenty years, but its output growth performance has been especially poor in recent years (Chart 3 and Summary Table 1). The 2000-2007 period saw real output fall by 1.34 percent per year in the forest products sector. Real output declined in all three of the forest products subsectors; average annual output growth was -0.94 per cent in forestry and logging, -0.57 per cent in wood product manufacturing, and -2.32 per cent in paper manufacturing. To put this poor performance in context, note that growth in total Canadian real GDP over the 2000-2007 time span averaged 2.58 per cent per year.

The forest products sector's post-2000 performance sharply contrasts with its experience over the 1989-2000 period. During that period, real output in the forest products sector grew by 1.64 per cent per year on average. Output in forestry and logging declined by 0.64 per cent per year, but wood product manufacturing and paper manufacturing experienced real output growth of 2.84 per cent and 1.80 per cent per year. The forest products sector was once again below average in terms of output growth – the output of the total economy grew by 2.72 per cent per year over the period – but its performance was not as bleak as it would be in the 2000-2007 period. While Canadian real GDP growth was effectively the same in both periods (2.72 versus 2.58 per cent per year), real output in the forest products sector deteriorated significantly after 2000.

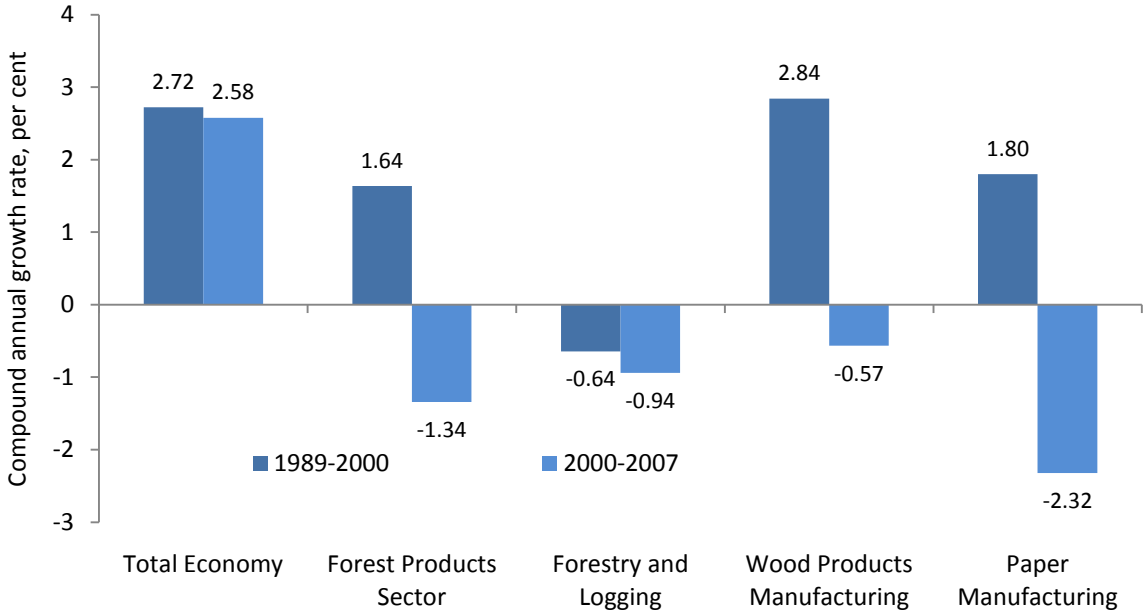
Detailed industry-level output data are available for the 2000-2007 period, and they reveal that real output growth has been diverse even within the three subsectors that

Chart 2: Real GDP, Forest Products Sector, Millions of Constant 2002 Dollars, 1986-2007



Source: Appendix Table 1a

Chart 3: Annual Growth Rates of Real Output in the Forest Products Sector, Canada, 1989-2000 and 2000-2007



Source: Appendix Table 1a

Summary Table 1: Real Output in the Forest Products Sector, Canada, Compound Annual Growth Rates, per cent, 1989-2007

	1989-2007	1989-2000	2000-2007
All Industries, Total Economy	**2.67**	**2.72**	**2.58**
Forest Products Sector	**0.47**	**1.64**	**-1.34**
Forestry and Logging	**-0.76**	**-0.64**	**-0.94**
Wood Product Manufacturing	**1.50**	**2.84**	**-0.57**
Sawmills and Wood Preservation	..	..	-1.94
Veneer, Plywood and Engineered Wood Product Manufacturing	..	..	0.73
Veneer and Plywood mills	..	..	-2.85
Structural Wood Product Manufacturing	..	..	8.88
Particle Board, Fibreboard and Waferboard Mills	..	..	0.91
Other Wood Product Manufacturing	..	..	1.90
Millwork	..	..	1.44
Wood Container and Other Wood Product Manufacturing	..	..	2.53
Paper Manufacturing	**0.18**	**1.80**	**-2.32**
Pulp, Paper and Paperboard Mills	**-0.16**	**1.68**	**-2.97**
Pulp Mills	..	..	-2.61
Paper Mills	..	..	-2.83
Paper (except newsprint) Mills	..	..	1.37
Newsprint Mills	..	..	-6.08
Paperboard Mills	..	..	-4.83
Converted Paper Product Manufacturing	**1.06**	**1.80**	**-0.09**
Paperboard Container Manufacturing	..	..	-2.21
Paper Bag and Coated and Treated Paper Manufacturing	..	..	1.49
Stationery and Other Converted Paper Product Manufacturing	..	..	1.53

Source: Appendix Table 1a

make up the forest products sector (Summary Table 1). While real output contracted in the wood product manufacturing subsector as a whole, the contraction was centered in sawmills and wood preservation industries (-1.94 per cent per year) and the veneer and plywood mills industry (-2.85 per cent per year). Other industries within the subsector did relatively well. Wood container and other wood product manufacturing saw real output expand by 2.53 per cent per year, in line with total economy GDP. Structural wood product manufacturing exhibited outstanding real output growth of 8.88 per cent per year.

Paper manufacturing also saw a variety of performances from its constituent industries over the 2000-2007 period. The real output of pulp mills contracted by 2.61 per cent per year. Newsprint mills (-6.08 per cent) and paperboard mills (-4.83 per cent) saw steep annual declines in real output. Paperboard container manufacturing also suffered with an average annual decline of 2.21 per cent. Bright spots in the paper manufacturing subsector were non-newsprint paper mills (with growth of 1.37 per cent per year), paper

bag and coated and treated paper manufacturing (1.49 per cent per year), and stationery and other converted paper product manufacturing (1.53 per cent per year).

Overall, real output growth in the Canadian forest products sector has been very weak in recent years. Since 2000, and particularly since 2004, the sector has seen real output contract. This contrasts with the 1989-2000 period, in which the sector's output growth was weak but nevertheless positive. There have been winners and losers since 2000 among the industries that make up the sector. Notably, structural wood product manufacturing grew very quickly, while newsprint and paperboard mills saw output contract most severely.

iii. Labour Input (Jobs and Hours Worked)

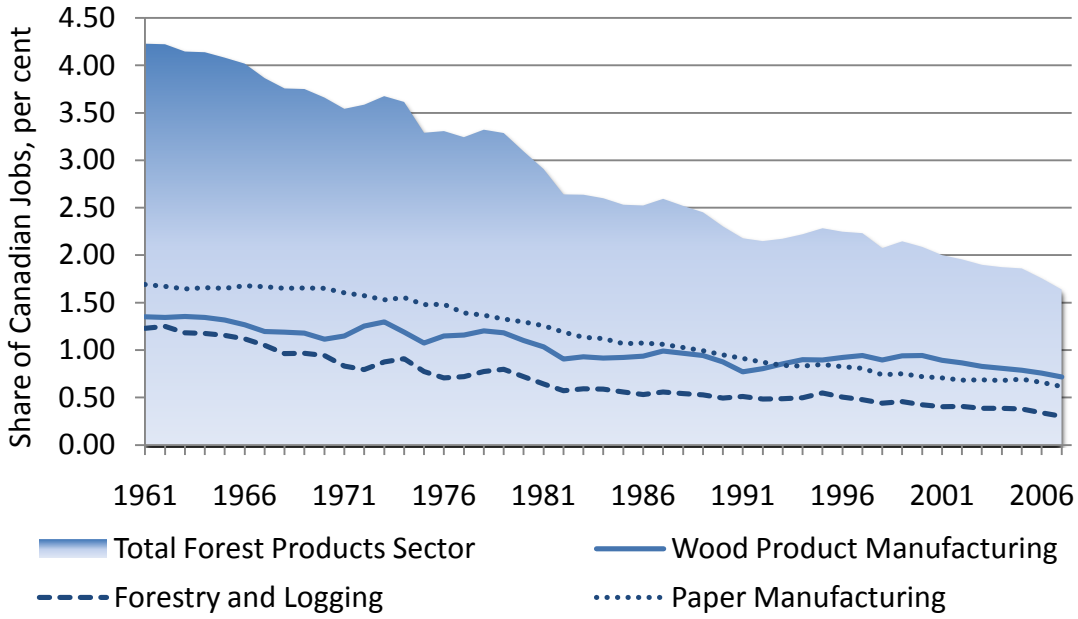
This subsection reviews trends in labour input in the forest products sector. Labour input can be expressed in number of workers or number of hours worked. Hours worked is more accurate, since the average number of hours worked per worker can change over time. After this section of the report, hours worked is used as the measure of labour input. However, it remains important to examine data on the number of workers because employment is an indicator of the importance of the sector in Canadians' everyday lives and because trends in employment provide insight into the reasons underlying changes in total hours worked.

There were 280,277 jobs in the forest products sector in 2007, essentially unchanged from 272,314 in 1961. The long-run stability of the absolute number of jobs has lead to a steep decline in the forest products sector's share of employment in the Canadian economy; the sector accounted for 4.23 per cent of Canadian jobs in 1961, but only 1.64 per cent in 2007 (Chart 4). The sector's share of Canadian employment declined by 2.04 per cent per year over the full 1961-2007 period. The rate of decline was slower over the 1989-2000 period – a mere 1.45 per cent per year – but it accelerated to 3.40 per cent per year between 2000 and 2007.

There have been notable changes in the composition of the forest products sector with respect to jobs. Between 1989 and 2000, the wood products manufacturing subsector's share of Canadian employment remained constant at 0.94 per cent, while the share of paper manufacturing declined by 2.87 per cent per year. As a result, wood manufacturing surpassed paper manufacturing in 1993 to become the largest of the subsectors within the forest products sector in terms of employment. This may not last, however; over the 2000-2007 period, wood manufacturing's share of Canadian employment declined by 3.81 per cent per year – faster than the annual 2.19 per cent decline in the paper manufacturing subsector's share.

Meanwhile, the forestry and logging subsector continues to account for the smallest share of employment; it provided 0.30 per cent of Canadian jobs in 2007, down from 1.23 per cent in 1961 and 0.42 per cent in 2000. Over the 2000-2007 period, the 4.70 per cent annual decline in the forestry and logging subsector's share of Canadian employment was the fastest among the three subsectors.

Chart 4: Number of Jobs in the Forest Products Sector as a Share of the Total Economy, Canada, 1961-2007



Source: Appendix Table 3

Total hours worked in the forest products sector have seen a slow decline over the past 45 years, averaging -0.25 per cent per year over the period 1961-2007 (Chart 5). The rate of decline has been faster in recent years. Between 2000 and 2007, total hours worked declined by 1.71 per cent per year in the sector (Summary Table 2). Average annual per-worker hours worked in the forest products sector were just 0.69 per cent lower in 2007 than in 2000, so the steep decline in total hours worked was driven by the employment changes discussed above. In contrast, total hours worked increased by 1.58 per cent per year in the economy as a whole over the 2000-2007 period.

Forestry and logging has seen the steepest and most sustained decline of any of the three subsectors. Total hours worked in forestry and logging fell by 3.28 per cent per year between 2000 and 2007, significantly faster than their annual decline of 1.02 per cent over the 1989-2000 period. Wood product manufacturing is the only one of the subsectors in which total hours worked were greater in 2007 than in 1961. However, it too has been on a downward trend since 2000. Total hours worked in wood product manufacturing fell by 2.02 per cent per year over the 2000-2007 period, a sharp reversal from the sector's positive growth of 1.43 per cent per year between 1989 and 2000.

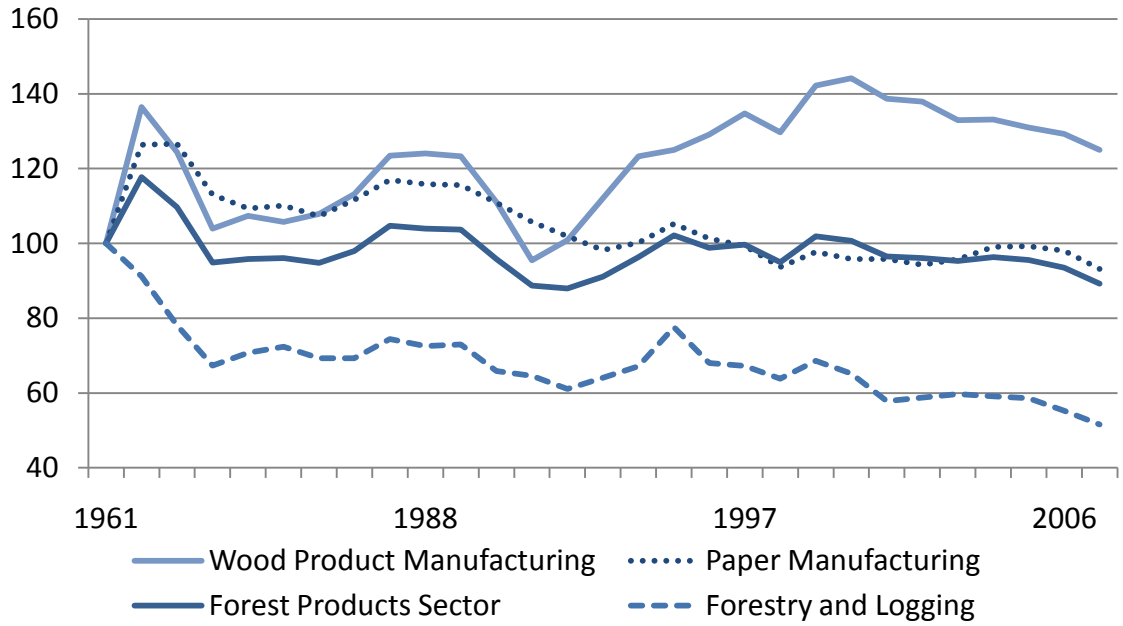
Paper manufacturing, on the other hand, slowed its decline in hours worked after 2000. Total hours worked in the subsector fell by 0.40 per cent per year between 2000 and 2007, slower than the annual decline of 1.68 per cent that the subsector experienced between 1989 and 2000. The industry-level data show that the post-2000 decline is entirely attributable to the pulp, paper, and paperboard mills industry; hours worked in converted paper product manufacturing actually increased by 1.07 per cent per year.

Summary Table 2: Total Hours Worked, Forest Products Sector, Canada, Compound Annual Growth Rates, per cent, 1989-2007

	1989-2007	1989-2000	2000-2007
All Industries, Total Economy	1.29	1.11	1.58
Forest Products Sector	-0.83	-0.27	-1.71
Forestry and Logging	-1.90	-1.02	-3.28
Wood Product Manufacturing	0.08	1.43	-2.02
Paper Manufacturing	-1.19	-1.68	-0.40
Pulp, Paper and Paperboard Mills	..	..	-1.25
Converted Paper Product Manufacturing	..	..	1.07

Source: Appendix Table 4

Chart 5: Total Hours Worked, Forest Products Sector, Canada, Index 1961= 100, 1961-2007



Source: Appendix Table 4a

Overall, trends in hours worked tell the same story as trends in GDP and employment: the forest products sector as a whole is in decline, and this decline has accelerated since 2000.

iv. Capital Input

In this subsection capital input is defined as the real net stock of capital depreciated using a geometric depreciation rate.[11] Real capital stock in the forest products sector in Canada declined between 2000 and 2007 at an average annual rate of 3.97 per cent (Summary Table 3). In contrast, it had declined by only 1.11 per cent per year over the 1989-2000 period. The sector's experience in the past two decades has been the opposite of the economy-wide trends; the capital stock in the Canadian economy grew by 1.32 per cent per year between 1989 and 2000, and that growth accelerated to 2.48 per cent per year between 2000 and 2007.

The real capital stock of the forest products industry increased in the 1980s, driven by significant net capital investments in the paper manufacturing subsector (Chart 6). Since the early 1990s, the stock of real capital in paper manufacturing has steadily declined. The capital stock in paper manufacturing fell by 2.18 per cent per year between 1989 and 2000, and then by 6.29 per cent per year between 2000 and 2007. In 2007, the stock was at the level of the late 1960s, and less than half the level of the early 1990s.

Wood product manufacturing saw a steady increase in real capital stock from the mid 1980s to the late 1990s; over the 1989-2000 period, capital growth in the subsector averaged 1.95 per cent per year. Since then, the real capital stock has declined slightly (by 0.26 per cent per year from 2000 to 2007). Forestry and logging has seen a steady decline in its real capital stock since 1981. Between 2000 and 2007, the average rate of decline was 1.77 per cent per year.

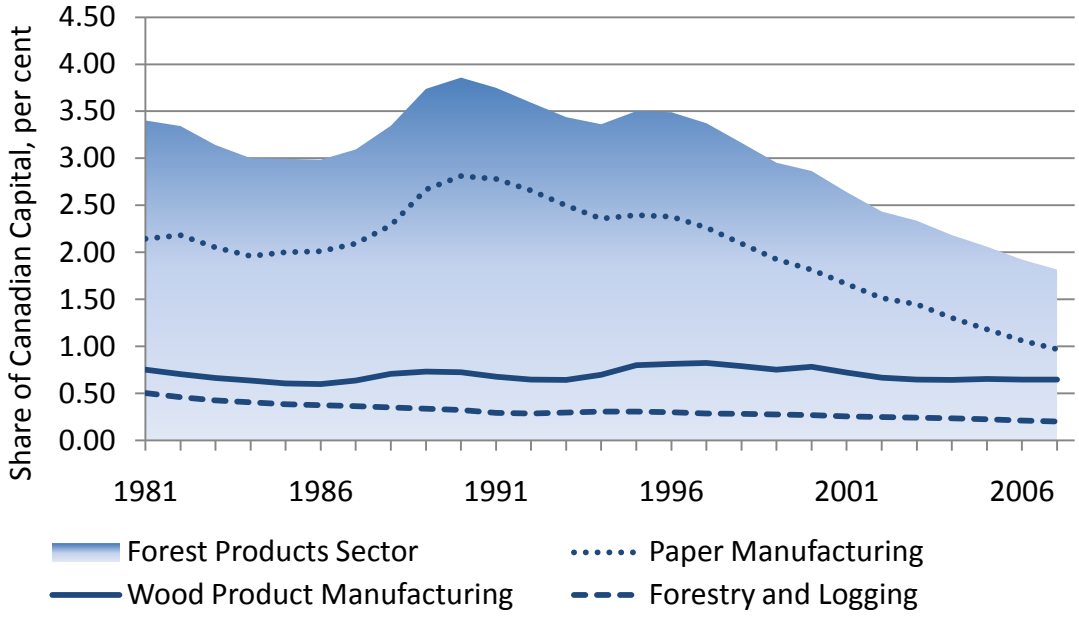
Summary Table 3: Real Capital Stock, Forest Products Sector, Canada, Compound Annual Growth Rates, Per Cent, 1989-2007

	1989-2007	1989-2000	2000-2007
All Industries, Total Economy	1.77	1.32	2.48
Forest Products Sector	-2.23	-1.11	-3.97
Forestry and Logging	-1.16	-0.77	-1.77
Wood Product Manufacturing	1.08	1.95	-0.26
Paper Manufacturing	-3.80	-2.18	-6.29

Source: Appendix Table 8

[11] Geometric depreciation assigns more depreciation to a capital asset in the early years of its service life than later in its service life. This practice is in contrast to straight line depreciation, which assigns an equal amount of depreciation to a capital asset in each year of its service life. Real capital stock, in contrast to nominal capital stock uses deflators to adjust the capital for the changing prices and quality of capital goods created or purchased.

Chart 6: Real Capital Stock in the Forest Products Sector as a Share of the Total Economy, Canada, 1981-2007



Source: Appendix Table 8

v. Labour Productivity

Labour productivity in the forest products sector fell dramatically after the year 2000. In a sense, this was consistent with the experience of the total economy; labour productivity in Canada grew by 1.60 per cent per year over the 1989-2000 period, but productivity growth declined to 0.98 per cent per year in the 2000-2007 period (Summary Table 4). However, the decline in the forest products sector was more pronounced. The forest products sector outperformed the total economy between 1989 and 2000, with an average annual labour productivity growth rate of 1.91 per cent. But between 2000 and 2007, the sector's labour productivity growth collapsed to 0.38 per cent per year.

The sector's productivity slowdown can be traced to the paper manufacturing subsector. The growth rate of labour productivity in that subsector was a robust 3.55 per cent per year over the 1989-2000 period, but it plummeted to -1.93 per cent per year over the 2000-2007 period – a decline of 5.5 percentage points. Neither of the other two subsectors experienced similar declines. Labour productivity growth in the wood product manufacturing subsector was effectively the same in both periods, averaging 1.39 per cent per year from 1989 to 2000 and 1.48 per cent per year from 2000 to 2007. In forestry and logging, labour productivity growth actually improved from 0.38 per cent per year over 1989-2000 to 2.42 per cent per year over 2000-2007. Paper manufacturing constitutes a substantially larger share of the forest products sector than forestry and logging, both in terms of output (Chart 2) and labour inputs (Charts Chart 4 and Chart 5), so the

Summary Table 4: Labour Productivity, Real GDP (Constant 2002 Dollars) per Hour Worked, Forest Products Sector, Canada, 1989-2007

	1989-2007	1989-2000	2000-2007
	(compound annual growth rate, per cent)		
All Industries, Total Economy	1.35	1.60	0.98
Forest Products Sector	1.31	1.91	0.38
Forestry and Logging	1.17	0.38	2.42
Wood Product Manufacturing	1.43	1.39	1.48
Paper Manufacturing	1.38	3.55	-1.93
Pulp, Paper and Paperboard Mills	..	..	-1.73
Converted Paper Product Manufacturing	..	..	-1.15
	1989	**2000**	**2007**
	(constant 2002 dollars per hour worked)		
All Industries, Total Economy	32.38	38.55	41.26
Forest Products Sector	37.79	46.54	47.77
Forestry and Logging	40.12	41.83	49.44
Wood Product Manufacturing	35.13	40.88	45.32
Paper Manufacturing	38.92	57.10	49.81
Pulp, Paper and Paperboard Mills	..	63.24	55.95
Converted Paper Product Manufacturing	..	43.59	40.19

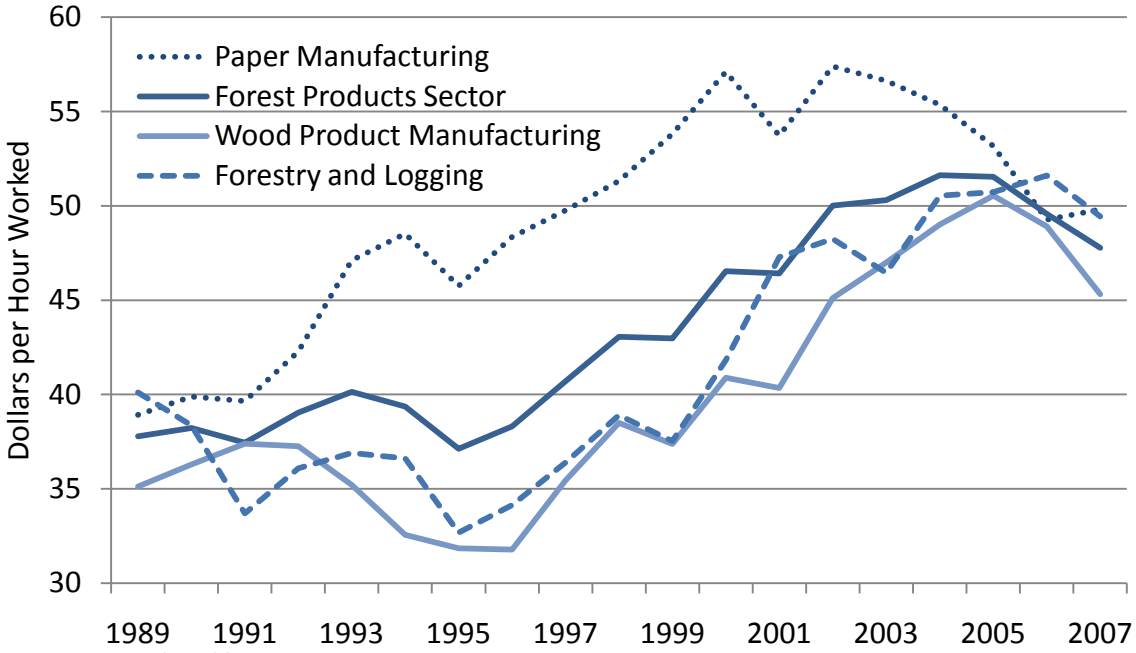
Source: Appendix Table 5

productivity collapse in paper manufacturing outweighed the gains elsewhere in the forest products sector.

As noted above, labour productivity growth in forestry and logging was higher in the 2000-2007 period than in the 1989-2000 period. In both the 1990s and the 2000s labour productivity grew because hours worked declined more quickly than real output. Labour productivity growth was positive in both periods in the wood product manufacturing sector. In the 1990s, productivity grew because real output grew faster than hours worked; after 2000, it grew because real output declined less rapidly than hours worked.

In paper manufacturing, labour productivity growth was very strong in the 1990s, at 3.55 per cent per year. This growth reflected growth in real output of 1.80 per cent per year, and declines in hours worked of 1.68 per cent per year. Between 2000 and 2007 reductions in hours continued, but output declined even more quickly, resulting in an average annual decline in labour productivity of 1.93 per cent per year. The decline in

Chart 7: Labour Productivity, Forest Products Sector, Canada, Constant 2002 Dollars, 1989-2007



Source: Appendix Table 5
Note: Labour productivity is real GDP per hour worked

labour productivity in paper manufacturing from 2000 to 2007 was divided roughly equally between both industry groups. In the converted paper product manufacturing industry, real output fell slightly (by 0.09 per cent per year) and hours worked increased by 1.07 per cent per year, translating into a decline of 1.15 per cent per year in labour productivity. Labour productivity declined in pulp, paper, and paperboard mills by 1.73 per cent per year despite aggressive reductions in hours worked; output declined faster than hours worked in the industry.

Output per hour worked in the forest products sector exceeded the economy-wide average in 1989, 2000, and 2007 (Summary Table 4). Labour productivity in the forest products sector was $47.77 per hour in 2007 (in constant 2002 dollars) in comparison to $41.26 in the economy as a whole. Paper manufacturing had the highest level of labour productivity among the forest products subsectors at $49.81 per hour, including $55.95 per hour in pulp, paper and paperboard mills, and $40.19 per hour in converted paper product manufacturing. Forestry and logging also had high productivity, with output per hour of $49.44 in 2007 – much higher than the total economy average. Wood product manufacturing was the lowest-productivity subsector, with output per hour of $45.32, but even this is greater than the total-economy average.

Overall, the labour productivity experience of the forest products sector has been diverse. In productivity levels, the forest products sector and each of its constituent subsectors are above the average for the Canadian economy. In terms of productivity growth, the sector as a whole has not performed well in recent years; labour productivity

growth in the sector slowed dramatically after 2000 and was well below the economy-wide average over the 2000-2007 period. This slowdown is attributable to the collapse of labour productivity in paper manufacturing; labour productivity growth remained above average in forestry and logging and word products manufacturing (Summary Table 4 and Chart 7). Firms in the forest products sector are responding to a very difficult economic situation by cutting back on hours worked. Except in paper manufacturing, real output has been falling less than hours worked, resulting in labour productivity improvements. Section five of this report explores several possible explanations for these trends.

vi. Capital Productivity

Capital productivity growth in the forest products sector was faster than the economy-wide average between 2000 and 2007 (Summary Table 5 and Chart 8). While total-economy capital productivity grew by 0.09 per cent per year on average from 2000 to 2007, capital productivity in the forest products sector advanced by 2.74 per cent per year. Unlike labour productivity, capital productivity growth in the forest products sector did not display significant differences across periods; it grew at practically the same rate in the period 1989-2000 (2.77 per cent per year) as it did after the year 2000. It is noteworthy that capital productivity continued to grow in the forest products sector after 2000 while total-economy capital productivity growth had slowed to a crawl.

Among the subsectors that make up the forest products sector, paper manufacturing experienced the most rapid capital productivity growth between 2000 and 2007 (4.23 per cent per year). Forestry and logging saw capital productivity increase by 0.85 per cent per year. Wood product manufacturing was the only subsector in which

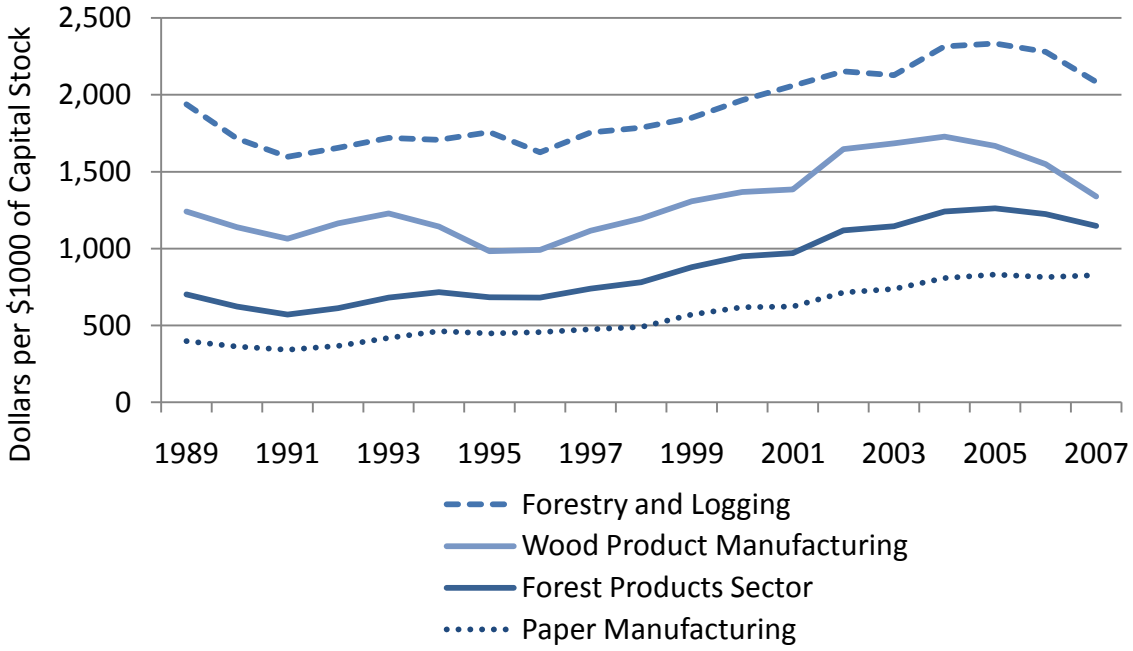
Summary Table 5: Capital Productivity, Forest Products Sector, Canada, 1989-2007

	1989-2007	1989-2000	2000-2007
	(compound annual growth rate, per cent)		
All Industries, Total Economy	0.88	1.39	0.09
Forest Products Sector	2.76	2.77	2.74
Forestry and Logging	0.41	0.12	0.85
Wood Product Manufacturing	0.42	0.88	-0.31
Paper Manufacturing	4.13	4.07	4.23
	1989	**2000**	**2007**
	(Real GDP per $1,000 of capital stock)		
All Industries, Total Economy	824	958	965
Forest Products Sector	703	950	1,147
Forestry and Logging	1,938	1,965	2,085
Wood Product Manufacturing	1,241	1,367	1,338
Paper Manufacturing	399	619	827

Source: Appendix Table 8b

Note: Capital productivity is real GDP per $1000 of capital stock, constant 2002 dollars, using geometric depreciation

Chart 8: Capital Productivity, Forest Products Sector, Canada, Constant 2002 Dollars, 1989-2007



Source: Appendix Table 8b

capital productivity declined over the period; it fell by 0.31 per cent per year. In the 1989-2000 period, capital productivity grew most rapidly in paper manufacturing (4.07 per cent per year), while wood product manufacturing saw capital productivity grow by 0.88 per cent per year. Forestry and logging saw capital productivity growth of 0.12 per cent per year.

Overall, the forest products sector has experienced much stronger capital productivity growth than the Canadian economy as a whole. However, this improvement in capital productivity has been the result of very weak real output growth coupled with a declining real capital stock, especially in paper manufacturing. These trends strongly suggest that firms have been retiring their least productive capital assets resulting in a smaller but more productive capital stock in the forest products sector. This hypothesis will be investigated further in section five of the report.

vii. Multifactor Productivity

Multifactor productivity (MFP) is a residual term that captures productivity growth not associated with the growth of labour and capital inputs. In comparison with the rest of the Canadian economy, the forest products sector performed very well in terms of MFP growth between 2000 and 2007 (Summary Table 6). In the period from 2000 to 2007, the forest products sector experienced MFP growth of 1.41 per cent per year, well above the total-economy average of 0.60 per cent per year. Indeed, all three subsectors

Summary Table 6: Multifactor Productivity, Forest Products Sector, Canada, 1989-2007

	1989-2007	1989-2000	2000-2007
	(compound annual growth rate, per cent)		
All Industries, Total Economy	1.16	1.51	0.60
Forest Products Sector	1.87	2.23	1.41
Forestry and Logging	0.86	0.28	1.77
Wood Product Manufacturing	1.05	1.21	0.65
Paper Manufacturing	2.41	3.74	0.73

Source: Appendix Tables 9, 9a, 9b, 9c, and 9d.

saw above average MFP growth. MFP grew by 1.77 per cent per year in forestry and logging; by 0.65 per cent per year in wood product manufacturing; and by 0.73 per cent per year in paper manufacturing.

Overall, multifactor productivity growth was slower after 2000 than in the 1989-2000 period. MFP in the forest products sector grew by 2.23 per cent per year in the 1990s, compared to 1.41 per cent per year after 2000. This slowdown was driven by a significant decrease in the growth rate of MFP in the paper manufacturing subsector, and to a lesser extent in wood product manufacturing. In contrast, MFP accelerated sharply in forestry and logging.

viii. Key Findings

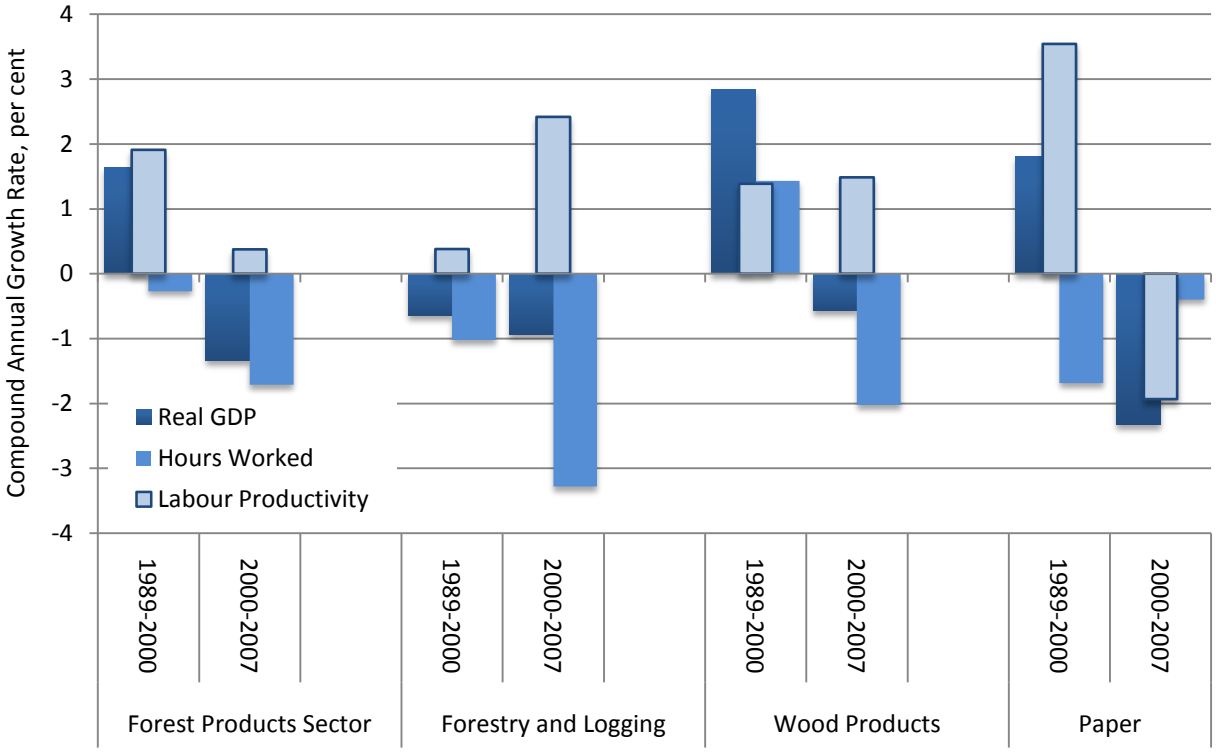
This subsection highlights the key trends uncovered in this exploration of productivity in the forest products sector from 2000 to 2007. These key findings will form the basis for the discussion of the drivers of productivity in the forest products sector in section five.

- The Canadian economy as a whole is grew between 2000 and 2007, but the forest products sector declined in terms of real output, employment, and capital stock.

- Normally, productivity growth is driven by output growing faster than inputs. In the forest products sector since 2000, the drivers of productivity growth have worked in reverse. Real output is falling, but so is the use of both labour and capital inputs (Chart 9 and Chart 10). Inputs declined faster than output in the sector as a whole, so labour and capital productivity growth rates were positive.

- Labour productivity grew more slowly in the forest products sector than in the Canadian economy as a whole over the 2000-2007 period. Over the same period, capital and multifactor productivity growth were stronger in the sector than in the Canadian economy as a whole.

Chart 9: Labour Input, Output, and Productivity Growth, Forest Products Sector, Canada, 1989-2007



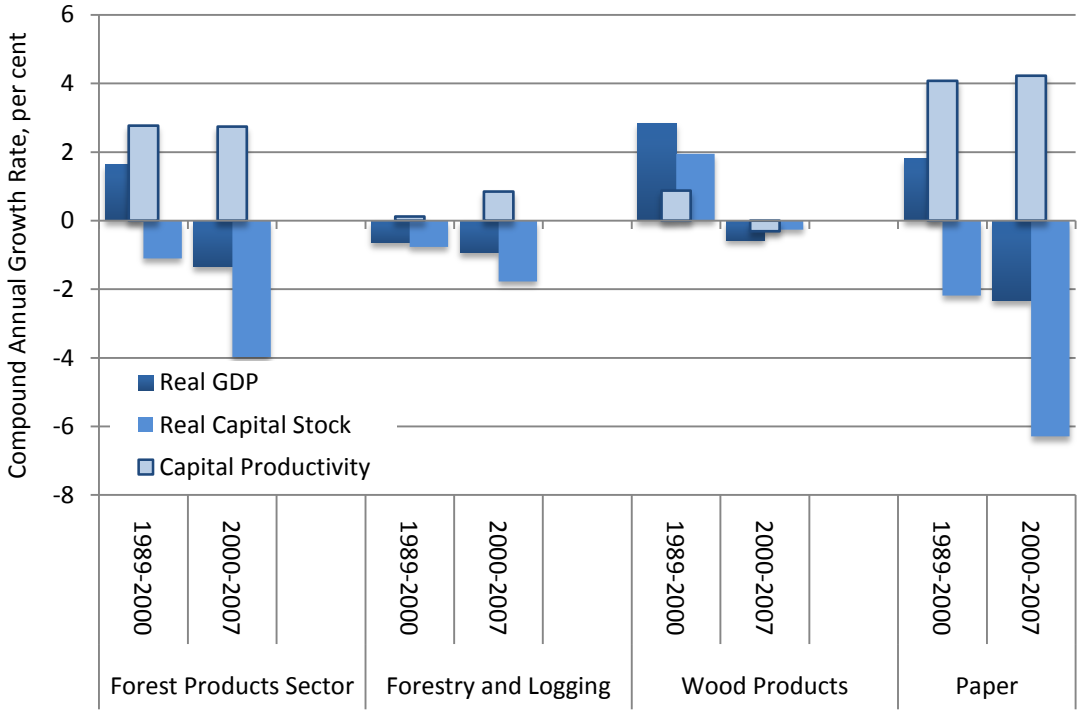
Source: Appendix Table 1a, 4 and 5.

- Labour productivity growth in the forest products sector was considerably slower after 2000 than it was during the 1989-2000 period. This slowdown was driven by a collapse of labour productivity in the paper manufacturing subsector. The growth rate of labour productivity in wood product manufacturing was essentially the same in both time periods, and labour productivity growth accelerated in the forestry and logging subsector after 2000.

- Capital productivity growth in the forest products sector was strong both before and after 2000. This is largely attributable to paper manufacturing, which saw very strong growth in capital productivity in both time periods. Given declining real output and declining capital stock, it is likely that the capital productivity improvements in paper manufacturing were driven by the retirement of the subsector's less productive assets, leaving a smaller but more productive capital stock.

- Multifactor productivity growth, which measures changes in real output not related to changes in hours worked or real capital stock, slowed significantly in the forest products sector after 2000 but remained above the economy-wide average. Paper manufacturing saw a significant decline in MFP growth, while MFP growth declined slightly in wood product manufacturing and accelerated in forestry and logging.

Chart 10: Capital Input, Output, and Productivity Growth, Forest Products Sector, Canada, Compound Annual Growth Rate, per cent, 1989-2007



Source: Appendix Table 1a,8 and 8b.

- Overall, firms in the forest products sector have been adapting to adverse market conditions by reducing hours worked and retiring the least productive capital stock. Since 2000, paper manufacturing has run into difficulty; it has been unable or unwilling to reduce hours worked to fully offset a fall in demand. This situation has adversely affected labour productivity in paper manufacturing, and because of this subsector's importance, in the entire forest products sector.

B. Forest Products Sector Productivity Trends by Province

This section examines productivity trends in the forest products sector by province. For many provinces, data are unavailable from Statistics Canada due to sample size issues or out of respect for commercial confidentiality. Generally, this lack of data affects provinces with small forest products sectors. For provinces with large forest products sectors, data are usually available for the period 1997-2007.[12] For this reason, this section focuses on trends in provinces for which substantial data are available.

[12] Because only chained 2002-dollar GDP data were available, it was not possible to produce estimates for the forest products sector as a whole, since chained-dollars are not additive across subsectors or industry groups. As well, Statistics Canada does not publish chained 2002 dollar estimates for the GDP of the paper manufacturing subsector by province. Rather, estimates of chained 2002-dollar GDP for the two constituent industry group (pulp, paper and

Summary Table 7: The Importance of the Forest Products Sector by Province, 2007

	Forest Products Sector	Forestry and Logging	Wood Product Manufacturing	Paper Manufacturing
	Gross Domestic Product in Chained 2002 Dollars			
Canada	26,481	5,303	10,999	10,179
NL	..	63	..	..
PE	..	7	..	..
NS	..	99	..	..
NB	1,552	328	429	795
QC	7,073	879	2,520	3,674
ON	5,947	644	2,042	3,262
MB	..	53	270	..
SK	..	9	209	..
AB	2,230	302	1,447	481
BC	8,826	3,018	4,426	1,382
	As a Share of Canada, per cent			
Canada	100.0	100.0	100.0	100.0
NL	..	1.2	..	..
PE	..	0.1	..	..
NS	..	1.9	..	..
NB	5.9	6.2	3.9	7.8
QC	26.7	16.6	22.9	36.1
ON	22.5	12.1	18.6	32.0
MB	..	1.0	2.5	..
SK	..	0.2	1.9	..
AB	8.4	5.7	13.2	4.7
BC	33.3	56.9	40.2	13.6

Source: Appendix Tables 1a and 801-810

Notes:

1. .. indicates that data were not available

2. Provinces may not sum to Canadian total because the chained-dollar series are not additive. Shares of Canada output should be seen as indicative only.

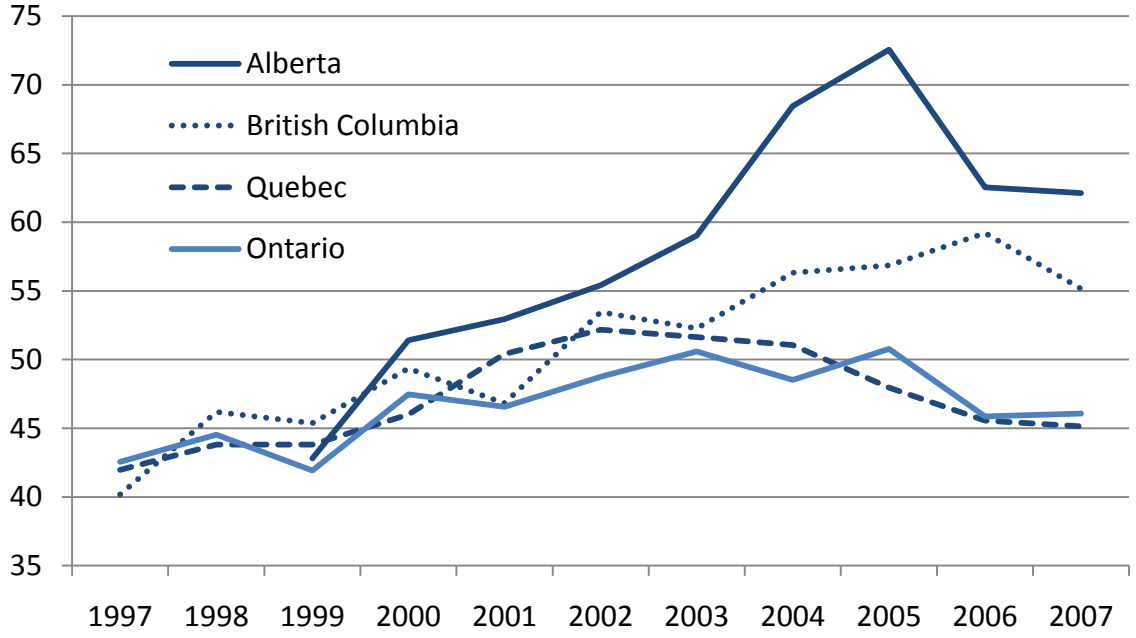
paperboard mills and converted paper product manufacturing) are published. Even though these estimates are not formally additive, they are summed in order to provide rough estimates for the paper manufacturing subsector.

In 2007, the importance of the forest products sector varied across provinces (Summary Table 7). In terms of output, British Columbia had the largest forest products sector in Canada, producing one-third of all output. Ontario and Quebec also had important forest products sectors, producing 22.5 per cent and 26.7 per cent of all sector output in 2007. Alberta (8.4 per cent) and New Brunswick (5.9 per cent) had important, but smaller, forest products sectors.

The output of the subsectors that make up the forest products industry is not evenly distributed. Ontario and Quebec produce respectively 32.0 per cent and 36.1 per cent of all paper manufacturing output in Canada. British Columbia is more focused in forestry and logging (56.9 per cent of Canadian output) and wood product manufacturing (40.2 per cent of Canadian output). Ontario (18.6 per cent) and Quebec (22.9 per cent) also had significant share of wood product manufacturing output. Because four provinces (Quebec, Ontario, Alberta, and British Columbia) dominate the output of the forest products sector in Canada, accounting for 91 per cent of output in 2007, and because data are very limited for other provinces, this report focuses on trends in these four provinces.

Labour productivity in the forest products sector increased in two of the four provinces over the period 2000-2007 (Chart 11 and Summary Table 8). In Alberta and British Columbia, labour productivity growth in the forest products sector exceeded average labour productivity growth in all industries. Quebec saw a decline in labour productivity of 0.27 per cent per year in forest products, while Ontario saw labour productivity contract by 0.42 per cent per year. This poor performance in central Canada was attributable to the negative labour productivity growth in paper manufacturing, an

Chart 11: Labour Productivity in the Forest Products Sector, by Province, Chained 2002 Dollars per Hour Worked, 1997-2006



Source: Appendix Tables 824, 825, 826, 829, and 830.

Summary Table 8: Labour Productivity, Forest Products Sector, Canada, by Province, Compound Annual Growth Rate, per cent, 2000-2007

	Canada	Quebec	Ontario	Alberta	British Columbia
All Industries, Total Economy	0.98	1.13	0.74	0.76	0.78
Forest Products Sector	0.38	-0.27	-0.42	2.74	1.60
Forestry and Logging	2.42	-0.20	0.15	2.08	3.41
Wood Product Manufacturing	1.48	1.64	1.89	3.60	1.66
Paper Manufacturing	-1.93	-2.48	-2.22	1.45	-1.72
Pulp, Paper and Paperboard Mills	-1.73	-3.94	0.63	..	-1.49
Converted Paper Product Manufacturing	-1.15	0.66	-3.05	..	-4.20

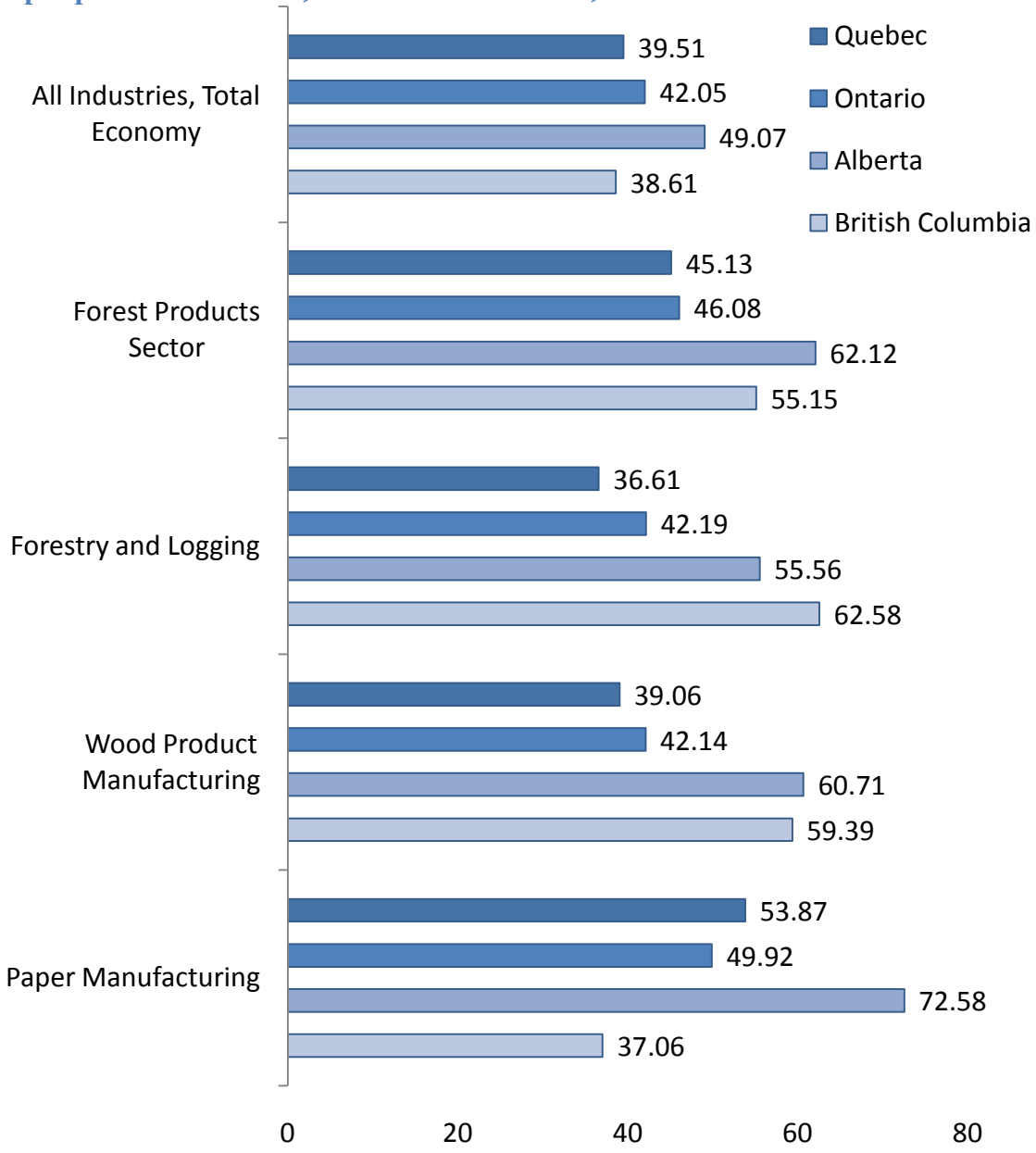
Source: Appendix Tables 824, 825, 826, 829, and 830.

important industry in Ontario and Quebec relative to other provinces. In contrast, British Columbia's heavy concentration in wood product manufacturing, a subsector which saw strong labour productivity growth in all provinces, helps to explain British Columbia's relatively good growth performance. Labour productivity growth in forestry and logging was mixed, performing strongly in Alberta and British Columbia, but relatively poorly in Ontario and Quebec.

The level of labour productivity in the forest products sector varies considerably by province as well, reflecting the differing composition of the forest products sector across provinces and cross-province differences in labour productivity levels at the industry level (Chart 12). In 2007, labour productivity in the forest products sector was highest in Alberta ($62.12 per hour worked, in chained 2002 dollars) and lowest in Quebec ($45.13 per hour worked). Ontario ($46.08 per hour) also performed poorly, while British Columbia ($55.15 per hour) performed relatively well. Turning to subsectors, forestry and logging had the highest labour productivity in British Columbia ($62.58 per hour) and the lowest in Quebec ($36.61 per hour). Wood product manufacturing had the highest level of labour productivity in Alberta ($60.71 per hour) and the lowest level in Quebec ($39.06 per hour). British Columbia also had fairly high labour productivity in wood product manufacturing ($59.39 per hour).

Paper manufacturing exhibited a somewhat different pattern from wood product manufacturing or forestry and logging. Labour productivity in paper manufacturing was highest in Alberta ($72.58 per hour) and lowest in British Columbia ($37.06 per hour). Alberta's outstanding labour productivity level was due to high labour productivity in the pulp, paper, and paperboard mills industry group; in that industry, Alberta's labour productivity of $108.96 per hour in 2005 (the latest year for which data are available) was about three times higher than that of neighbouring British Columbia. Alberta's labour productivity in the other industry group in the paper manufacturing subsector, converted

Chart 12: Labour Productivity in the Forest Products Sector, Canada, by Province, Output per Hour Worked, Chained 2002 Dollars, 2006



Source: Appendix Tables 824, 825, 826, 829, and 830.

paper product manufacturing, was similar to those of British Columbia and Ontario.

Chart 13, Chart 14, and Chart 15 offer a summary of the key findings of this section and a graphical representation of the productivity performance of the forest products sector across provinces. The size of the ball represents the relative importance of a subsector, for example, British Columbia's forestry and logging subsector is much larger than that of Alberta, so the corresponding ball for British Columbia is much larger than that for Alberta (Chart 13). The horizontal axis represents the level of labour productivity in 2007 in chained 2002 dollars per hour worked. The vertical axis represents labour productivity growth measured by the compound annual growth rate from 2000 to 2007. To the extent that a forest products subsector is performing well, it will be further to the right, further towards the top of the chart, and will be represented by a larger ball.

On this basis we can see that the Quebec and Ontario are underperforming. In forestry and logging Ontario and Quebec have lower levels of labour productivity than Alberta and British Columbia, and they have been experiencing lower labour productivity growth than Alberta and BC since 2000. Similarly, wood product manufacturing in Ontario and Quebec is lagging in terms of labour productivity levels compared to British Columbia and Alberta. Since growth rates have been similar, Ontario and Quebec have not been closing the labour productivity gap with British Columbia. In paper manufacturing Ontario and Quebec had higher levels of labour productivity than British Columbia in 2007, but they lagged behind the smaller paper manufacturing subsector in Alberta. Moreover, Alberta was the only province to see its paper manufacturing sector improve labour productivity over the past seven years.

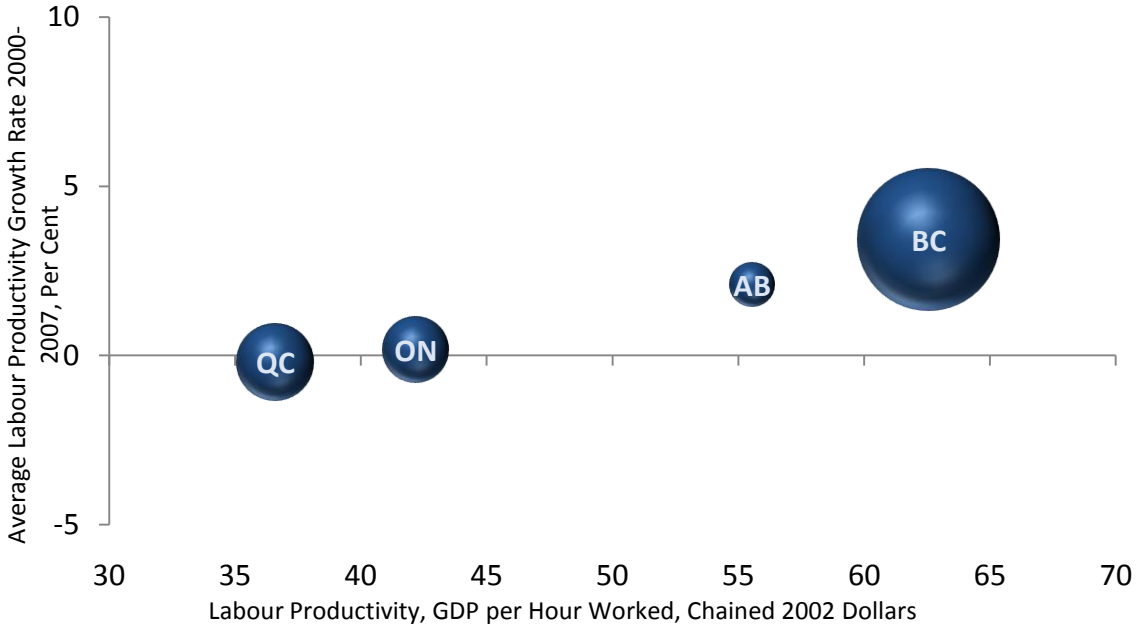
Based on the trends observed in this section, three findings are particularly noteworthy:

- Alberta has the smallest forest products sector of the top four forest products-producing provinces, but generally has high levels of labour productivity and has seen robust labour productivity growth rates since 2000. Alberta has an exceptionally high level of labour productivity in paper manufacturing.

- Quebec and Ontario appear to face the greatest productivity challenges. Not only do they have relatively large forest products sectors, but they underperform in every subsector in terms of labour productivity growth and levels.

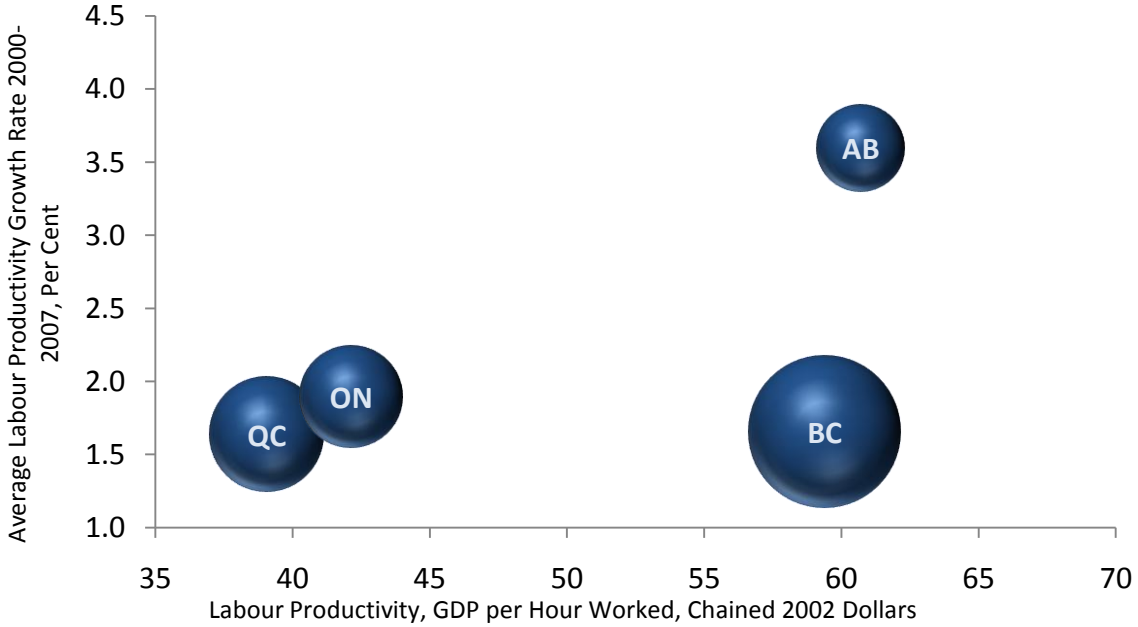
- British Columbia has the largest forest products sector in Canada, and by far the largest forestry and logging and wood product manufacturing subsectors. These subsectors have high levels of labour productivity. Wood product manufacturing in the province saw strong growth after 2000. Paper manufacturing was less successful; BC's labour productivity in that subsector declined to the lowest level of any of the four provinces.

Chart 13: Labour Productivity Levels, Growth, and Real GDP, Forestry and Logging, Canada, by Province, 2007



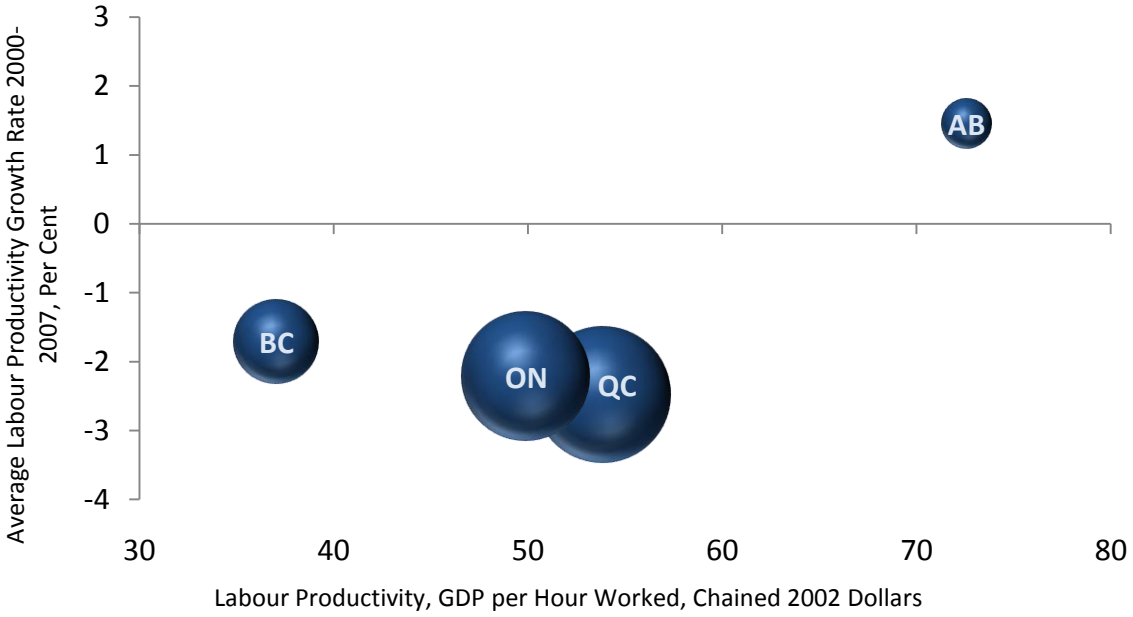
Source: Appendix Table 824, 825, 826, 829, and 830.
Note: The size of the ball represents the real GDP (chained 2002 dollars) in 2007.

Chart 14: Labour Productivity Levels, Growth, and Real GDP, Wood Product Manufacturing, Canada, by Province, 2007



Source: Appendix Table 824, 825, 826, 829, and 830.
Note: The size of the ball represents the real GDP (chained 2002 dollars) in 2007.

Chart 15: Labour Productivity Levels, Growth, and Real GDP, Paper Manufacturing, Canada, by Province, 2007



Source: Appendix Table 824, 825, 826, 829, and 830.
Note: The size of the ball represents the real GDP (chained 2002 dollars) in 2007.

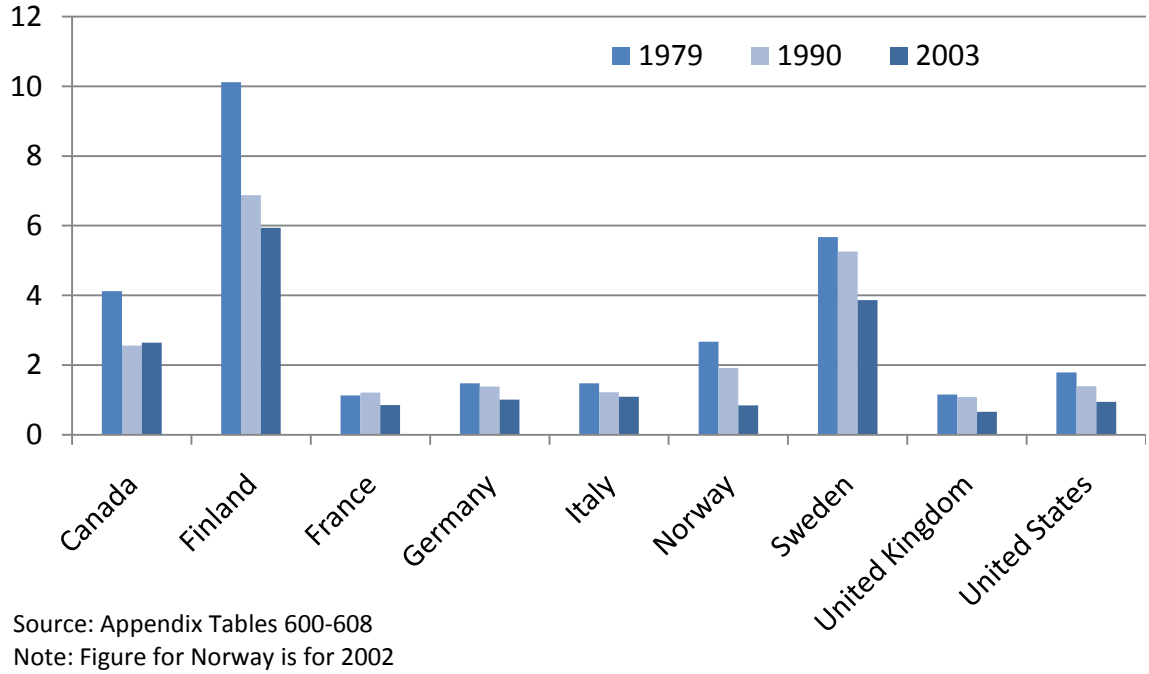
IV. Forest Products Sector Productivity in International Perspective

This part of the report examines trends in productivity in the forest products sector from an international perspective. First, data on countries that are members of the Organisation for Economic Cooperation and Development (OECD) are examined. Second, the productivity performance of the United States is explored in more detail.

A. OECD Countries[13]

The forest products sector is important to the Canadian economy as it produced more than 2 per cent of GDP in 2003. In most other G7 countries, including the United States, the forest products sector produces less than 1 per cent of GDP (Chart 16). Finland and Sweden, like Canada, are exceptions. Both have relatively important forest products sectors, producing 5.94 per cent and 3.87 per cent of GDP respectively in 2003. Every country examined has seen a decline in the importance of its forest products sector since 1979.

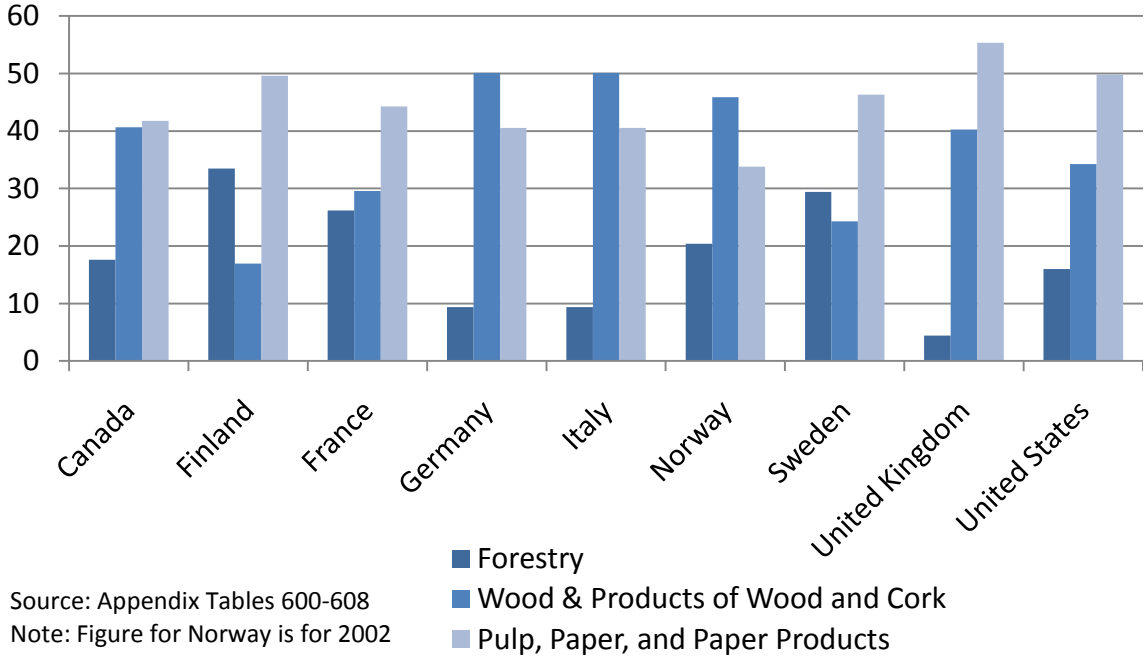
Chart 16: The Importance of the Forest Products Sector, Selected OECD Countries, Nominal Value Added of the Forest Products Sector as a Share of Total Economy, per cent, 1979, 1990, and 2003



Source: Appendix Tables 600-608
Note: Figure for Norway is for 2002

[13] The data used in this section are calculated by CSLS from the Groningen Growth and Development Centre (GGDC), 60-Industry Database, September 2006, http://www.ggdc.net/, updated from O'Mahony and van Ark (2003). These data are used because they offer comparability across countries. Unfortunately, the latest year for which these data were generally available was 2003. Because GGDC data differ somewhat from Statistics Canada data used in the previous part, the figures that appear in this section for Canada may be different from those that appeared earlier.

Chart 17: The Importance of Forest Products Subsectors, Nominal Value Added as a Share Total Forest Products Sector Nominal Value Added, per cent, 2003



Source: Appendix Tables 600-608
Note: Figure for Norway is for 2002

The relative importance of the three subsectors of the forest products industry differs from country to country (Chart 17). Interestingly, Canada is the only country where wood product manufacturing and paper manufacturing are of roughly equal importance. In Finland, France, Sweden, the United Kingdom, and the United States, paper manufacturing is more important than wood product manufacturing. Also interesting is the high relative importance of forestry and logging in Finland and Sweden, the only two countries where this subsector was more important than wood product manufacturing.

In comparison with other countries, over the 1979-2003 period, Canada had the slowest labour productivity growth in the forest products sector of the nine countries examined (Summary Table 9 and Chart 18). Labour productivity in Canada's forest products sector grew at an annual average rate of 1.48 per cent in this period, while other countries with major forest products sectors experienced greater labour productivity growth. For example, labour productivity in the Finnish forest products sector grew by 2.98 per cent per year between 1979 and 2003, while labour productivity in the United States expanded by 1.77 per cent per year. Sweden saw labour productivity in its forest products sector grow by a brisk 3.60 per cent annually.

Unfortunately, estimates of labour productivity levels in forest products subsectors cannot be constructed because data on the relative prices of output in different countries, which are needed to adjust prices, are not available. As a result, our analysis focuses only on growth rates.

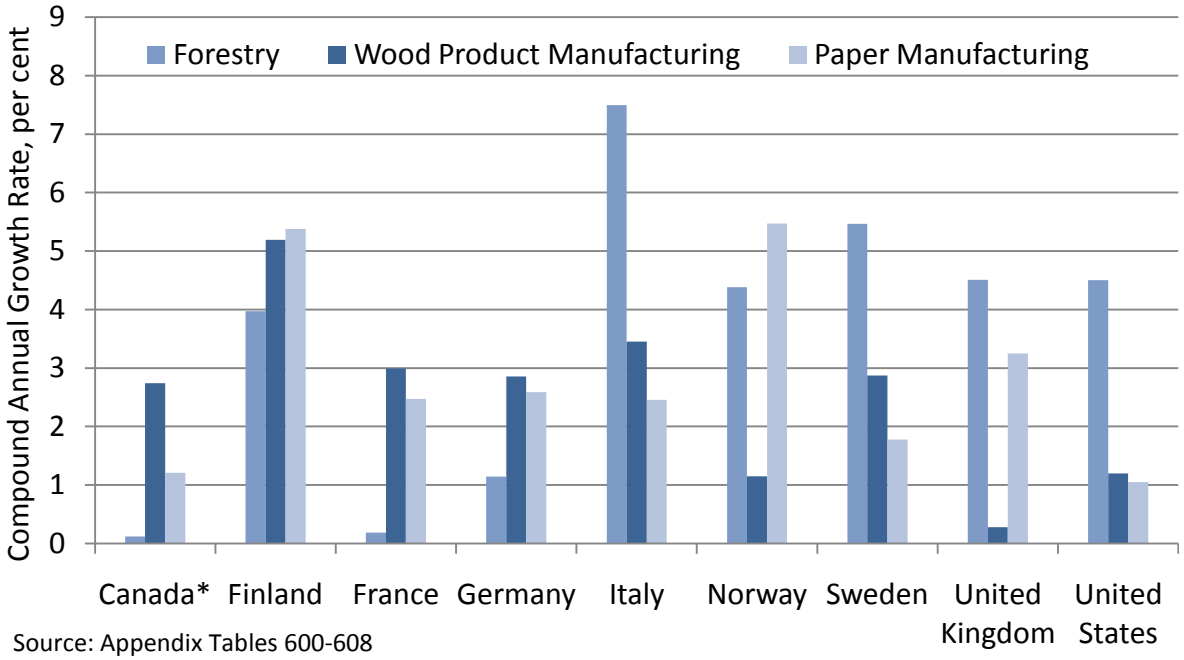
Summary Table 9: Labour Productivity Growth in the Forest Products Sector, Selected OECD Countries, 1979-2003

	Canada	Finland	France	Germany	Italy	Norway	Sweden	United Kingdom	United States
	Compound Annual Growth Rate, per cent								
Forest Products Sector									
1979-2003	1.48	2.98	2.56	2.66	3.79	3.28	3.60	2.07	1.77
1979-1990	1.73	3.13	3.75	2.62	4.90	5.11	2.55	3.35	2.46
1990-2000	1.32	3.21	1.46	2.90	3.44	3.13	4.65	0.49	0.48
2000-2003	1.09	1.62	1.90	2.00	0.98	-5.49	4.00	2.74	3.61
Forestry									
1979-2003	0.12	3.97	0.19	1.15	7.49	4.38	5.46	4.51	4.50
1979-1990	2.48	2.54	2.35	4.64	15.65	8.91	3.26	3.32	4.75
1990-2000	-1.53	6.22	-4.09	-3.75	0.11	-0.14	7.73	3.44	2.93
2000-2003	-2.86	1.86	7.13	5.34	4.22	3.15	6.15	12.79	9.00
Wood Product Manufacturing									
1979-2003	2.74	5.19	2.99	2.86	3.45	1.15	2.87	0.28	1.20
1979-1990	2.92	5.08	3.29	0.53	4.02	2.09	2.33	0.01	3.26
1990-2000	1.89	5.84	2.96	5.35	3.74	0.67	3.13	-0.25	-2.20
2000-2003	4.97	3.46	2.01	3.28	0.45	-1.57	3.99	3.06	5.31
Paper Manufacturing									
1979-2003	1.21	5.38	2.47	2.59	2.46	5.47	1.78	3.25	1.05
1979-1990	0.34	5.75	3.35	2.82	2.28	6.51	1.86	5.71	0.76
1990-2000	2.96	6.19	2.43	3.12	3.10	5.53	1.16	0.95	1.03
2000-2003	-1.36	1.38	-0.52	-0.02	1.00	-0.38	3.54	2.06	2.20

Source: Appendix Tables 600-608. Calculated by CSLS from Groningen Growth and Development Centre, 60-Industry Database, September 2006, http://www.ggdc.net/, updated from O'Mahony and van Ark (2003)

Note:
2002 is the last for data were available for Norway

Chart 18: Labour Productivity Growth, Forest Products Sector, Selected OECD Countries, 1979-2003



Source: Appendix Tables 600-608
Note:
Figure for Norway is for the period ending in 2002
* Figures for Canada should not be compared to those that appeared in section III, because different data sources are used.

It should also be noted that international comparisons of productivity growth must be interpreted with caution, because countries may have different mixes of the three forest products subsectors. In Canada, for example, wood product manufacturing tends to have a higher labour productivity growth rate than forestry and logging. Assuming for a moment that wood product manufacturing has a higher labour productivity growth rate than forestry and logging in all countries, it means that countries with relatively larger wood product manufacturing subsectors would have higher labour productivity growth rates in the forest products sector as a whole.

In the forestry subsector over the 1979-2003 period, the fastest labour productivity growth occurred in Italy (7.49 per cent per year), Sweden (5.46 per cent per year), the United Kingdom (4.51 per cent per year), the United States (4.50 per cent per year) and Finland (3.97 per cent per year). Canada had anemic labour productivity growth of just 0.12 per cent per year over the same period, the slowest growth among the nine countries.

Forestry in Canada experienced especially weak labour productivity growth in the 1990s (-1.53 per cent per year). Canada was not alone in having a decline in labour productivity in the 1990s in the subsector. France, Germany, and Norway also saw labour productivity fall between 1990 and 2000. At the same time, labour productivity in Sweden (7.73 per cent per year) and Finland (6.22 per cent per year) experienced outstanding growth. The United Kingdom (3.44 per cent per year) and the United States

(2.93 per cent per year) also saw healthy labour productivity growth in the forestry subsector.

From 1979 to 2003, labour productivity growth in wood product manufacturing was most rapid in Finland at an average annual rate of 5.19 per cent. Canada experienced a rate of growth of 2.74 per cent per year, quite similar to labour productivity growth rates in France, Germany, and Sweden. Italy (3.45 per cent per year) had notably strong labour productivity growth in wood product manufacturing, while the United Kingdom and United States saw fairly weak growth of 0.28 and 1.20 per cent per year respectively.

In the 1990s labour productivity growth in Canadian wood product manufacturing (1.89 per cent per year) slipped behind labour productivity growth in many other countries. Finland, with annual growth of 5.84 per cent, and Germany, with annual growth of 5.35 per cent, were the clear leaders.

In paper manufacturing the 1979-2003 period saw Canada's labour productivity growth at the slowest rate of the countries examined, with the exception of the United States. Norway and Finland led the field with labour productivity growth in paper manufacturing of 5.47 per cent per year and 5.38 per cent per year respectively. France (2.47 per cent per year), Germany (2.59 per cent per year), and Italy (2.46 per cent per year) also did well, while in the United Kingdom labour productivity grew by 3.25 per cent per year. Interestingly, Sweden saw relatively slow labour productivity growth in paper manufacturing, just 1.78 per cent per year. Still, this was better than either Canada or the United States.

In paper manufacturing, the 1990s broadly reflected trends observed over the longer 1979-2003 period. Canada did fairly well, with labour productivity expanding by 2.96 per cent per year. But Finland (6.19 per cent per year) and Norway (5.53 per cent per year) continued to lead the field. The United Kingdom (0.95 per cent per year) and the United States (1.03 per cent per year) continued to lag.

What conclusions can be drawn from this overview of labour productivity trends in selected OECD countries?

- In comparison with other high-income countries, Canada's labour productivity performance in the forest products sector has been weak. Between 1979 and 2003, Canada had the slowest labour productivity growth of the nine countries examined.

- Relative to the other eight countries, Canada performed especially poorly in forestry, where productivity has been declining in recent years.

- Canada's performance in wood product manufacturing productivity growth was fairly average by international standards, but was better than that of the United States.

- In paper manufacturing Canada generally had weak labour productivity growth by international standards over the 1979-2003 period, although in the 1990s the performance was average.

B. The United States

Because more information is available on the United States, this section presents a more up-to-date comparison of the labour productivity performance of the wood product manufacturing and paper manufacturing subsectors in Canada and the United States. Interested readers may wish to consult Appendix II, which provides a detailed discussion of trends in key indicators (output, hours worked, investment, labour productivity, capital productivity and multifactor productivity) for these two subsectors in the United States.

Summary Table 10 shows that the United States has had a different experience than Canada since 1989 in wood product manufacturing and paper manufacturing. In both countries, labour productivity growth in wood product manufacturing accelerated after 2000. This acceleration was more dramatic in the United States, where growth increased from a weak 0.68 per cent per year during the 1990s to 3.30 per cent per year between 2000 and 2006. In Canada the acceleration was from 1.39 per cent per year in the 1990s to 3.03 per cent per year.

In paper manufacturing Canada and the United States followed divergent paths. From 2000 to 2006, labour productivity in Canada has declined on average by 2.43 per cent per year, while in the United States paper manufacturing labour productivity grew by 3.05 per cent per year. This performance was a collapse for Canada from the brisk 3.55 per cent per year rate of labour productivity growth in the 1990s, but a significant improvement for the United States, which managed only 1.79 per cent per year labour productivity growth in the period from 1989 to 2000.

Summary Table 10: Labour Productivity, Wood Product and Paper Manufacturing, Canada and the United States, Compound Annual Growth Rate, per cent, 1989-2000 and 2000-2006

	1989-2000		2000-2006	
	Canada	United States	Canada	United States
All Industries*	1.60	2.10	1.05	2.68
Wood Product Manufacturing	1.39	0.68	3.03	3.30
Paper Manufacturing	3.55	1.79	-2.43	3.05
Pulp, Paper, and Paperboard Mills	..	2.90	-2.18	4.46
Converted Paper Product Manufacturing	..	1.07	-1.62	2.41

Source: Appendix Tables 5, 905, and 905a
*Note: Total economy in Canada, business sector in the United States

V. Factors Influencing Productivity in the Forest Products Sector

This part of the report offers potential explanations for the productivity performance of the forest products sector that was described in section three. It begins by setting out the overall approach to identifying productivity growth drivers, then discusses each of the potential drivers with a view to which offer the most promising hypotheses for the productivity performance of the forest products sectors in Canada.

A. Sources of Productivity Growth

i. The Seven Key Drivers of Productivity

The drivers of productivity are multiple and a vast number of factors can indirectly affect the productivity performance of a sector. Sharpe (2002) identifies the following seven determinants of productivity growth:

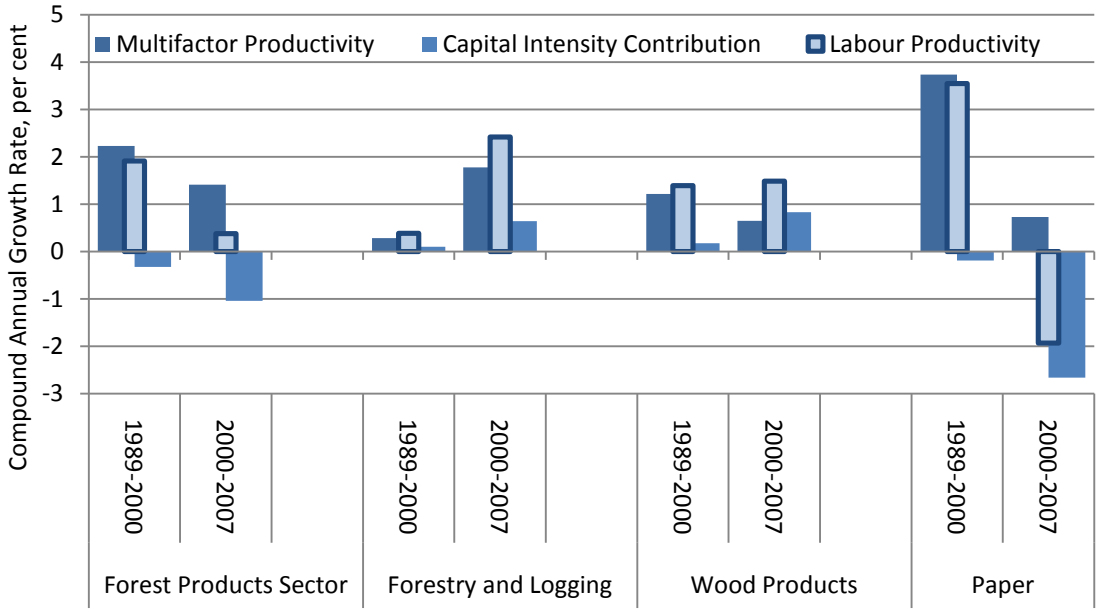
- *Rate of technical progress*, determined by the rate of developing new product and process innovations and the pace of diffusing those innovations.
- *Investment in physical capital* such as machinery and equipment and structures. The more capital a worker has to work with, the greater the output he can produce. It is estimated that 80 per cent of technical change is embodied in new capital equipment, particularly machinery. Without gross investment, technical progress would be all but impossible.
- *Quality of the workforce*, including average educational, training, and experience levels. Literacy and numeracy skills as well as technical skills are essential if an industry is to benefit from technical advances and make effective use of machinery.
- *Size and quality of the natural resource base*. For example, large quantity of easily exploited and high quality timber could be expected to increase the productivity of a logging operation.
- *Industrial structure and intersectoral shifts*, since the aggregate level of labour productivity is a weighted average of industry labour productivity levels, where weights are the labour input shares.
- *The macroeconomic environment* or aggregate demand conditions defined by the size of the output gap and the relationship between actual and potential output growth. Prolonged periods of insufficient demand can have a negative long-term effect of productivity growth.
- *The microeconomic policy environment*, broadly defined as the policies that affect behaviour at the firm level, including trade policy, tax policy, industrial policy, competition policy, and policies on intellectual property, regulation and foreign ownership.

This part of the report uses the Sharpe (2002) framework to identify potential explanations for the productivity performance of the forest products sector. There is still considerable uncertainty about the drivers of productivity. The contributions made by the factors listed above may vary across time and location. Many of the productivity growth drivers are interrelated and may act in synergy. Before discussing each driver in detail, we conduct a preliminary analysis using a growth accounting decomposition of labour productivity growth for the forest products sector in Canada.

ii. Capital Intensity and Multifactor Productivity

Labour productivity growth can be decomposed into change in capital intensity[14] and change in multifactor productivity (Chart 19 and Summary Table 11). This decomposition can help guide our inquiry into the explanations of the productivity performance of the forest products sector. Because of the synergy between productivity growth drivers, in practice it is often difficult to disentangle drivers of capital intensity from drivers of multifactor productivity and this report does not attempt to do so. Nonetheless, any potential explanations offered below must be able to fit the basic facts presented here.

Chart 19: Sources of Labour Productivity Growth, Forest Products Sector, 1989-2000 and 2000-2007



Source: Appendix Tables 9-9d.

[14] Capital intensity measures the amount of capital that each worker has at his or her disposal. In this report it is measured as real capital stock per hour worked.

Summary Table 11: Sources of Labour Productivity Growth, Forest Products Sector, 1989-2007

	1989-2007	1989-2000	2000-2007	Change from 1989-2000 to 2000-2007
	Contribution to Labour Productivity Growth, Percentage Points			Percentage Points
All Industries, Total Economy				
Labour Productivity	1.35	1.60	0.98	-0.62
Capital Intensity	0.19	0.08	0.38	0.29
Multifactor Productivity	1.16	1.51	0.60	-0.91
Forest Products Sector				
Labour Productivity	1.31	1.91	0.38	-1.53
Capital Intensity	-0.56	-0.32	-1.04	-0.72
Multifactor Productivity	1.87	2.23	1.41	-0.82
Forestry and Logging				
Labour Productivity	1.17	0.38	2.42	2.04
Capital Intensity	0.31	0.10	0.64	0.54
Multifactor Productivity	0.86	0.28	1.77	1.49
Wood Product Manufacturing				
Labour Productivity	1.43	1.39	1.48	0.09
Capital Intensity	0.38	0.18	0.83	0.66
Multifactor Productivity	1.05	1.21	0.65	-0.56
Paper Manufacturing				
Labour Productivity	1.38	3.55	-1.93	-5.48
Capital Intensity	-1.03	-0.19	-2.66	-2.47
Multifactor Productivity	2.41	3.74	0.73	-3.01

Source: Appendix Tables 9-9d.

B. Drivers of Productivity Growth

This section explores each of the seven major drivers of productivity growth that were described in the previous section. It concludes with a summary of key findings.

i. Rate of Technical Progress

There are two key ways that the Canadian forest products sector can innovate to increase productivity: either the sector performs research and development itself, or it adopts innovations from other countries and other sectors. The adoption of innovations can occur through imports of machinery and equipment, skilled personnel, new productive processes, and product innovations. In this section, we examine the best available measure of research and development (R&D) effort based on Statistics Canada data: R&D intensity. After noting the limitations of this measure, we look at alternative indicators of innovation. R&D in the Canadian forest products sector is compared to that of other high-income countries, and finally, a measurement issue related to technical progress is discussed.

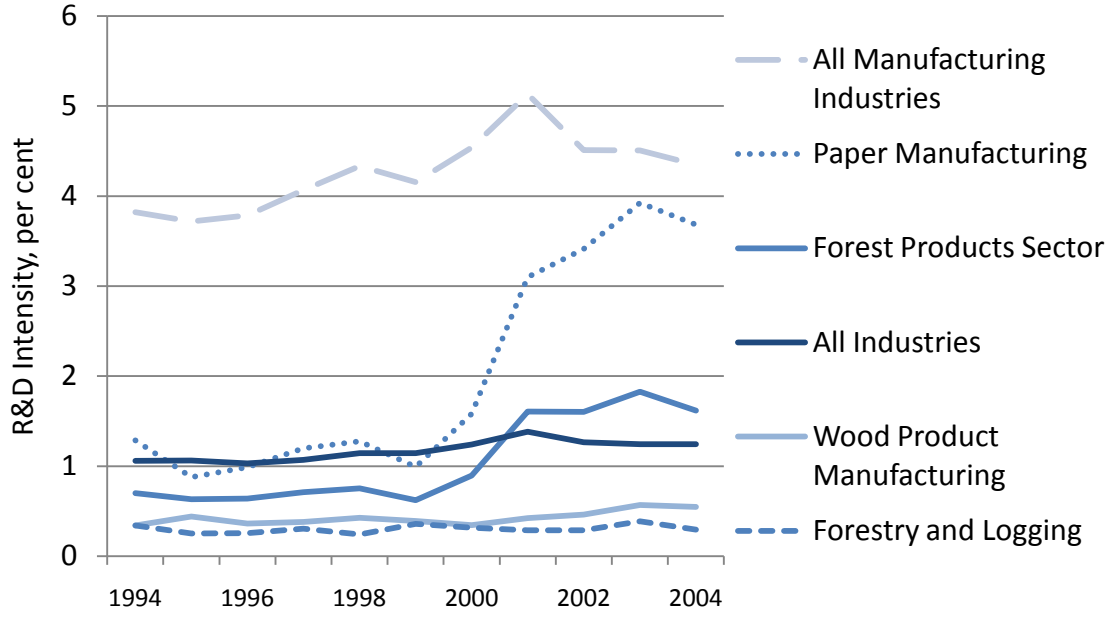
R&D Intensity

Research and development spending as a share of GDP (R&D intensity) in the forest products sector in Canada increased significantly from 1994 to 2004 (Chart 20). This increase was almost entirely due to the increase in R&D intensity in paper manufacturing. R&D intensity in the forestry and logging and wood manufacturing subsectors was stable at around 0.3 per cent of GDP. This level of R&D spending was considerably less than the total economy average of 1.24 per cent. Even more striking, paper manufacturing and especially wood product manufacturing are seriously lagging behind other manufacturing industries, which on average devote between 4 and 5 per cent of GDP to R&D. In 2003, the peak year for R&D intensity in the forest products sector, wood product manufacturing had R&D intensity of 0.57 per cent and paper manufacturing had R&D intensity of 3.92 per cent.

The increase in R&D intensity in paper manufacturing since 2000 is likely to be good news for productivity growth in the future, but is unlikely to have had a major impact to date. It is also unlikely that the increase in R&D spending can in any way account for the deceleration in labour or multifactor productivity growth observed in paper manufacturing since 2000.

These data include only the R&D activities in Canadian industries and non-profit industrial research institutes and associations. They do not include the R&D activities of the federal and provincial governments or educational institutions. Also excluded are research and development expenditures by the makers of the machinery and equipment used in the forest products sector. As noted above, machinery and equipment often embodies significant new technology, so these exclusions are significant. These exclusions make it difficult to assess the overall R&D picture in the Canadian forest

Chart 20: Research and Development Expenditures, Forest Products Sector, Canada, Current Dollars, As a Share of GDP, Per Cent, 1994-2004



Source: Appendix Table 12f

products sector. In order to gain a broader picture of technical progress in the sector we briefly survey some alternative indicators.[15]

Other Indicators of Innovation

Another perspective on innovation in the Canadian forest products sector is provided by a study by the Committee on State of Science and Technology in Canada (2006) of the Council of Canadian Academies. The study examined science and technology in Canada from a global perspective, which is of particular interest for a global sector like forest products.[16] The survey generally found the forest products sector to be a strong science and technology sector. Sixty-seven per cent of respondents ranked forestry engineering as strong in science and technology, while only 11 per cent said it was weak. Meanwhile, 23 per cent of respondents said forestry engineering in Canada was gaining ground globally, while 18 per cent thought it was losing ground.

In pulp and paper, 61 per cent thought the subsector was a strong science and technology performer, and 12 per cent thought it was weak. On the other hand, 10 per

[15] Based on publicly available information, it seems that the forest products sector is taking innovation and R&D seriously. The recent creation of FPInnovations, now the world's largest not-for-profit forest research institute, is certainly a step in the right direction. FPInnovations brings together research institutes (FERIC, Forintek, Paprican, and the Canadian Wood Fibre Centre of Natural Resources Canada) that each focus on a different element of the forest products sector value chain.

[16] The study used four different techniques to gauge the strength of science and technology in Canada: an opinion survey of Canadian science and technology experts; bibliometric data (quantity and quality of scientific journal publications and patents); a summary of reports and comments obtained from foreign sources; and a review of relevant publications including internationally comparable indicators of important aspect of science and technology strength. The survey of Canadian experts was by far the most important and widely used source in the report.

cent of respondents thought pulp and paper in Canada was gaining ground globally, while 36 per cent felt it was losing out to foreign competitors. Similarly, in timber harvesting, 64 per cent of respondents rated Canada strong, while only 12 per cent found Canada weak. Nonetheless, respondents were pessimistic about the future, with 36 per cent saying Canada was losing ground and only 10 per cent responding that it was gaining ground.

In the bibliometric component of the study, Canada's forest products sector came out very well. Forestry engineering ranked first in publication intensity and performed well above the world average in publication quality. No data were available on wood product or paper manufacturing for this element of the study.

Overall, Canada's forest product sector seems to be doing well in terms of innovation, but broad comparisons with other countries and over time are difficult.

International Comparisons

Even if Canada has increased its R&D effort over time, Canada could still be lagging other countries. Data from the Organisation for Economic Cooperation and Development (OECD) allow a comparison of R&D spending across countries. In order to adjust for differences in the cost of doing R&D in different countries, the figures presented in are in US dollars at purchasing power parity.[17] The latest year for which data are available is 2004.

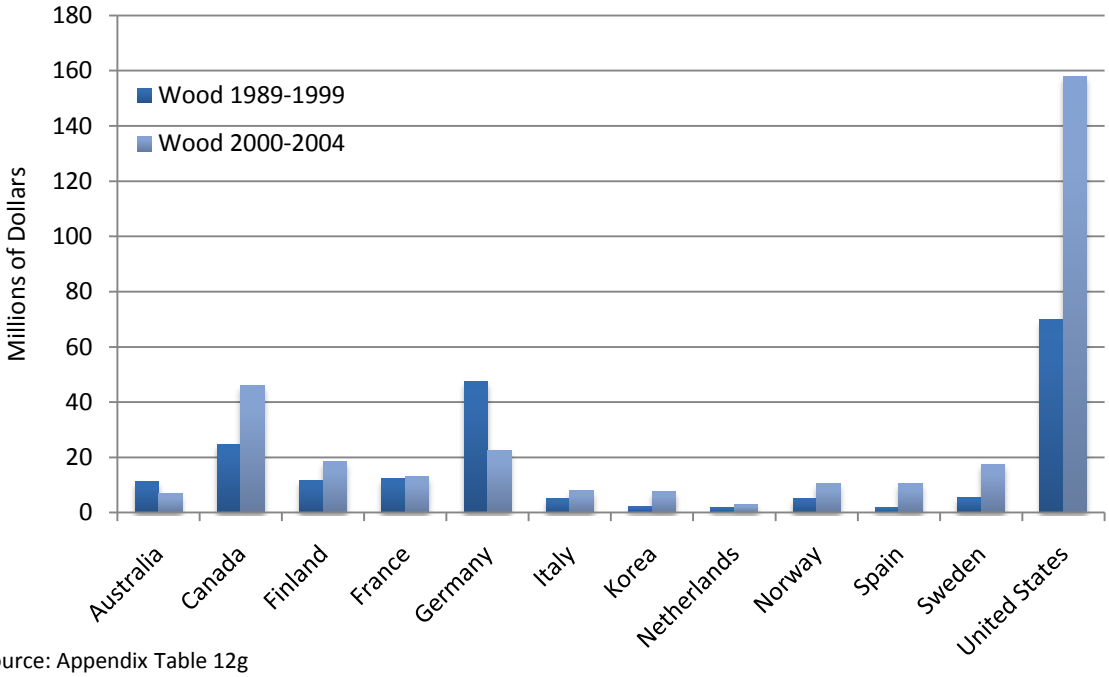
Canada appears to do very well in R&D spending in the paper manufacturing subsector, especially between 2000 and 2004 (Chart 21 and Chart 22). Other leaders in paper manufacturing R&D were Australia, Finland, France, Germany, and Sweden. Unfortunately, data for the United Kingdom and the United States were not available. It is also notable that Canada has significantly increased spending on R&D in paper manufacturing since 2000, as was seen above. In wood product manufacturing the United States is the clear international leader in R&D. Canada is second, and no other country seems to be a major player.

Potential Measurement Problems

It is often the case that the interaction of technical change and the system that statisticians use to capture data can create confusion. Often those working in the sector will observe productivity gains that will not show up in official statistics.[18] For instance, as noted in section two of this report, trucking is not considered part of the forest products sector in this report. However, many might consider trucking companies that primarily move logs from logging limits to mills as an integral part of the forest products sector. This exclusion means that productivity gains in the trucking industry will not show up in the forest products sector.

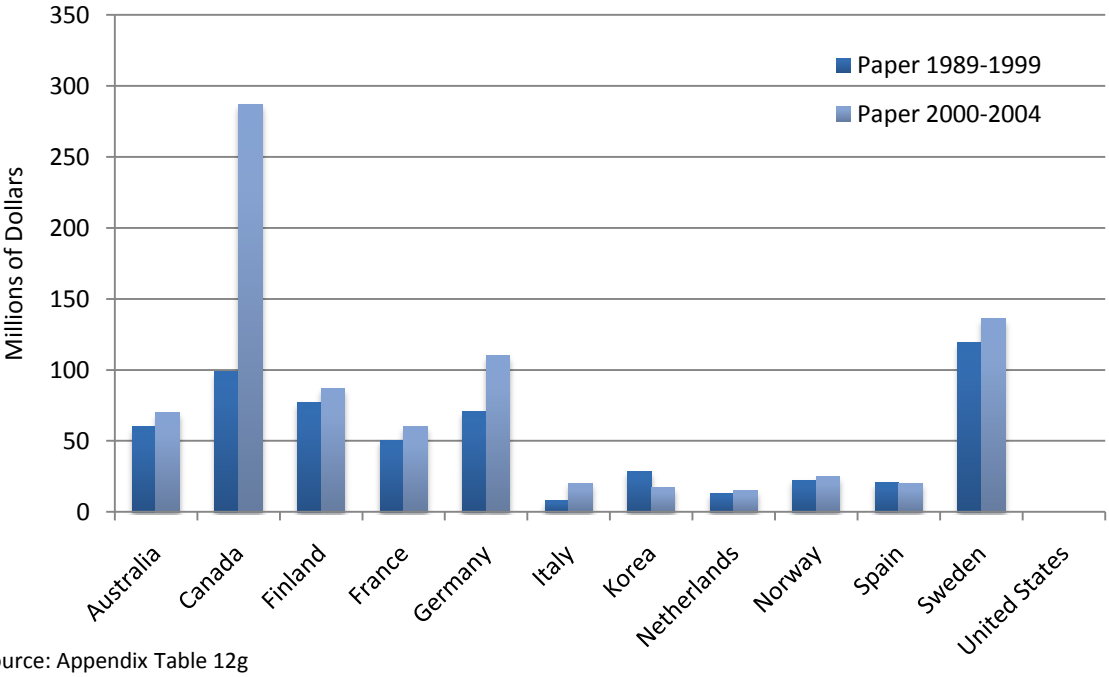
[17] That is, adjusted for the different amount of goods and services that the same US dollar can buy in different countries.
[18] See for example, the discussion of pre-work in the construction sector in Harrison (2007).

Chart 21: Average Annual Business Enterprise Expenditures on Research & Development, 'Wood and Products of Wood and Cork' Sector, Millions of Current US Dollars at Purchasing Power Parity, 1989-1999 and 2000-2004



Source: Appendix Table 12g

Chart 22: Average Annual Business Enterprise Expenditures on Research & Development, 'Paper and Paper Products' Sector, Millions of Current US Dollars at Purchasing Power Parity, 1989-1999 and 2000-2004



Source: Appendix Table 12g

In the future, it seems likely that the outputs of processes of the forest products sector will be transformed in ways that could result in productivity improvements, but productivity improvement that may show up in the official statistics of other sectors. For example, Rheaume and Roberts (2007: 47) suggest that over the next 10 years technological advances in the forest products sector could include the development of dedicated biochemical mills and the production of pharmaceuticals from trees. If such developments come to pass, depending on the nature of the production processes involved, establishments engaged in such activities could be classified in non-forest products industries like chemical manufacturing or refining.

It is also possible that much of the R&D spending that will transform the forest products sector is not taking place in the forest products sector at all. For instance, pharmaceutical and energy firms are exploring the potential uses of wood fiber. To the extent that such R&D is taking place, R&D spending in the forest products sector could be underestimated.

Going forward, it will be important to continue to redefine the forest products sector. While there is no theory that can predict the precise course of technical progress, there is no doubt that technical progress will occur. Further research on productivity in the forest products sector should pay close attention to such developments.

ii. Investment in Physical Capital

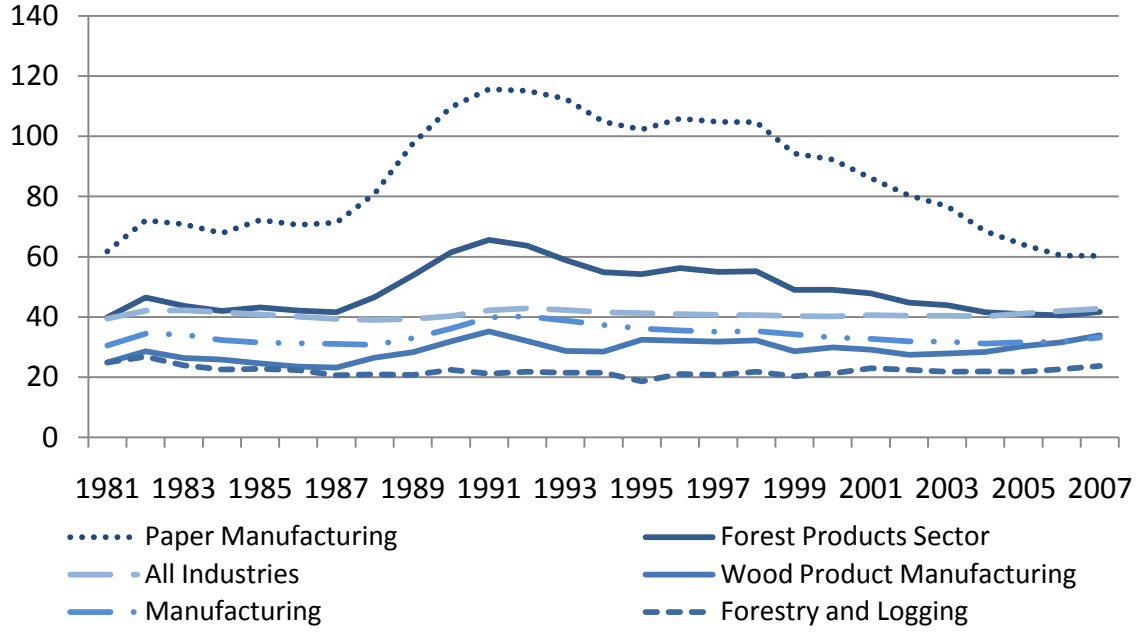
The relationship between physical capital and labour productivity is relatively direct. With more and better capital to work with, each worker can produce more output per hour. Investment in physical capital is also important, because it is the primary means by which technical change is introduced into production processes. With little investment, it is unlikely that major technical progress will occur.

But not all capital is of equal value in increasing labour productivity. Capital is classified by statistical agencies as either structures (buildings, roads, pipelines, canals, etc.) or machinery and equipment (trucks, industrial machines, computers, etc.). A number of cross-country studies have found investment in machinery and equipment (M&E) to have a particularly strong positive relationship with economic growth and productivity growth.[19] In any case, machinery and equipment is by far the most important type of investment in the forest products sector, accounting for 89 per cent of nominal gross investment in 2007 in Canada (Appendix Tables 10d and 10e).

The measure of physical capital available to workers used in this report is capital intensity. Capital intensity is obtained by dividing an industry's real capital stock (in constant dollars) by the total number of hours worked in that industry. Capital intensity,

[19] The classic work from this literature is that of De Long and Summers (1991), who use cross-country regression analysis to relate M&E and structures investment to per-worker GDP growth. They find that a 3 percentage points increase in M&E investment as a share of GDP is associated with an increase of 1.0 percentage points in the annual rate of per-worker GDP growth. This is a significant effect; it amounts to 29 per cent faster per worker GDP growth over their 25-year sample period. By contrast, De Long and Summers find no statistically significant relationship between per-worker GDP growth and investment in structures.

Chart 23: Capital Intensity, Forest Products Sector, Real (Net) Capital Stock per Hour Worked, Constant 2002 Dollars, Canada, 1981-2007



Source: Appendix Table 8e

Summary Table 12: Capital Intensity, Forest Products Sector, Real (Net) Capital Stock per Hour Worked, Constant 2002 Dollars, Canada, 1981-2007

	Total All Industries	Manufacturing	Forest Products Sector			
			Total, Forest Products Sector	Forestry and Logging	Wood Product Manufacturing	Paper Manufacturing
Compound Annual Growth Rate, Per Cent						
1989-2007	0.47	0.04	-1.41	0.76	1.01	-2.64
1989-2000	0.20	0.06	-0.84	0.26	0.50	-0.51
2000-2007	0.89	0.01	-2.30	1.55	1.80	-5.91
Level, Constant 2002 Dollars Per Hour Worked						
1989	39.32	32.94	53.76	20.70	28.29	97.61
2000	40.22	33.15	49.00	21.29	29.90	92.30
2007	42.78	33.18	41.64	23.71	33.88	60.26

Source: Appendix Table 8e

through the capital stock, is determined by business investment, which is in turn determined by business decisions based on risk and return, and by depreciation, which is affected by changes in the level and mix of technology used in production processes.

As was seen in Chart 19, changes in capital intensity influence labour productivity in the forest products sector. For example, although MFP growth declined substantially in the wood products subsector after 2000, an increase in capital intensity kept labour productivity growth from falling. This increase in capital intensity was the result of a stable real capital stock coupled with a decline in hours worked.

In paper manufacturing, plummeting capital intensity (a decline of 5.91 per cent per year over 2000-2007) helps to explain the labour productivity growth slowdown after the year 2000 (Summary Table 12). This decline in capital intensity was the result of a significant acceleration in disinvestment in the subsector, with net investment in machinery and equipment as a share of GDP in paper manufacturing falling from -1.30 per cent on average over the 1989-2000 period to -6.32 per cent over the 2000-2007 period (Summary Table 13).

It is well known in the forest products sector that "despite pockets of excellence, the capital stock of the industry as a whole is older and less productive than that of leading global competitors" (Forest Products Industry Competitiveness Task Force, 2007: 4). Forestry and logging did not offset depreciation of its machinery and equipment with new investment over the 2000-2007 period; net investment in the subsector was negative over the period, though small in absolute value at -0.12 per cent of subsector GDP (Summary Table 13). By comparison, wood product manufacturing made positive net investments in machinery and equipment, but there were numerous years when depreciation exceeded new investment. Gross real investment in machinery and equipment as a share of GDP in wood product manufacturing was average in comparison with the manufacturing sector as a whole over the 2000-2007 period.

Paper manufacturing has not matched the economic depreciation of its assets with new investment in any year since the late 1980s, with the sole exception of 1995. On average, paper manufacturing invested 14.35 per cent of GDP in new machinery and equipment over the period from 2000 to 2007, less than half the level of the period 1989 to 2000, 30.95 per cent. These were high rates of gross investment relative to the rest of the economy, but depreciation rates are unusually high in paper manufacturing. Since depreciation, on average, exceeded new investment in both the period 1989-2000 and 2000-2007, the stock of machinery and equipment in the paper manufacturing subsector has fallen.

Overall, the lack of investment is one of the most serious problems facing the forest products sector. Without significant new investment, new technology cannot be adopted as easily and the sector will continue to decline.

Summary Table 13: Investment in Machinery and Equipment, Forest Products Sector, Canada, 1989-2007

	All Industries, Total Economy	Manufacturing	Forest Products Sector			
			Total, Forest Products Sector	Forestry and Logging	Wood Product Manufacturing	Paper Manufacturing
Real Gross Investment in Machinery and Equipment as a Share of GDP, Constant 2002 Dollars, Per Cent						
1989-2007	8.73	11.68	15.82	4.75	11.91	24.67
1989-2000	8.12	12.64	18.96	5.09	12.94	30.95
2000-2007	9.70	10.03	10.84	4.26	10.61	14.35
Real Depreciation in Machinery and Equipment as a Share of GDP, Constant 2002 Dollars, Per Cent						
1989-2007	7.76	11.30	16.77	4.53	10.98	27.82
1989-2000	7.30	11.96	19.08	4.66	11.59	32.26
2000-2007	8.45	10.14	13.07	4.38	9.96	20.67
Real Net Investment in Machinery and Equipment as a Share of GDP, Constant 2002 Dollars, Per Cent						
1989-2007	0.97	0.37	-0.96	0.23	0.93	-3.15
1989-2000	0.82	0.68	-0.13	0.43	1.35	-1.30
2000-2007	1.25	-0.11	-2.23	-0.12	0.64	-6.32
Cumulative Real Net Investment in Machinery and Equipment, Millions of Constant 2002 Dollars						
1989-2007	186,688	9,830	-5,244	229	1,613	-7,085
1989-2000	85,288	11,624	-362	274	1,385	-2,020
2000-2007	114,278	-1,441	-5,234	-54	640	-5,820

Source: Appendix Tables 10m, 10p, and 10q

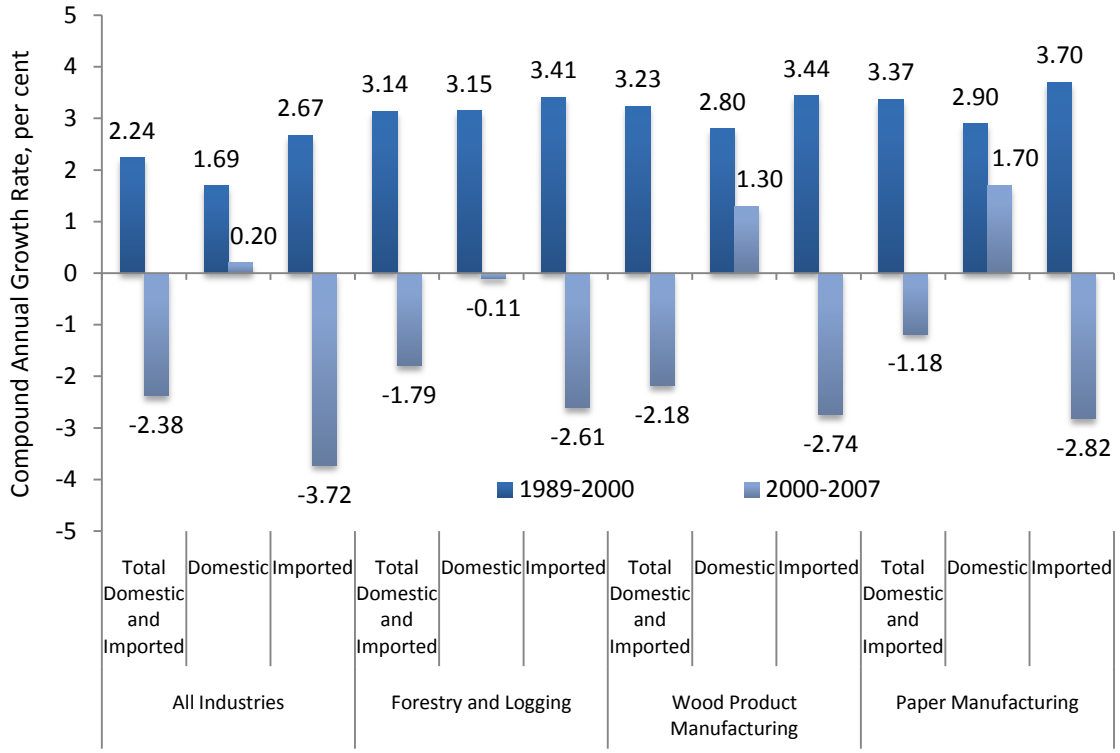
Overall, the lack of investment is one of the most serious problems facing the forest products sector. Without significant new investment, new technology cannot be adopted as easily and the sector will continue to decline. Labour productivity may continue to grow if capital intensity improves through deeper cuts in hours worked than in capital stock, but such a trend is not sustainable in the long run, because the sector will eventually run out of workers and capital to cut.

Machinery and Equipment Prices

Much has been made of the potential impact of the decline in machinery and equipment (M&E) prices that has resulted from the appreciation of the Canadian dollar in relation to the US dollar since 2003. Statistics Canada's machinery and equipment price indexes measure the cost of machinery and equipment purchased by industry. Generally speaking, we expect that decreasing prices for M&E should make investment more attractive and lead to higher capital intensity and higher productivity.

Overall, M&E prices rose in the 1989-2000 period, but have declined in the 2000-2007 period (Chart 24). This price reduction is the result of declining prices for imported M&E; prices for Canadian-produced M&E have not declined. In comparison with the prices of machinery and equipment in the economy as a whole, the forest products sector saw prices rise more quickly from 1989 to 2000, then decline more slowly since 2000. All else being equal, this pattern would tend to discourage investment in the forest products sector in comparison with other sectors, but would tend to increase investment in the 2000-2007 period relative to the 1989-2000 period.

Chart 24: Machinery and Equipment Prices, Forest Products Sector, Canada, 1989-2000 and 2000-2007



Source: Appendix Table 2g

If anything, these trends understate the importance of the price declines in M&E, since they are based on the domestic/foreign weights from 1997. It is likely that Canadian forest products companies have increased the share of M&E that they purchase from foreign suppliers since prices have begun to fall.

It is notable that the declines in paper manufacturing M&E prices since 2000 have been smaller than declines in forestry and logging and wood product manufacturing M&E. It is possible that the good productivity performance of the forestry and logging and wood product manufacturing subsectors after 2000 was partly attributable to lower M&E prices, while the M&E price declines in paper manufacturing ware insufficient to offset other factors that resulted in declining investment and labour productivity in that subsector.

iii. Quality of the Workforce

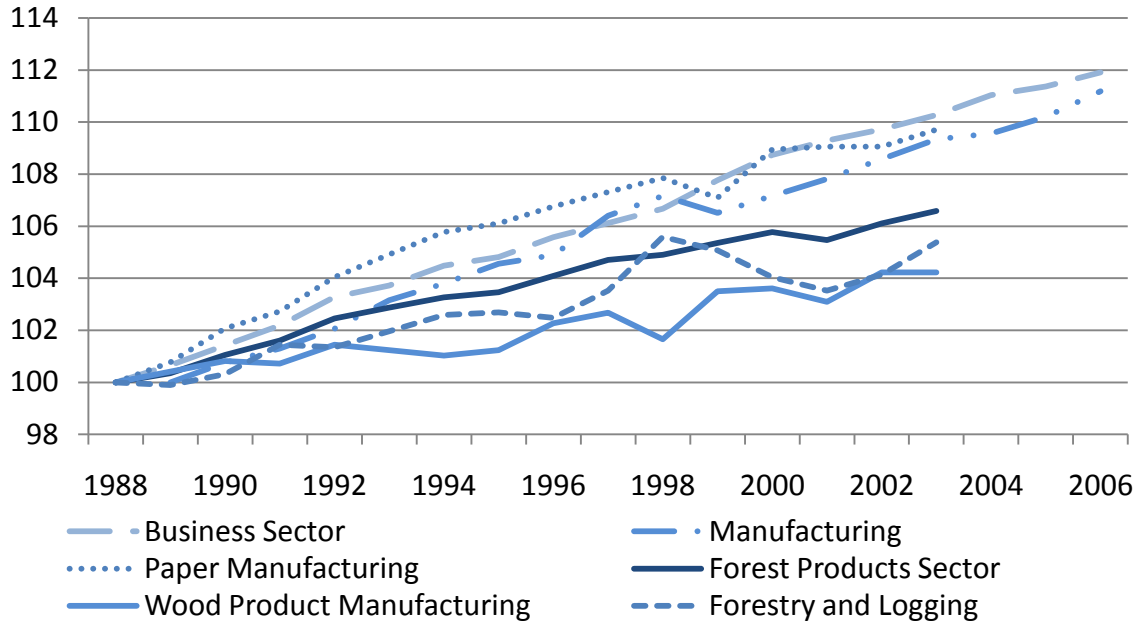
Human capital is another driver of productivity. The higher the education level and the greater the experience of workers, the more they can produce per hour of labour. Changes in the human capital embodied in the labour force of the forest products sector are captured by Statistics Canada's measure of labour composition. Unfortunately, this measure is only available to 2004 for the forest products sector. Labour composition captures changes in the skill level of the workforce, as measured by work experience, educational attainment, and whether or not the worker is self-employed (Chart 25 and Chart 26). In the measure of multifactor productivity used in this report, improvements in labour quality are captured in multifactor productivity growth.[20]

Using the labour composition measure of Statistics Canada as a measure of labour quality shows us that the forest products sector has lagged the economy as a whole over the period from 1989 to 2004. The relatively slow growth of labour quality in the forest products sector is entirely the result of slow growth in labour quality in the forestry and logging and wood product manufacturing subsectors. Paper manufacturing has seen labour quality improve at a rate similar to the overall manufacturing sector and the business sector as a whole.

Assuming that the improvement in labour quality between 2005 and 2007 was similar to the improvement between 2000 and 2004, labour quality does not appear to offer an explanation for any of the trends observed in forest products sector productivity from 1989 to 2007. In forestry and logging, the apparent slowdown in labour quality improvement after 2000 coincided with an increase in the rate of growth of labour productivity. The same pattern occurred in wood product manufacturing. In paper manufacturing the improvement in labour composition was constant over the entire period 1989-2007, in spite of the dramatic slowdown in labour productivity growth after 2000.

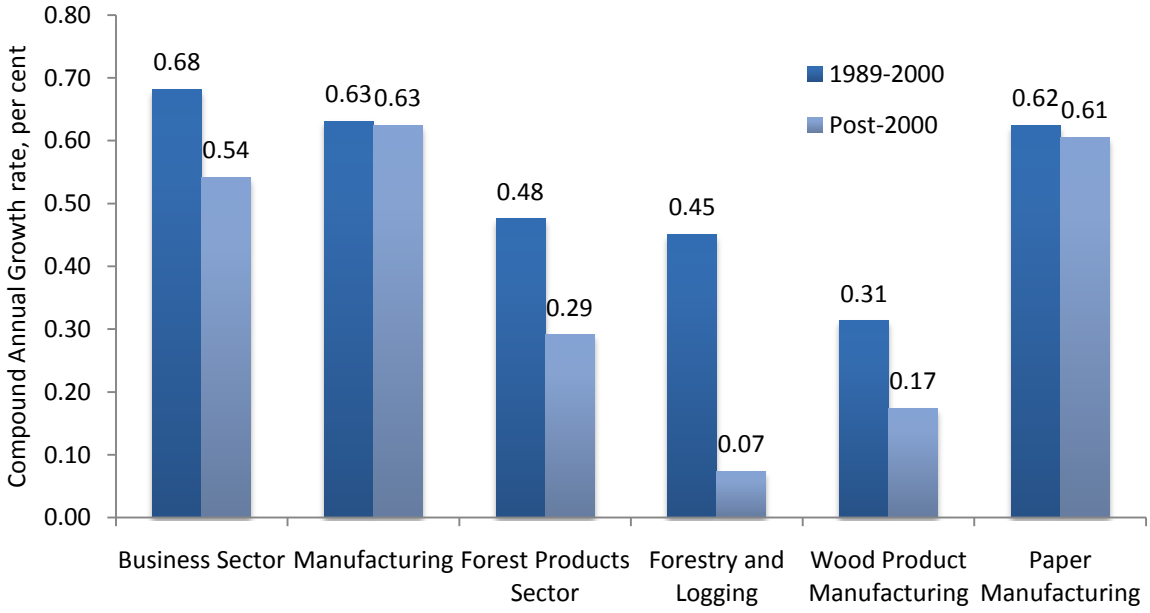
[20] In order to produce estimates of multifactor productivity growth up to 2007, CSLS calculations using Statistics Canada data had to be used in place of official Statistics Canada estimates of MFP. The CSLS estimates are less precise, in part because CSLS does not have access to the data that would allow for the estimation of labour composition. As a result, labour composition cannot be separated from our MFP estimate.

Chart 25: Labour Composition (Quality), Forest Products Sector, Canada, 1989 = 100, 1989-2007



Source: Appendix Tables 16a, 16c, 17a, 18a, 19a, and 20a

Chart 26: Labour Composition (Quality), Forest Products Sector, Canada, 1989-2000 and Post-2000



Source: Appendix Tables 16a, 16c, 17a, 18a, 19a, 20a.
Note: Data for the business sector and the manufacturing sector are for 2000-2007. For the forest products sector and its subsectors, data are for 2000-2004.

iv. Size and Quality of the Natural Resource Base

The quality of natural resources can have a major effect on productivity, especially in the forestry and logging subsector. Firms exploiting high quality, easily accessible natural resources that generate large economic rents[21] will have higher productivity levels than firms exploiting poor quality resources. A depletion of natural resources over time, everything else being equal, will lead to slower productivity growth or even negative productivity growth, as more inputs are needed to obtain a given output. The reliance on less accessible timber stocks, for example, can raise the cost in terms of labour and capital of producing a given quantity of logs, decreasing productivity. This tendency toward depletion and diminishing returns can be, and often is, offset by technological advances.

It is possible that Canada's relatively slow-growing forests, which result in long-distance hauling of logs being required, makes super mills less viable than in countries where wood fibre grows more quickly (Rheaume and Roberts, 2007:21). This situation could have a significant impact on productivity in the paper manufacturing subsector.

Environmental changes are also having an impact on the forest products sector, with implications for productivity. Adapting production processes to deal with changing patterns of forest fires and insect species like the spruce budworm and mountain pine beetle require investment. In the long run, the effect of these changes on productivity is not clear, but in the short and medium run, the cost of adjusting can hurt productivity. Abbott *et al.* (2008) suggest that timber supply reductions resulting from the pine beetle outbreak will result in smaller, but more profitable and more productive, forestry and logging and wood product manufacturing subsectors in British Columbia.

Overall, it is difficult to gauge the precise impact from the changing quality of fiber resources on productivity.

v. Industrial Structure and Intersectoral Shifts

Over time, a changing technological and business environment means that the importance of the industries that make up the forest products sector rise and fall. Indeed, as was noted in the discussion of technical progress, whole new industries can emerge (e.g. biorefineries). The lack of data restricts our analysis of productivity in the forest products sector to the constituent three subsectors and to the two industry groups that make up the paper manufacturing subsector (pulp, paper, and paperboard mills and converted paper product manufacturing).

Even among the three subsectors of the forest products sector, there have been major changes over the past quarter century, as noted in section three of this report. While forestry and logging has maintained roughly the same level of real GDP, paper manufacturing has seen GDP grow very slowly compared to wood product

[21] An economic rent is the difference between the income generated from the current use of a factor of production and the minimum income that would be required to draw the factor of production into use.

manufacturing (Chart 2). Because paper manufacturing has a higher level of labour productivity than wood product manufacturing, the intersectoral shift from paper manufacturing to wood product manufacturing has slowed the overall rate of growth of labour productivity in the forest products sector.[22]

While detailed productivity estimates are not available for the industries that make up the forest products subsectors, real GDP estimates are generally available for the period 1997-2007. These estimates allow us to see how the composition of the subsectors has changed over time (Appendix Table 1a). For example, the real GDP of the structural wood product manufacturing industry has more than doubled between 1997 and 2007, whereas real output in wood product manufacturing as a whole is only up 19 per cent. Similarly, in the paper mills industry, newsprint mills have seen real output fall almost 30 per cent in the last 10 years, while non-newsprint paper mills have seen real GDP increase 26 per cent. It is unfortunate that data on hours worked is not available at the same level of detail as these data on real GDP. Statistics Canada should be encouraged to continue efforts to make available more detailed estimates of hours worked, so that important changes in industrial structure can be analyzed more thoroughly.

vi. Macroeconomic Environment

This sub-section analyses the impact of (macroeconomic) demand conditions on productivity in the forest products sector. As noted above, prolonged periods of weak demand can have negative effects on productivity in the long run.

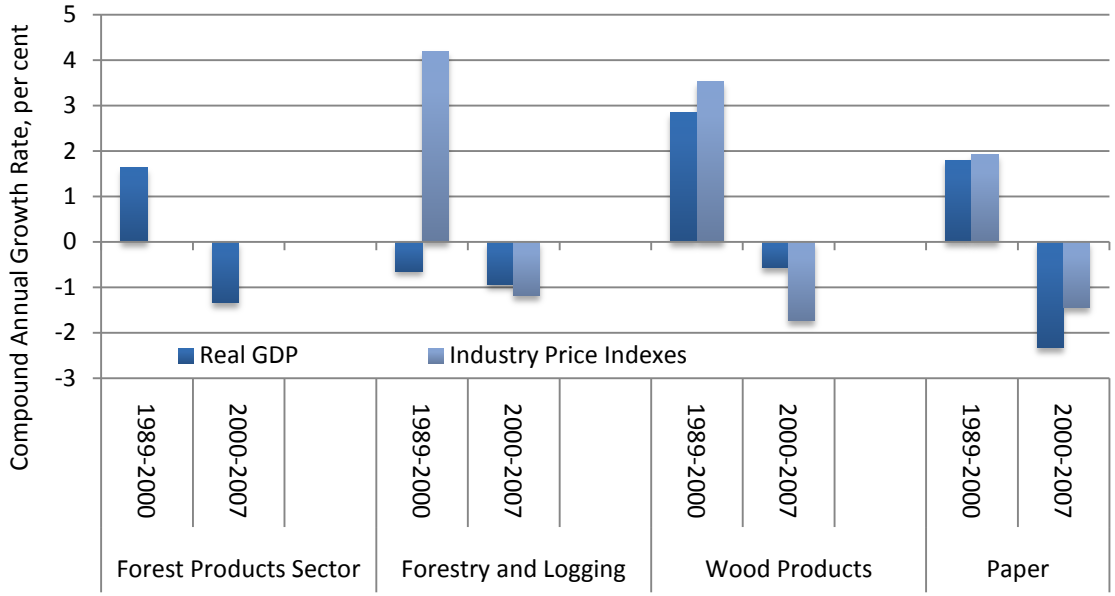
Real GDP, Prices, and Profits

Output prices influence productivity by changing the average quality of the firms in the sector and of the resources used. Price increases bring into production establishments or productive resources that are of relatively low productivity and would not have been profitable at lower prices. In contrast, falling prices force marginal establishments to close, leaving only higher productivity establishments operating, which tends to raise the average level of productivity of a subsector.

This theory offers an explanation for productivity trends in the forestry and logging subsector. Wood prices, which generally reflect the prices of the output of the forestry and logging subsector, increased quickly after the recession of the early 1990s (Chart 27). As predicted, this rapid increase in wood prices was associated with weak labour, capital, and multifactor productivity growth. When wood prices declined in the 2000-2007 period, productivity growth in forestry and logging increased. This is consistent with the conjecture that less productive firms and establishments were forced out of the subsector by lower prices. At the same time, it is puzzling to note that in spite of the rapid increase in prices on average in the 1989 to 2000 period, real output fell. This

[22] Appendix III discusses the contribution of the forest products sector to aggregate labour productivity growth, as well as the contribution of each subsectors to labour productivity growth in the sector. If we add up the effect of relative size changes in the three constituent subsectors presented in Appendix III, we find that intersectoral shifts within the forest products sector hindered labour productivity growth in the sector by 7.44 per cent between 1986 and 2004.

Chart 27: Growth of Real GDP and Output Prices, Forest Products Sector, Canada, 1989-2000 and 2000-2007



Source: Appendix Tables 1a, 2c, 2d, and 2h.

pattern suggests that other factors were at work to constrain the subsector's output, a hypothesis that will be examined in the next section in more detail.

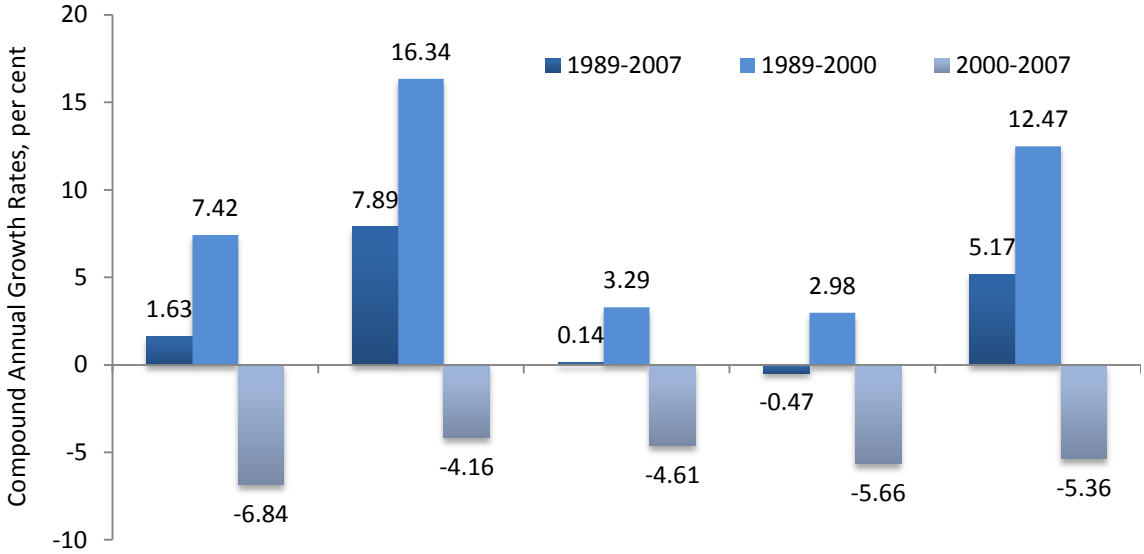
Output prices in wood product manufacturing increased significantly from 1989 to 2000, but fell after 2000. As in forestry and logging, this pattern is consistent with the story of lower productivity firms and establishments entering the subsector because they were profitable when prices were rising, but exiting the subsector when prices declined. The significant decline in hours worked in wood product manufacturing in the 2000-2007, with only small declines in capital stock and real output, suggest that relatively labour-intensive operations have been closed and that those remaining have invested in new capital to survive.

Pulp and paper prices increased in the 1990s, but have declined since 2000. However, productivity in paper manufacturing did not respond as expected. Rising prices in the 1990s were associated with increasing productivity, while falling prices in the 2000-2007 period were associated with a decline in labour productivity, but an increase in capital productivity. This pattern suggests that unlike the forestry and logging and wood product manufacturing subsectors, paper manufacturing was slower in adjusting its labour inputs to price changes. This was indeed the case; recall that total hours worked in paper manufacturing declined by just 0.40 per cent per year between 2000 and 2007, compared to annual declines of 2.02 and 3.28 per cent in wood product manufacturing and forestry and logging (Summary Table 2). This slow pace of adjustment has hurt labour productivity in paper manufacturing since 2000. The next section explores some

of the microeconomic reasons why paper manufacturing firms did not cut hours worked sufficiently to boost productivity in the 2000-2007 period, and why forestry and logging and wood product manufacturing firms did.

Exchange rates can also exert a short-run influence on productivity through their effect on output demand. During the 2000-2007 period (in particular after 2003), the Canadian dollar appreciated against the US dollar; the annual average value of the Canadian dollar rose from $0.6369 US in 2002 to $0.9350 US in 2007 (Appendix Table 28). This made Canadian products more expensive to American buyers and, by simple supply and demand logic, reduced American demand for Canadian exports. Indeed, exports from the Canadian forest products sector declined over the period in nominal terms (Chart 28).[23] This was a reversal from the 1989-2000 period, in which the Canadian dollar depreciated against the US dollar and the sector's exports increased. If firms responded to the fall in foreign demand after 2000 by reducing output faster than inputs, then productivity would decline. We would not expect a trade-driven productivity decline to be permanent – demand conditions are not a long-run driver of productivity in the same sense as technological progress, capital intensification and so on – but the effect of exchange rate changes on export demand may have contributed to some of the productivity trends in the forest products sector in recent years.

Chart 28: Growth of Nominal Exports, Forest Products, 1989-2007



Source: Appendix Table 29

[23] Since the export figures reported in Chart 28 are expressed in nominal terms, they partly reflect the output price changes illustrated in Chart 27. To some degree, Chart 28 overstates the changes in the real volume of output exported by the forest products sector over the 1989-2000 and 2000-2007 periods.

Summary Table 14: Operating Profits/Losses, Forest Products Sector, Canada, Millions of Current Dollars, 1999-2006

	Forestry, Logging and Support Activities[1]	Wood Product Manufacturing	Paper Manufacturing
2000	476	2,531	5,080
2001	437	1,460	3,777
2002	436	1,922	2,419
2003	298	1,326	1,204
2004	486	4,968	1,376
2005	446	2,533	443
2006	488	960	931
Compound Annual Growth Rate, Per Cent			
2000-2006	0.42	-14.92	-24.63

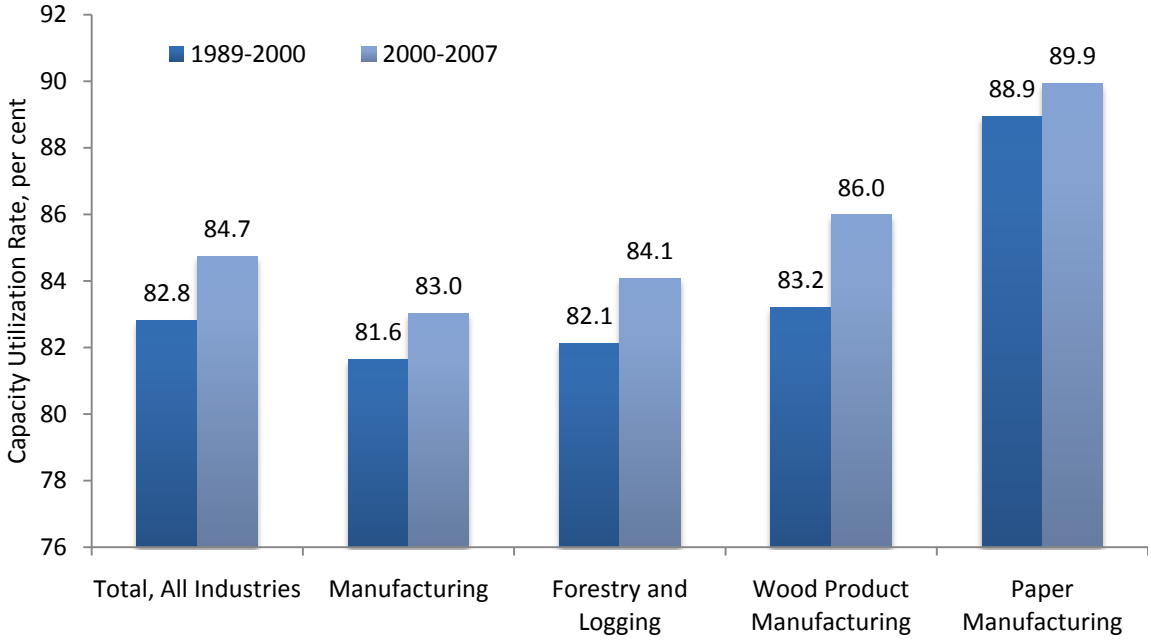
Source: Statistics Canada CANSIM Table 180-0003 and 180-0001
Notes:
1. This combines the North American Industry Classification System (NAICS) codes 113 and 1153.

Unfortunately, consistent data on profits are not available for the forest products sector or its constituent subsectors before 2000. Data are available for 2000 to 2006, and they show a precipitous decline in both wood product manufacturing and paper manufacturing profits over the period. Over the seven-year period, profits fell by 14.92 per cent per year in wood product manufacturing, and by 24.63 per cent per year in paper manufacturing (Summary Table 14). These declines are consistent with poor economic conditions for these subsectors, and may help explain why the subsectors – particularly paper manufacturing – have had difficulty maintaining their rates of capital investment (Summary Table 13). Interestingly, profits in the forestry, logging, and support activities subsector have held up well, actually increasing slightly between 2000 and 2006.

Capacity Utilization

The capacity utilization rate is the proportion of the capital stock that is used in the production process. Capacity utilization is a procyclical measure; it rises during booms and falls during recessions. Capacity utilization falls as output falls because the amount of capital does not vary in the short term. As the capacity utilization rate falls, hours worked and output fall as well. If output falls proportionally more than employment, labour productivity will fall. If, on the other hand, hours worked fall proportionally more than output as a consequence of a decline in capacity utilization, labour productivity will rise. Can capacity utilization rates help explain the productivity performance of the forest products sector over the past two decades?

Chart 29: Capacity Utilization Rate, Forest Products Sector, Canada, 1989-2000 and 2000-2007



Source: Appendix Table 21

Capacity utilization in the forest products sector was higher on average in the period 2000-2007 than in the period 1989-2000 (Chart 29). In forestry and logging and wood product manufacturing, higher capacity utilization in the later period is consistent with faster growth of multifactor and labour productivity, and with a higher rate of growth of capital productivity in forestry and logging. In paper manufacturing high rates of capacity utilization could offer an explanation for strong capital productivity growth in the subsector. In spite of significant reductions in the real capital stock, the subsector has been able to use the remaining stock more intensively. At the same time, high capacity utilization cannot explain either the decline in labour productivity growth or the slowdown in multifactor productivity growth observed in paper manufacturing after 2000.

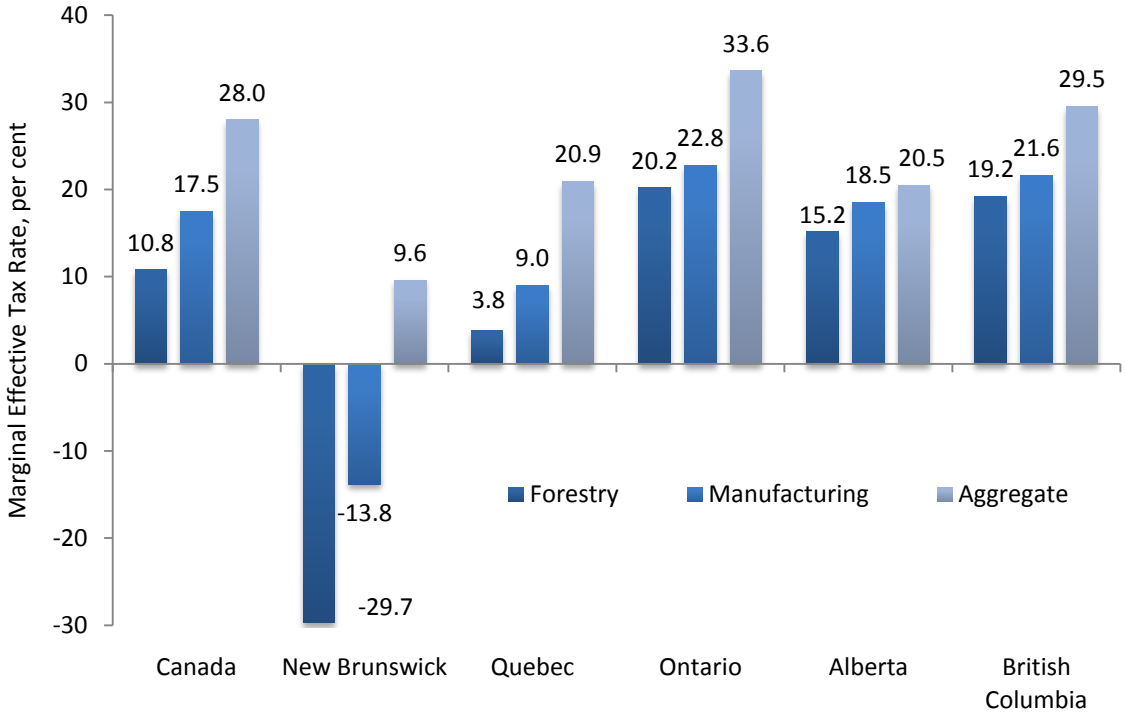
vii. Microeconomic Environment

This subsection explores how microeconomic factors that influence behaviour at the firm level have affected productivity in the forest products sector. We examine tax policy and other regulations.

Taxation

Taxation can influence productivity through investment decisions, which affect capital intensity. Firms make investments to maximize profit by investing until the return from the last dollar invested equals the cost. Taxes on firms' profits reduce the return on

Chart 30: Marginal Effective Tax Rate on Capital Investment, Canada, 2009



Source: Mintz and Chen (2009).
Note: Manufacturing METR is the average METR for all of the manufacturing sector. While this includes wood product and paper manufacturing, the illustrated tax rates are not necessarily the rates that actually apply to these two forest products subsectors.

investment, while tax allowances, like the allowance for capital consumption, reduce marginal cost.

The marginal effective tax rate (METR) is the most common measure of the total impact that taxes and allowances have on the return to marginal investments. The theoretical METR on investment is the pre-tax return minus the post-tax return, divided by the pre-tax return and expressed as a percentage. All else being equal, a firm should invest in jurisdictions and assets with low METRs. Taxes on capital lower the return that investors receive from capital investment, and in this way, taxes can reduce investment and result in lower capital intensity. As discussed above, lower capital intensity leads to lower labour productivity.

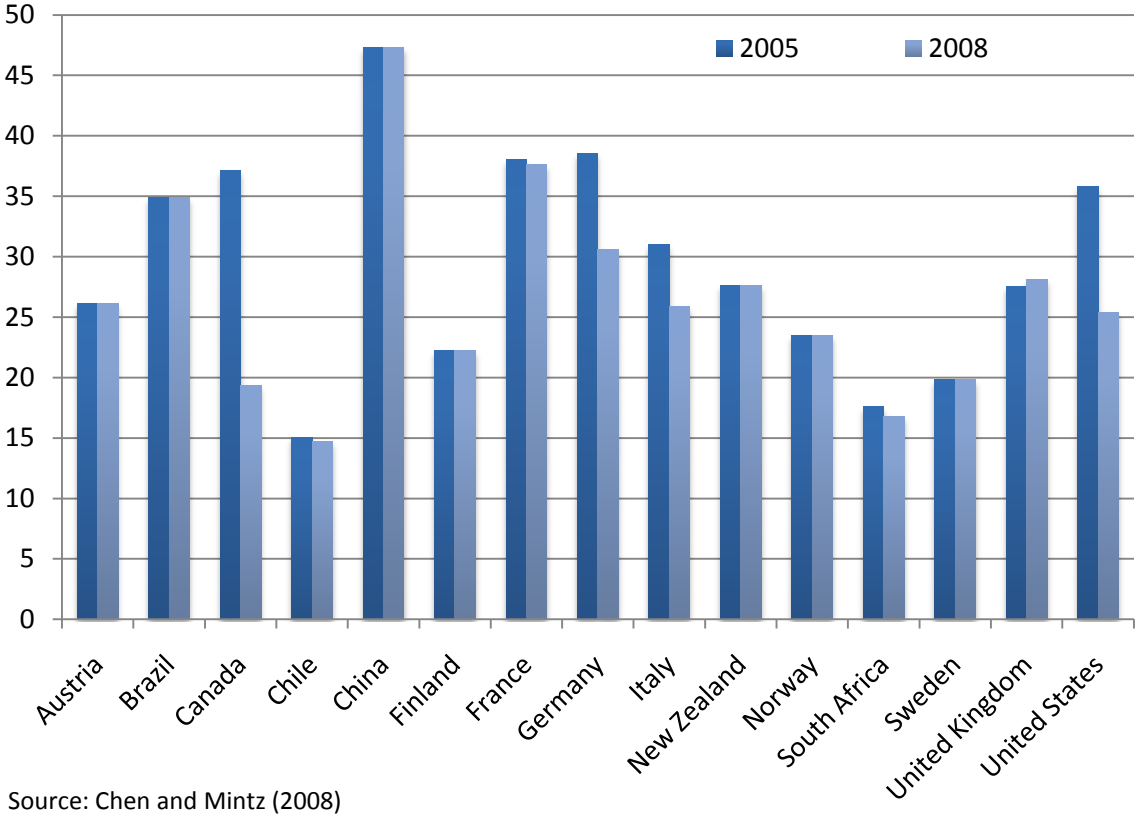
Chart 30 presents METR estimates for forestry, manufacturing and the aggregate economy for 2009.[24] These estimates represent the total annualized value of corporate

[24] On the basis of planned tax policy changes to be implemented by governments in the coming years, Mintz and Chen (2009) provide estimates of the METR on capital investment in 2013. These forecasts are important because firms make investments today that will not produce a return until 2013 or beyond. According to the projections, METRs will generally decline, but not in every province and subsector. The aggregate METR is expected to decline in all five of the major forest products-producing provinces and in Canada as a whole. In forestry, the METR is expected to fall in

and capital taxes and the sales tax paid on capital purchases, expressed as a proportion of the gross rate of return on capital (Mintz and Chen, 2009). In all provinces, forestry faces very low METRs on capital investment. New Brunswick and Quebec stand out with METRs on capital investment in the forestry subsector of -29.7 per cent and 3.8 per cent respectively. Ontario imposes the highest METR on forestry, 20.2 per cent, while rates in Alberta (15.2 per cent) and British Columbia (19.2 per cent) are somewhat lower.

In manufacturing, which includes wood product and paper manufacturing, METRs on capital investment are generally higher than in forestry. Of the major forest products producing provinces, New Brunswick has the lowest METR in the manufacturing sector (-13.8 per cent). Quebec also has a low METR for manufacturing (9.0 per cent), while Ontario again has the highest taxes (22.8 per cent). British Columbia has a slightly lower METR than Ontario (21.6 per cent), and Alberta is not far behind that (18.5 per cent). The current tax situation is advantageous for forest products companies in New Brunswick and Quebec.

Chart 31: Marginal Effective Tax Rates on Capital, Manufacturing, Selected OECD Countries, per cent, 2005-2008



Source: Chen and Mintz (2008)

New Brunswick, Ontario, and British Columbia, but it will rise to 7.0 per cent in Quebec and to 17.3 per cent in Alberta. Similarly, the METR on investment in manufacturing is expected to decline in New Brunswick, Ontario, and British Columbia while rising to 10.7 per cent in Quebec and to 19.1 per cent in Alberta.

Even if METRs on capital have been falling in Canada, the global nature of investment decisions means that Canada's METRs should be judged in comparison to the METRs of other countries. Chart 31 makes such a comparison for the manufacturing sector in 2005 and 2008. Canada has cut METRs on capital investment significantly since 2005. Even Sweden and Finland, both countries with large forest products sectors, now have higher METRs on manufacturing capital than Canada. All else being equal, this situation suggests that forest products manufacturers should favour Canada as a location to invest (under to the assumption that METRs in the forest products sector reflect those in the manufacturing sector as a whole). This tax advantage is relatively recent and it will take some years for firms to adjust. But slowly higher investment should lead to higher productivity, since workers will have more and better capital at their disposal.

While Canadian taxes policies may have been an impediment to productivity growth in the forest products sector in the past, our analysis suggests that this is no longer the case. METRs on capital in the forest products sector in Canada are low in comparison with other sectors and have been falling over the past 10 years. Internationally, Canada has recently gained an advantage with very low METRs. Defending this advantage will be challenging, as other countries will seek to lower their rates as well. In order to see a sustained positive impact on productivity, Canada will have to keep METRs low.

Regulation

Government regulation can have both positive and negative effects on productivity growth. For example, government regulations that restrict certain types of logging practices for safety or environmental reasons, or that require stringent controls on air and water emissions from paper plants, can increase operating and capital costs and thereby reduce labour, capital, and multifactor productivity. Alternatively, government regulations can force firms to take actions they would not normally take. These actions may have unexpected positive consequence for productivity and competitiveness, particularly if other countries eventually adopt the same regulations, giving the early adopters an advantage. Of course, the evaluation of the effectiveness of government regulation must go beyond the impact of the regulations on productivity, and must also factor in the societal benefits of less pollution and other non-economic benefits.

Regulation plays an important role in Canada because around 95 per cent of forest land is publicly owned, mostly by provincial governments (Rheaume and Roberts, 2007: 21). FPAC (2005) identifies three key areas of concern with respect to government regulation in the forest products sector. First, the *Competition Act* may unnecessarily obstruct consolidation within the sector. The main argument in favour of consolidation from a competition policy perspective is that forest products prices are set in global markets and there are few barriers to entry in the sector. These characteristics make it unlikely that large Canadian forest products firms could adversely affect consumers through the anticompetitive exercise of market power. Excessively stringent competition policy could harm productivity growth in the sector if there are significant economies of scale to be exploited. The issue of scale is explored in the next subsection of this report.

The second key area of concern is overlapping regulation from different levels of government. Each province regulates harvesting levels and practices in forestry, but the federal government oversees the *Competition Act*. As such, there is frequent jurisdictional overlap during merger reviews. FPAC suggests that the federal and provincial governments should better coordinate their regulatory actions.

The final key area of concern is that governments' forest management policies often make resource access contingent upon the maintenance of specific production facilities. Presumably, the purpose of such policies is to prevent job losses among workers in the forest products sector. Such policies encourage the maintenance of inefficient productive capacity. This point is especially interesting in light of the findings of this report with respect to productivity in the paper manufacturing subsector. Government policies that result in the operation of inefficient capacity would be consistent with the fact that the subsector has not been able to cut hours worked as quickly as it cut capital stock and real output. This could have contributed to the subsector's labour productivity collapse since 2000.

viii. Other Factors

In this subsection, we explore two additional factors that may influence the productivity performance of the forest products sector and its constituent subsectors: economies of scale and foreign direct investment.

Economies of Scale

One potential cause of the lagging productivity of the Canadian forest products sector is the lack of large companies and large establishments. Large plants can offer economies of scale in the use of resources, leading to higher productivity. Not only is plant size a potential productivity driver, firm size can be as well. FPAC (2005:11-12) notes that credit ratings from Moody's and S&P demonstrate that larger firms, with higher capitalization, have better credit ratings. According to the Forest Products Industry Competitiveness Task Force (2007), significant advantages enjoyed by large firms in the forest products sector include a lower cost of capital, greater scale economies in production and marketing, and more efficient risk management of innovation and major capital projects. Similarly, FPAC (2005:11) argues that consolidation in the sector could offer "critical competitive advantages" such as increased efficiency; asset, product, or geographic diversification; and lower capital costs. The report also notes that diversification is desirable as it reduces cash flow volatility and improves market access. Large firms are also able to attract more capital for innovative investments.

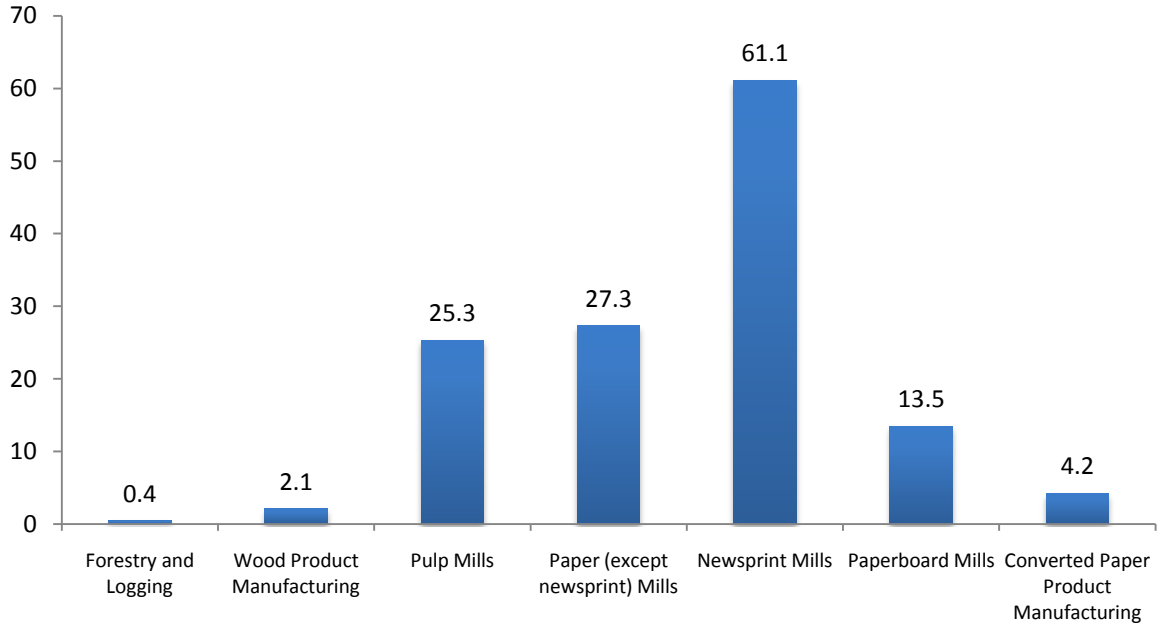
The Canadian forest products sector is not exploiting the advantages of scale. By global standards, Canadian forest products firms are generally small. Prior to 2007, there was no Canadian forest products company among the top 20 forest products companies in the world (Forest Products Industry Competitiveness Task Force, 2007:5). With sales of $6.0 billion[25] in 2007, Domtar moved into 15th place from 26th place in 2006

[25] All dollar figures in this paragraph are in current US dollars.

(PricewaterhouseCoopers, 2008; see also Appendix Table 23). Other major Canadian firms were well behind. AbitibiBowater ranked 23rd with sales of $3.9 billion, and Cascades was in 24th place with sales of $3.7 billion. Other Canadian firms in the top 100 were West Fraser Timber, Canfor, Tembec, Catalyst, Norbord (Nexfor), Mercer International, Western Forest Products, Fraser Papers, Interfor, and Ainsworth. Even Canada's largest firms were small relative to the global giants International Paper (USA, sales of $21.9 billion), Stora Enso (Finland, $18.3 billion), Kimberly-Clark (USA, $18.3 billion), and Svenska Cellulosa (Sweden, $15.7 billion). International Paper alone had sales in 2007 that were larger than the top five Canadian forest products companies combined. If economies of scale at the firm level can increase productivity, Canadian firms are at a significant disadvantage.

Plant size is also important, and like Canadian firms, Canadian plants tend to be small by international standards. Pulp mills in Canada are on average considerably smaller than many state-of-the-art mills that are now operating abroad. In 2003, the average capacity of Canadian pulp mills was 204,000 tonnes per mill, whereas in 2005 a 900,000-tonne pulp mill commenced operation in Brazil (Rheaume and Roberts, 2007:20). In 2005, Canada had 72 market pulp and newsprint mills producing 10.8 million tonnes of market pulp and 7.8 million tonnes of newsprint. Rheaume and Roberts (2007:21) point out that if Canada had the type of million-tonne super mill that had recently opened in Japan (the Canadian average among 72 mills was 285,000 tonnes), Canada would only require 10 pulp and seven newsprints mills to achieve the same level of production.

Chart 32: Real Value Added per Establishment, Forest Products Sector, Canada, Millions of Constant 2002 Dollars per Establishment, 2006



Source: Appendix Table 25f

Statistics Canada's Annual Survey of Manufacturers and Logging provides data on the number of establishments by industry. These data, combined with the data on real value-added by industry that we presented in part three of this report, allow us to assess how the average real value-added per establishment in the forest products sector has changed over time. Unfortunately, changes in survey methodology and coverage do not allow for direct comparisons of the series between 1999 and 2000 and between 2003 and 2004 (Appendix Table 25f). As a result, the data must be interpreted with caution, and we only draw general conclusions.

In forestry and logging the average establishment is very small. In 2006, it had real value-added (GDP) of $430,000[26] and 3.5 employees (Chart 32). This average undoubtedly masks a significant number of much larger establishments, but nonetheless, it suggests that the typical forestry and logging establishment in Canada is very small. Data from the Survey of Employment Payroll and Hours show that there were at most 21 establishments with more than 500 employees in 2007 (Appendix Table 26).

In wood product manufacturing, there has been a trend toward higher real output per establishment since 1990. In 2006, the average wood product manufacturing establishment had value-added of $2.1 million and 20.6 employees.

In paper manufacturing, pulp mills show a trend towards higher real output per establishment since 1997, whereas paper and paperboard mills do not. Converted paper product manufacturing also shows a trend toward higher real output per establishment since 1990. The largest average establishment size was in the newsprint mills ($61.1 million). Non-newsprint paper mills averaged $27.3 million. Pulp mills averaged $25.3 million of value-added, paperboard mills $13.5 million, and converted paper product manufacturing establishments averaged value added of $4.2 million.

Foreign Direct Investment

Foreign direct investment (FDI) occurs when a foreign resident gains substantial control over the management of an enterprise residing in Canada, either through the acquisition of an existing Canadian enterprise or the establishment of a new one.[27] FDI can improve productivity if foreign firms are more likely than domestic firms to modernize production facilities and import new and better machinery and production methods. Statistics Canada publishes an aggregate FDI series that combines the wood product and paper manufacturing subsectors.

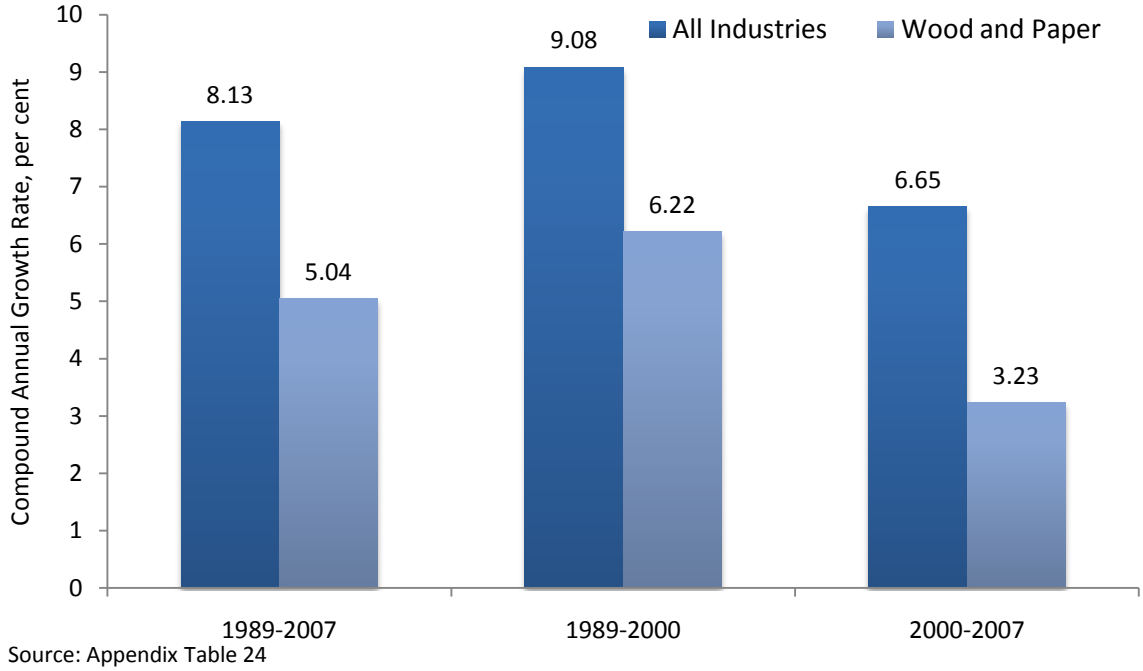
There was a slowdown in foreign direct investment in the wood products and paper manufacturing subsectors after 2000 (Chart 33 and Chart 34). The low point was reached in 2004, after which FDI increased until 2007. Before 2000, the aggregate FDI in wood product and paper manufacturing increased steadily from the early 1980s. Indeed,

[26] All figures of value added by establishment are in constant 2002 Canadian dollars.
[27] When a foreigner owns less than a controlling interest in a Canadian firm, the investment is referred to as portfolio investment.

Chart 33: Nominal Stock of Foreign Direct Investment, Wood Products and paper Manufacturing, Canada, Millions of Current Dollars, 1983-2007

Source: Appendix Table 24

Chart 34: Growth of Nominal Stock of Foreign Direct Investment, Wood Products and Paper Manufacturing, Canada, Current Dollars, 1989-2007



Source: Appendix Table 24

FDI fell in absolute terms for the first time in 2000. It is possible that the reduction in FDI could account for some of the slowdown in productivity growth in paper manufacturing.

ix. Key Findings

Summary Tables 15, 16, and 17 (beginning on the next page) summarize the key findings of this part of the report for each of the three subsectors of the forest products sector.

Summary Table 15: Factors Driving Productivity in Canadian Forestry and Logging Since 2000

Factor	Evidence	Conclusion
1. Rate of Technical Progress	- R&D intensity: 0.32 per cent of GDP over 2000-2004 (well below economy-wide average) - No increase in R&D after 2000 relative to 1990s - In 2006, Canadian forestry engineering ranked first in the world in publication intensity and was well above average in publication quality	Since R&D activity did not pick up after 2000, it is unlikely that R&D spending can explain the forestry and logging subsector's good post-2000 productivity performance -- particularly its increased growth rates in labour and multifactor productivity. Canadian forestry R&D was of high quality by international standards in 2006, but we do not know whether or not R&D quality has increased over time in the subsector.
2. Investment in Physical Capital	- Capital intensity growth: 1.55 per cent per year over 2000-2007 (well above economy-wide average) - This was an increase over the 1990s growth rate (0.26 per cent per year, 1989-2000) - Net capital investment: -0.12 per cent of GDP over 2000-2007 (below economy-wide average)	Rising capital intensity may explain the strong labour productivity growth in forestry and logging after 2000. Capital intensity grew not because of new investment (net investment was negative), but because labour hours declined substantially faster than the capital stock. This is not a sustainable source of productivity growth in the long run.
3. Quality of the Workforce	- Workforce quality growth: 0.07 per cent per year over 2000-2004 (below economy-wide average)	The quality of the workforce barely grew after 2000, so it is unlikely that labour quality (skills, experience, etc.) can explain the subsector's good post-2000 multifactor productivity growth.
4. Size and Quality of the Natural Resource Base	- Environmental changes leading to more forest fires, spread of pests (mountain pine beetle, etc.) - Depletion of highest-quality resources should inhibit productivity growth	Adapting to environmental challenges is costly in the short term and should hinder productivity growth. The long-run effects are difficult to predict. More data are required to study environmental changes, the sustainability of logging operations, and so on, as they pertain to productivity.
5. Industrial Structure and Intersectoral Shifts	- Share of forestry and logging in total output of forest products sector was stable over 2000-2007	Since forestry and logging did not grow relative to the total forest products sector, its relative importance as a determinant of productivity growth in forest products was essentially unchanged between 2000 and 2007.

6. Macroeconomic Environment	- Both real output and output prices declined by about one per cent per year over 2000-2007 - Nominal lumber exports fell 6.84 per cent per year, 2000-2007 - Capacity utilization: 84.1 per cent over 2000-2007; up from 82.1 per cent over 1989-2000	In response to reduced demand and falling prices, the subsector reduced real output. This was associated with strong productivity growth and higher capacity utilization because firms cut inputs faster than they reduced output.
7. Microeconomic Environment	- 2009 Marginal effective tax rate (METR) in Canada: low in forestry relative to manufacturing and the total economy - METR varies significantly across provinces; particularly low in New Brunswick and Quebec - Regulatory concerns: regulatory overlap, excessive resistance to consolidation	Taxes in forestry and logging are low relative to those in other sectors of the Canadian economy and seem unlikely to be a significant impediment to investment in the subsector. Wherever possible, regulatory processes should be streamlined to prevent overlap between different levels of government.
8. Other Factors	- Average establishment size: 3.5 employees and $430,000 value-added in 2006 (very small relative to other subsectors) - Only one Canadian forest products firm in world top twenty in terms of sales in 2007	Evidence suggests that larger firms could achieve productivity improvements through economies of scale. Canadian forestry and logging has not been able to exploit this potential; the average establishment is very small. However, this has not prevented the subsector's productivity from growing over 2000-2007.

Summary Table 16: Factors Driving Productivity in Canadian Wood Product Manufacturing Since 2000

Factor	Evidence	Conclusion
1. Rate of Technical Progress	- R&D intensity: 0.47 per cent of GDP over 2000-2004 (well below average of 4.61 per cent for total manufacturing sector) - Post-2000 R&D intensity was slightly up from 0.38 per cent of GDP over 1994-2000	The slight increase in R&D spending after 2000 is at odds with the wood products manufacturing subsector's decline in capital and multifactor productivity growth, although it is consistent with the stability of the subsector's labour productivity growth.
2. Investment in Physical Capital	- Capital intensity growth: 1.80 per cent per year over 2000-2007 (well above economy-wide and manufacturing sector averages) - This was an increase over the 1990s growth rate (0.50 per cent per year, 1989-2000) - Net M&E investment: 0.64 per cent of GDP over 2000-2007 (below economy-wide average, but above manufacturing sector average)	Strong growth in capital intensity after 2000 offset a slowdown in the growth of multifactor productivity, leaving labour productivity growth in wood product manufacturing essentially unchanged from its 1989-2000 rate. The subsector's positive net M&E investment kept its overall capital stock from falling as fast as output; this led to the decline in capital productivity in wood products manufacturing over 2000-2007.
3. Quality of the Workforce	- Workforce quality growth: 0.17 per cent per year over 2000-2004 (below economy-wide and manufacturing sector averages)	The quality of the workforce barely grew after 2000. This may help explain the subsector's post-2000 slowdown in multifactor productivity growth.
4. Size and Quality of the Natural Resource Base	- Environmental changes leading to more forest fires, spread of pests (mountain pine beetle, etc.) - Depletion of highest-quality resources should inhibit productivity growth	Environmental challenges and resource depletion may affect the wood product manufacturing subsector's access to its main intermediate input, wood. Adapting to environmental challenges is costly in the short term and should hinder productivity growth. The long-run effects are difficult to predict.

5. Industrial Structure and Intersectoral Shifts	- Wood product manufacturing as share of total output of forest products sector increased from 39.9 per cent in 2000 to 42.6 per cent in 2006; fell to 41.5 per cent in 2007 - Wood product manufacturing surpassed paper manufacturing in 2002 to become the largest subsector in the forest products sector in terms of output	The level of labour productivity was always lower in wood product manufacturing than in paper manufacturing over 2000-2007, so the rise of wood products and the decline of paper manufacturing hindered labour productivity growth in the forest products sector as a whole. This may change in the future, since labour productivity grew much faster in wood products than in paper manufacturing over the period.
6. Macroeconomic Environment	- Real output and output prices declined by 2.32 and 1.44 per cent per year over 2000-2007 - Nominal exports of wood fabricated materials fell 4.16 per cent per year, 2000-2007 - Capacity utilization: 86.0 per cent over 2000-2007; up from 83.2 per cent over 1989-2000	In response to reduced demand and falling prices, the subsector reduced real output. This was associated with strong labour productivity growth as firms cut hours worked faster than they reduced output. The increase in capacity utilization is puzzling, since the subsector did not reduce its capital stock as quickly as its real output over 2000-2007.
7. Microeconomic Environment	- 2009 Marginal effective tax rate (METR) in Canada: low in manufacturing relative to the total economy, but high relative to forestry - METR varies significantly across provinces; particularly low in New Brunswick and Quebec - METRs in Canadian manufacturing are low by international standards	METR data exist for the manufacturing sector as a whole, but not for the wood product manufacturing subsector in particular. To the extent that the existing data reflect taxation in the subsector, tax rates appear low relative to the total-economy average. METRs have declined in recent years and Canada has gained an advantage over its international competitors
8. Other Factors	- Average establishment size: 20.6 employees and $2.1 million value-added in 2006; small relative to paper subsector, but trending upward since 1990 - Only one Canadian forest products firm in world top twenty in terms of sales in 2007	Evidence suggests that larger firms could achieve productivity improvements through economies of scale. Canadian wood product manufacturing has not been able to exploit this potential; the average establishment is small. However, this has not prevented the subsector's productivity from growing over 2000-2007.

Summary Table 17: Factors Driving Productivity in Canadian Paper Manufacturing Since 2000

Factor	Evidence	Conclusion
1. Rate of Technical Progress	- R&D intensity: 3.14 per cent of GDP over 2000-2004 (below average of 4.61 per cent for total manufacturing sector) - Post-2000 R&D intensity was a significant increase from 1.17 per cent of GDP over 1994-2000 - Over 2000-2004, R&D spending paper manufacturing was significantly higher in Canada than in any other country for which data are available	The significant increase in R&D spending after 2000 is at odds with the paper manufacturing subsector's labour productivity growth collapse, as well as its slowdown in multifactor productivity growth. It is also puzzling that in spite ofvery high R&D spending by international standards, the Canadian paper subsector had the worst post-2000 labour productivity performance of any country analyzed in our report.
2. Investment in Physical Capital	- Capital intensity growth: -5.91 per cent per year over 2000-2007 (very far below economy-wide and manufacturing sector averages) - This was an decrease from the 1990s growth rate (-0.51 per cent per year, 1989-2000) - Net M&E investment: -6.32 per cent of GDP over 2000-2007 (very far below economy-wide and manufacturing sector averages)	The dramatic decline of capital intensity in Canadian paper manufacturing, coupled with the slowdown in multifactor productivity, helps explain why labour productivity collapsed in the subsector after 2000. Capital intensity fell because labour hours were not cut as fast as capital stock; capital stock declined by 6.29 per cent per year over 2000-2007, while hours worked fell by only 0.40 per cent per year.
3. Quality of the Workforce	- Workforce quality growth: 0.61 per cent per year over 2000-2004 (above economy-wide average and on par with manufacturing sector average)	The quality of the workforce continued to improve after 2000. This is at odds with the subsector's post-2000 slowdown in multifactor productivity growth.
4. Size and Quality of the Natural Resource Base	- Canada's slow-growing forests reduce viability of large-scale super mills - Environmental changes leading to more forest fires, spread of pests (mountain pine beetle, etc.)	If Canada's slow-growing forests require long-distance hauling of logs and reduce the viability of large-scale super mills, then Canadian paper firms are unable to improve productivity through economies of scale (see below). However, it is unclear that such concerns could explain the subsector's labour productivity collapse since 2000.

5. Industrial Structure and Intersectoral Shifts	- Paper manufacturing as share of total output of forest products sector increased from 41.2 per cent in 2000 to 38.4 per cent in 2007 - Wood product manufacturing surpassed paper manufacturing in 2002 to become the largest subsector in the forest products sector in terms of output	The level of labour productivity was always lower in wood product manufacturing than in paper manufacturing over 2000-2007, so the rise of wood products and the decline of paper manufacturing hindered labour productivity growth in the forest products sector as a whole. This may change in the future, since labour productivity grew much faster in wood products than in paper manufacturing over the period.
6. Macroeconomic Environment	- Real output and output prices declined by 2.32 and 1.44 per cent per year over 2000-2007 - Operating profits fell by 24.63 per cent per year over 2000-2006 - Capacity utilization: 89.9 per cent over 2000-2007; up from 88.9 per cent over 1989-2000	In response to reduced demand and falling prices, the subsector reduced real output. With loss profit available for reinvestment, the capital stock fell precipitously. The rise in capacity utilization reflects decreasing capacity. The fast reduction of the capital stock explains the subsector's strong capital productivity growth over the 2000-2007 period.
7. Microeconomic Environment	- 2009 Marginal effective tax rate (METR) in Canada: low in manufacturing relative to the total economy, but high relative to forestry - METR varies significantly across provinces; particularly low in New Brunswick and Quebec - METRs in Canadian manufacturing are low by international standards	METR data exist for the manufacturing sector as a whole, but not for the paper manufacturing subsector in particular. To the extent that the existing data reflect taxation in the subsector, tax rates appear low relative to the total-economy average. METRs have declined in recent years and Canada has gained an advantage over its international competitors
8. Other Factors	- Canadian establishments small by international standards - Average capacity of Canadian pulp mills in 2003: 204,000 tonnes per mill; compare with 900,000-tonne Brazilian and Japanese super mills - Growth of FDI in wood and paper subsectors: 3.23 per cent per year over 2000-2007, down from 6.22 per cent per year over 1989-2000	Evidence suggests that larger firms could achieve productivity improvements through economies of scale. Canadian paper manufacturing has not been able to exploit this potential, while some international competitors have. This is likely to be a contributing factor in the subsector's decline in Canada.

VI. Conclusion

The productivity performance of the forest products sector in Canada has been decidedly mixed since 2000. Each subsector – forestry and logging, wood product manufacturing, and paper manufacturing – had a somewhat different productivity performance over this period, and different productivity measures exhibited different patterns. In terms of labour productivity, the forest products sector underperformed relative to the total economy. This was entirely attributable to the collapse of labour productivity in paper manufacturing; the other two subsectors achieved above-average labour productivity growth. The forest products sector had significantly above-average capital productivity over the 2000-2007 period as capital stocks declined faster than output. Multifactor productivity growth in forest products was also above the total-economy average over the period.

Forestry and Logging

The forestry and logging subsector saw strong productivity growth between 2000 and 2007. In all three measures of productivity growth – labour, capital, and multifactor – the forestry and logging subsector outperformed the total economy. This was the result of declining real GDP coupled with reductions in hours worked and real capital stock. Capital intensity grew as labour hours fell faster than the capital stock; this, along with strong multifactor productivity growth, led to the subsector's strong labour productivity performance. At the same time, capital productivity increased as the capital stock declined faster than output.

Forestry and logging faces challenges. Cutting inputs faster than output falls is not a sustainable long-run source of productivity growth. Although the subsector's R&D is of high quality, R&D spending by forestry and logging firms is far below the total-economy average and has not been increasing in recent years. The subsector's relatively low capital depreciation rate, combined with its negative net investment since 2000, suggests that the sector is using a lot of old capital equipment that does not embody the latest technological innovations. Finally, forestry and logging has had to deal with significant environmental changes, in part as a result of climate change. In the short run, the costs of these changes will likely reduce productivity growth.

Wood Product Manufacturing

The wood products manufacturing subsector is important because it has accounted for the largest share of output in the forest products sector since 2002. Wood product manufacturing saw above average labour productivity growth between 2000 and 2007. This was driven by strong growth in capital intensity, which itself was a result of labour hours falling more quickly than the capital stock as in the forestry and logging subsector. Unlike forestry and logging, however, the wood products manufacturing subsector also experienced a slowdown in multifactor productivity growth. Capital productivity in

wood products manufacturing decreased over the 2000-2007 period as output fell slightly faster than the capital stock.

Paper Manufacturing

Paper manufacturing presents the most interesting and puzzling trends. The subsector enjoyed robust growth in labour, capital, and multifactor productivity between 1989 and 2000, but after 2000 multifactor productivity growth slowed and labour productivity growth turned sharply negative. On one level, the reason for this pattern is straightforward. From 1989 to 2000, paper manufacturing responded to higher prices by increasing real output. At the same time, the subsector was able to reduce capital stock and hours worked. The result was a significant improvement in productivity. After 2000, prices and output fell. Paper manufacturing cut back capital stock even more aggressively than in the 1990s and maintained the pace of capital productivity growth. For some reason, however, the subsector was unwilling or unable to cut back as aggressively on hours worked. As a result capital intensity, and therefore, labour productivity, declined. Why did paper manufactures not reduce hours worked when they cut output? One potential explanation may lie in government policies that encourage firms to maintain inefficient capacity so as to maintain workers' jobs.

Where to Now?

The Canadian forest products sector currently faces great challenges but also great opportunities. In recent years productivity growth has varied significantly across the subsectors that constitute the forest products sector. It has generally been strong in forestry and logging and wood product manufacturing, but much of the productivity improvement has come from cuts in inputs (labour and capital) that have exceeded cuts in real output. Clearly, this pattern can only be sustained temporarily since there will eventually be no more labour or capital to cut. Meanwhile, the paper manufacturing industry is undergoing a more serious productivity crisis.

Investment in research and development, education and training, and new machinery and equipment is key to improving productivity in the long run. And improving productivity is the only sustainable way to ensure the long-term viability of the sector. At the same time, investment in Canada's forest products sector will only occur if the likely return is higher than elsewhere in the world economy. The federal and provincial governments must assist the sector in adjusting to the changing global environment while softening the adverse affects of such adjustment on communities and individuals.

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Appendix I: Definition and Description of the Forest Products Sector

This appendix defines the forest products sector, as the term is used in this report. This definition is based on the North American Industry Classification (NAICS) 2002. For statistical purposes, NAICS classifies all establishments into two-digit sector, such as agriculture, forestry, fishing, and hunting (NAICS code 11) or manufacturing (NAICS codes 31 through 33). Two-digit sectors are further subdivided into three-digit subsectors, such as forestry and logging (113) and wood product manufacturing (321). These three-digit subsectors are then divided into four digit industry groups and five-digit industries.

As noted in section I, this report defines the forest products sector to include three, three-digit, subsectors: forestry and logging (113), wood product manufacturing (321), and paper product manufacturing (322). The remainder of this appendix is a detailed description of the three-, four-, five-, and six-digit industries that make up the forest products sector. This description is drawn from Statistics Canada (2007) and can be accessed at http://www.statcan.ca/english/Subjects/Standard/naics/2002/naics02-menu.htm. The principal exclusions from the forest products sector as defined in this report are the support activities for forestry industry group (1153) and forest product trucking, both local (484223) and long distance (484233). As noted in section I, these industries were excluded due to data limitations. These excluded industries are described in this appendix following the descriptions of the industries that are included in the forest products sector as defined in this report.

The superscript at the end of NAICS titles indicates comparability:

CAN Canadian industry only,
US Canadian and United States industries are comparable,
MEX Canadian and Mexican industries are comparable,
[blank] Canadian, Mexican and United States industries are comparable.

113 Forestry and Logging

This subsector comprises establishments primarily engaged in growing and harvesting timber on a long production cycle (of ten years or more). Long production cycles use different production processes than short production cycles, which require more horticultural interventions prior to harvest, resulting in processes more similar to those found in the Crop Production subsector. Consequently, Christmas tree production and other production involving production cycles of less than ten years, are classified to the Crop Production subsector.

Industries in this subsector specialize in different stages of the production cycle. Reforestation requires production of seedlings in specialized nurseries. Timber production requires natural forests or suitable areas of land that are available for a long

duration. The maturation time for timber depends upon the species of tree, the climatic conditions of the region, and the intended purpose of the timber. The harvesting of timber, except when done on an extremely small scale, requires specialized machinery unique to the industry. The gathering of forest products, such as gums, barks, balsam needles and Spanish moss, are also included in this subsector.

1131 Timber Tract Operations

This industry group comprises establishments primarily engaged in the operation of timber tracts, for the purpose of selling standing timber.

11311 Timber Tract Operations

This industry comprises establishments primarily engaged in the operation of timber tracts, for the purpose of selling standing timber.

Exclusion(s): Establishments primarily engaged in:
- growing short rotation woody crops, such as Christmas trees and cottonwood for pulpwood, where the typical life cycle for growing and harvesting is ten years or less (11142, Nursery and Floriculture Production)
- cutting timber (11331, Logging)
- holding timbered property as real property and not for the sale of timber (53119, Lessors of Other Real Estate Property)

113110 Timber Tract Operations

This Canadian industry comprises establishments primarily engaged in the operation of timber tracts, for the purpose of selling standing timber.

1132 Forest Nurseries and Gathering of Forest Products

This industry group comprises establishments with two different production processes, those primarily engaged in growing trees for the purpose of reforestation, and those primarily engaged in gathering forest products.

11321 Forest Nurseries and Gathering of Forest Products

This industry comprises establishments with two different production processes, those primarily engaged in growing trees for the purpose of reforestation, and those primarily engaged in gathering forest products.

Exclusion(s): Establishments primarily engaged in:
- gathering maple sap (11199, All Other Crop Farming)

113210 Forest Nurseries and Gathering of Forest Products [US]

This Canadian industry comprises establishments with two different production processes, those primarily engaged in growing trees for the purpose of reforestation, and those primarily engaged in gathering forest products.

1133 Logging

This industry group comprises establishments primarily engaged in cutting timber, producing rough, round, hewn, or riven primary wood, and producing wood chips in the forest. Establishments primarily engaged in cutting and transporting timber are also included in this industry.

11331 Logging

This industry comprises establishments primarily engaged in cutting timber, producing rough, round, hewn, or riven primary wood, and producing wood chips in the forest. Establishments primarily engaged in cutting and transporting timber are also included in this industry.

Exclusion(s): Establishments primarily engaged in:
- trucking timber (48422, Specialized Freight (except Used Goods) Trucking, Local)
- trucking timber (484233, Forest Products Trucking, Long Distance)

113311 Logging (except Contract) [CAN]

This Canadian industry comprises establishments primarily engaged in cutting timber, producing rough, round, hewn, or riven primary wood, and producing wood chips in the forest, on an own-account basis. Establishments primarily engaged in cutting and transporting timber are also included.

Exclusion(s): Establishments primarily engaged in:
- trucking timber (484223, Forest Products Trucking, Local)
- trucking timber (484233, Forest Products Trucking, Long Distance)

113312 Contract Logging [CAN]

This Canadian industry comprises establishments primarily engaged in cutting timber, producing rough, round, hewn, or riven primary wood, and producing wood chips in the forest, on a fee or contract basis. Establishments primarily engaged in cutting and transporting timber are also included.

Exclusion(s): Establishments primarily engaged in:
- trucking timber (484223, Forest Products Trucking, Local)
- trucking timber (484233, Forest Products Trucking, Long Distance)

Example Activities
Contract logging
Logging contractor (felling, cutting, bucking)
Pulpwood cutting, on contract
Timber cutting, on contract
Yarding, timber, on contract

321 Wood Product Manufacturing

This subsector comprises establishments primarily engaged in manufacturing products from wood. There are three industry groups in this subsector, comprising establishments engaged in sawing logs into lumber and similar products, or preserving these products; making products that improve the natural characteristics of wood, by making veneers, plywood, reconstituted wood panel products or engineered wood assemblies; and making a diverse range of wood products, such as millwork.

Exclusion(s): Establishments primarily engaged in:
- logging; and chipping logs in the field (113, Forestry and Logging)
- manufacturing wood pulp, paper and paper products (322, Paper Manufacturing)
- manufacturing wood kitchen cabinets and counters, and bathroom vanities (337, Furniture and Related Product Manufacturing)
- manufacturing wood signs and coffins (339, Miscellaneous Manufacturing)

3211 Sawmills and Wood Preservation

This industry group comprises establishments primarily engaged in manufacturing boards, dimension lumber, timber, poles and ties from logs and bolts. These establishments produce lumber that may be rough, or dressed by a planing machine to achieve smoothness and uniformity of size, but is generally not further worked or shaped. Establishments that preserve wood are also included.

32111 Sawmills and Wood Preservation

This industry comprises establishments primarily engaged in manufacturing boards, dimension lumber, timber, poles and ties from logs and bolts. These establishments produce lumber that may be rough, or dressed by a planing machine to achieve smoothness and uniformity of size, but is generally not further worked or shaped. Establishments that preserve wood are also included.

Exclusion(s): Establishments primarily engaged in:
- chipping logs in the field (11331, Logging)
- manufacturing glued-laminated timber, nailed-laminated lumber beams, parallel strand lumber, laminated veneer lumber, fingerjoined lumber, and similar products (32121, Veneer, Plywood and Engineered Wood Product

Manufacturing)
- peeling or slicing logs to make veneer (32121, Veneer, Plywood and Engineered Wood Product Manufacturing)
- planing purchased lumber or working lumber further than dressed (32191, Millwork)

321111 Sawmills (except Shingle and Shake Mills) MEX

This Canadian industry comprises establishments primarily engaged in manufacturing boards, dimension lumber, timber, poles and ties, and siding, from logs and bolts. These establishments produce lumber that may be rough, or dressed by a planing machine to achieve smoothness and uniformity of size, but (except in the case of siding) is generally not further worked or shaped.

321112 Shingle and Shake Mills [MEX]

This Canadian industry comprises establishments primarily engaged in sawing blocks of wood to produce shingles or splitting blocks of wood to produce shakes.

321114 Wood Preservation [US]

This Canadian industry comprises establishments primarily engaged in treating lumber, plywood, poles and similar wood products, produced in other establishments, with preservatives to prevent decay and to protect against fire and insects. Establishments primarily engaged in cutting to size and treating poles, pilings, posts and similar roundwood products are included. Pressure treating is the most common method used. Some common preservatives are water-borne inorganic compounds, such as chromated copper arsenate and creosote.

3212 Veneer, Plywood and Engineered Wood Product Manufacturing

This industry group comprises establishments primarily engaged in manufacturing softwood and hardwood veneer and plywood; structural wood members, except lumber; and reconstituted wood panel products. Veneer is produced as a thin sheet of wood of uniform thickness by peeling or slicing logs. Plywood is produced by gluing and compressing together, three or more sheets of veneer, with the grain of alternate sheets usually laid crosswise. Structural wood members are made by laminating, joining and assembling wood components according to specified engineering design criteria. Reconstituted wood panel products are produced by processes involving pressure, adhesives and binders. The laminated products produced in this industry may have layers of materials other than wood.

32121 Veneer, Plywood and Engineered Wood Product Manufacturing

This industry comprises establishments primarily engaged in manufacturing softwood and hardwood veneer and plywood; structural wood members, except lumber;

and reconstituted wood panel products. Veneer is produced as a thin sheet of wood of uniform thickness by peeling or slicing logs. Plywood is produced by gluing and compressing together, three or more sheets of veneer, with the grain of alternate sheets usually laid crosswise. Structural wood members are made by laminating, joining and assembling wood components according to specified engineering design criteria. Reconstituted wood panel products are produced by processes involving pressure, adhesives and binders. The laminated products produced in this industry may have layers of materials other than wood.

Exclusion(s): Establishments primarily engaged in:
- manufacturing solid wood structural members, such as dimension lumber and timber; and preserving purchased plywood (32111, Sawmills and Wood Preservation)
- manufacturing containers, such as fruit baskets and boxes, from veneer made in the same establishment (32192, Wood Container and Pallet Manufacturing)
- manufacturing gypsum board (32742, Gypsum Product Manufacturing)

321211 Hardwood Veneer and Plywood Mills [US]

This Canadian industry comprises establishments primarily engaged in manufacturing hardwood veneer and plywood.

Exclusion(s): Establishments primarily engaged in:
- preserving purchased plywood (321114, Wood Preservation)

321212 Softwood Veneer and Plywood Mills [US]

This Canadian industry comprises establishments primarily engaged in manufacturing softwood veneer and plywood.

Exclusion(s): Establishments primarily engaged in:
- preserving purchased plywood (321114, Wood Preservation)

321215 Structural Wood Product Manufacturing [CAN]

This Canadian industry comprises establishments primarily engaged in manufacturing structural wood members, other than solid dimension lumber and timber.

Exclusion(s): Establishments primarily engaged in:
- fabricating structural wood members at construction sites (23, Construction)
- manufacturing solid wood structural members, such as dimension lumber and timber (321111, Sawmills (except Shingle and Shake Mills))

321216 Particle Board and Fibreboard Mills CAN

This Canadian industry comprises establishments primarily engaged in manufacturing particle board and fibreboard. Particle board is made from wood particles, which are often the residue from other wood processing operations, combined under heat and pressure with a water resistant binder. Fibreboard is made from wood fibres, bonded together completely or partially by the lignin in the wood.

321217 Waferboard Mills [CAN]

This Canadian industry comprises establishments primarily engaged in manufacturing waferboard and oriented strandboard (OSB). These products are made from wafers or strands of wood such as aspen, poplar or southern yellow pine, combined with a waterproof binder, and bonded together by heat and pressure.

3219 Other Wood Product Manufacturing

This industry group comprises establishments, not classified to any other industry group, primarily engaged in manufacturing wood products.

Exclusion(s): Establishments primarily engaged in:
- manufacturing wood kitchen cabinets and counters, and bathroom vanities (3371, Household and Institutional Furniture and Kitchen Cabinet Manufacturing)
- manufacturing wood signs and coffins (3399, Other Miscellaneous Manufacturing)

32191 Millwork

This industry comprises establishments primarily engaged in millwork. These establishments generally use woodworking machinery, such as jointers, planers, lathes and routers, to shape wood. Establishments primarily engaged in seasoning and planing purchased lumber are included. Wood millwork products may be covered with another material, such as plastic.

Exclusion(s): Establishments primarily engaged in:
- carpentry, including installing prefabricated windows, doors and stairs in buildings (23, Construction)
- manufacturing dressed lumber from logs (32111, Sawmills and Wood Preservation)

321911 Wood Window and Door Manufacturing [US]

This Canadian industry comprises establishments primarily engaged in manufacturing wood doors and frames, and wood window units and frames, including those covered with metal or plastic.

Exclusion(s): Establishments primarily engaged in:
- installing prefabricated windows and doors in buildings (23, Construction)
- manufacturing metal windows and doors (332321, Metal Window and Door Manufacturing)

321919 Other Millwork [CAN]

This Canadian industry comprises establishments, not classified to any other Canadian industry, primarily engaged in millwork. These establishments generally use woodworking machinery, such as jointers, planers, lathes and routers, to shape wood. Establishments primarily engaged in seasoning and planing purchased lumber are included. Wood millwork products may be covered with another material, such as plastic.

Exclusion(s): Establishments primarily engaged in:
- carpentry, including installing prefabricated stairs in buildings (23, \ Construction)
- manufacturing dressed lumber from logs (32111, Sawmills and Wood Preservation)

32192 Wood Container and Pallet Manufacturing

This industry comprises establishments primarily engaged in manufacturing wood containers, container parts (shook) ready for assembly, cooper's products and parts, and pallets.

321920 Wood Container and Pallet Manufacturing

This Canadian industry comprises establishments primarily engaged in manufacturing wood containers, container parts (shook) ready for assembly, cooper's products and parts, and pallets.

32199 All Other Wood Product Manufacturing

This industry comprises establishments, not classified to any other industry, primarily engaged in manufacturing wood products.

321991 Manufactured (Mobile) Home Manufacturing [US]

This Canadian industry comprises establishments primarily engaged in manufacturing mobile homes and non-residential mobile buildings. These units are portable structures built on a chassis equipped with wheels, but not designed for multiple or continuous movement, and are designed to be connected to sewage and water utilities.

Exclusion(s): Establishments primarily engaged in:
- manufacturing motor homes or recreational travel trailers (336215, Motor Home, Travel Trailer and Camper Manufacturing)

321992 Prefabricated Wood Building Manufacturing [US]

This Canadian industry comprises establishments primarily engaged in manufacturing prefabricated or pre-cut wood buildings, sections and panels. All buildings that are made away from the construction site, either in sections, complete units, or in components for on-site erection, are included. Establishments primarily engaged in manufacturing log cabins and log houses are included.

Exclusion(s): Establishments primarily engaged in:
- constructing wood frame buildings on site (23, Construction)

321999 All Other Miscellaneous Wood Product Manufacturing [US]

This Canadian industry comprises establishments, not classified to any other Canadian industry, primarily engaged in manufacturing wood products.

322 Paper Manufacturing

This subsector comprises establishments primarily engaged in manufacturing pulp, paper and paper products. The manufacture of pulp involves separating the cellulose fibres from other impurities in wood, used paper or other fibre sources. The manufacture of paper involves matting these fibres into a sheet. Converted paper products are produced from paper and other materials by various cutting and shaping techniques.

3221 Pulp, Paper and Paperboard Mills

This industry group comprises establishments primarily engaged in manufacturing pulp, paper or paperboard. Establishments that manufacture pulp, paper or paperboard, either alone or in combination with paper converting, are included.

Exclusion(s): Establishments primarily engaged in:
- manufacturing paper or paperboard products from purchased paper or paperboard (3222, Converted Paper Product Manufacturing)

32211 Pulp Mills

This industry comprises establishments primarily engaged in manufacturing pulp from any material, by any process. These establishments sell or transfer the pulp to separate paper-making establishments; they do not make it into paper themselves. Establishments that process waste paper into pulp ("de-inking plants") are included.

Exclusion(s): Establishments primarily engaged in:
- manufacturing pulp and making paper (32212, Paper Mills)
- manufacturing pulp and making paperboard (32213, Paperboard Mills)

322111 Mechanical Pulp Mills [CAN]

This Canadian industry comprises establishments primarily engaged in manufacturing pulp from any material, using mechanical or semi-chemical methods. Some important products of this Canadian industry are mechanical pulp (sometimes called "groundwood" pulp), thermo-mechanical pulp (TMP) and semi-chemical pulp.

Exclusion(s): Establishments primarily engaged in:
- manufacturing pulp and making paper, except newsprint (322121, Paper (except Newsprint) Mills)
- manufacturing pulp and making newsprint (322122, Newsprint Mills)
- manufacturing pulp and making paperboard (322130, Paperboard Mills)

322112 Chemical Pulp Mills [CAN]

This Canadian industry comprises establishments primarily engaged in manufacturing pulp from any material, using chemical methods. "Kraft" pulp is chemical pulp obtained from the sulphate or soda processes. Establishments that process waste paper into pulp are included.

Exclusion(s): Establishments primarily engaged in:
- manufacturing pulp and making paper, except newsprint (322121, Paper (except Newsprint) Mills)
- manufacturing pulp and making newsprint (322122, Newsprint Mills)
- manufacturing pulp and making paperboard (322130, Paperboard Mills)

32212 Paper Mills

This industry comprises establishments primarily engaged in manufacturing paper, other than paperboard. Establishments that manufacture paper in combination with pulp manufacture or paper converting, are included.

Exclusion(s): Establishments primarily engaged in:
- manufacturing pulp, but not making any paper or paperboard (32211, Pulp Mills)
- converting purchased paper into paperboard containers (32221, Paperboard Container Manufacturing)
- converting purchased paper and paperboard into paper bags and coated and treated paper products (32222, Paper Bag and Coated and Treated Paper Manufacturing)
- converting purchased paper and paperboard into paper products other than paperboard containers, paper bags and coated and treated paper products (32229, Other Converted Paper Product Manufacturing)

322121 Paper (except Newsprint) Mills [US]

This Canadian industry comprises establishments primarily engaged in manufacturing paper, other than newsprint and paperboard. Establishments that manufacture paper (except newsprint) in combination with pulp manufacture or paper converting, are included.

322122 Newsprint Mills [US]

This Canadian industry comprises establishments primarily engaged in manufacturing newsprint, including groundwood printing paper. Establishments that manufacture newsprint in combination with pulp manufacture, are included.

32213 Paperboard Mills

This industry comprises establishments primarily engaged in manufacturing paperboard. Establishments that manufacture paperboard in combination with pulp manufacture or paperboard converting, are included.

Exclusion(s): Establishments primarily engaged in:
- manufacturing particle board, fibreboard, waferboard and similar reconstituted wood board products (32121, Veneer, Plywood and Engineered Wood Product Manufacturing)
- manufacturing building paper (32212, Paper Mills)

322130 Paperboard Mills [US]

This Canadian industry comprises establishments primarily engaged in manufacturing paperboard. Establishments that manufacture paperboard in combination with pulp manufacture or paperboard converting, are included.

3222 Converted Paper Product Manufacturing

This industry group comprises establishments primarily engaged in manufacturing paper products from purchased paper and paperboard.

Exclusion(s): Establishments primarily engaged in:
- manufacturing paper or paperboard, and converting it into paper or paperboard products (3221, Pulp, Paper and Paperboard Mills)

32221 Paperboard Container Manufacturing

This industry comprises establishments primarily engaged in manufacturing paperboard containers, such as setup paperboard boxes, corrugated boxes, fibre boxes, cans and drums, and sanitary food containers, from purchased paperboard. These establishments use corrugating and cutting machinery to form paperboard into containers.

Exclusion(s): Establishments primarily engaged in:

- manufacturing paperboard and converting it into containers (32213, Paperboard Mills)

322211 Corrugated and Solid Fibre Box Manufacturing [US]

This Canadian industry comprises establishments primarily engaged in manufacturing corrugated and solid fibre boxes and related products, such as corrugated sheets, from purchased paperboard.

Exclusion(s): Establishments primarily engaged in:
- manufacturing paperboard and converting it into corrugated and fibre boxes (322130, Paperboard Mills)

322212 Folding Paperboard Box Manufacturing [US]

This Canadian industry comprises establishments primarily engaged in manufacturing folding paperboard boxes, from purchased paperboard.

Exclusion(s): Establishments primarily engaged in:
- manufacturing paperboard and converting it into folding boxes (322130, Paperboard Mills)
- manufacturing milk cartons (322219, Other Paperboard Container Manufacturing)

322219 Other Paperboard Container Manufacturing [CAN]

This Canadian industry comprises establishments, not classified to any other Canadian industry, primarily engaged in manufacturing paperboard containers, such as setup paperboard boxes, fibre cans and drums, and sanitary food containers, from purchased paperboard.

Exclusion(s): Establishments primarily engaged in:
- manufacturing paperboard and converting it into containers other than corrugated, solid fibre and folding boxes (322130, Paperboard Mills)

32222 Paper Bag and Coated and Treated Paper Manufacturing

This industry comprises establishments primarily engaged in manufacturing paper bags, and coated and treated paper and paperboard products, from purchased paper and other flexible film materials. The products produced in this industry may be made from a single layer; or from several layers laminated together. The laminated products may consist entirely of materials other than paper, such as plastic film and aluminum foil.

Exclusion(s): Establishments primarily engaged in:
- manufacturing textile bags (31491, Textile Bag and Canvas Mills)
- manufacturing paper and converting it into paper bags and coated and

treated paper products (32212, Paper Mills)
- manufacturing sensitized photographic and blueprint paper (32599, All Other Chemical Product Manufacturing)
- manufacturing plastic bags, either single or multi-web, entirely of plastic (32611, Plastics Packaging Materials and Unlaminated Film and Sheet Manufacturing)
- manufacturing aluminum foil (331317, Aluminum Rolling, Drawing, Extruding and Alloying)
- manufacturing metal foil containers, such as aluminum pie plates (332999, All Other Miscellaneous Fabricated Metal Product Manufacturing)
- manufacturing medical adhesive tape and plasters (33911, Medical Equipment and Supplies Manufacturing)
- manufacturing carbon paper (33994, Office Supplies (except Paper) Manufacturing)

322220 Paper Bag and Coated and Treated Paper Manufacturing MEX

This Canadian industry comprises establishments primarily engaged in manufacturing paper bags, and coated and treated paper and paperboard products, from purchased paper and other flexible film materials. The products produced in this industry may be made from a single layer; or from several layers laminated together. The laminated products may consist entirely of materials other than paper, such as plastic film and aluminum foil.

32223 Stationery Product Manufacturing

This industry comprises establishments primarily engaged in manufacturing paper stationery products, used for writing, filing and similar applications.

Exclusion(s): Establishments primarily engaged in:
- manufacturing paper and converting it into stationery products (32212, Paper Mills)
- manufacturing paperboard and converting it into stationery products (32213, Paperboard Mills)
- manufacturing carbon paper and non-paper office supplies (33994, Office Supplies (except Paper) Manufacturing)

322230 Stationery Product Manufacturing MEX

This Canadian industry comprises establishments primarily engaged in manufacturing paper stationery products, used for writing, filing and similar applications.

32229 Other Converted Paper Product Manufacturing

This industry comprises establishments, not classified to any other industry, primarily engaged in manufacturing paper products from purchased paper and paperboard.

Exclusion(s): Establishments primarily engaged in:
- manufacturing paper and converting it into paper products (32212, Paper Mills)
- manufacturing paperboard and converting it into paperboard products (32213, Paperboard Mills)

322291 Sanitary Paper Product Manufacturing [US]

This Canadian industry comprises establishments primarily engaged in manufacturing converted paper products from purchased sanitary paper stock. Establishments primarily engaged in manufacturing disposable sanitary products, such as tampons, from textile materials are included.

Exclusion(s): Establishments primarily engaged in:
- manufacturing sanitary paper and converting it into paper products (322121, Paper (except Newsprint) Mills)

322299 All Other Converted Paper Product Manufacturing [US]

This Canadian industry comprises establishments, not classified to any other Canadian industry, primarily engaged in manufacturing converted paper products, from purchased paper. Establishments primarily engaged in manufacturing moulded pulp products, such as egg cartons, are included.

Exclusion(s): Establishments primarily engaged in:
- manufacturing paper, except newsprint, and converting it into paper products (322121, Paper (except Newsprint) Mills)
- manufacturing paperboard and converting it into paper products (322130, Paperboard Mills)

Industry Groups and Industries Excluded from the Forest Products Sector (as defined in this report)

1153 Support Activities for Forestry

This industry group comprises establishments primarily engaged in performing particular support activities, related to harvesting timber.

Example activities include cruising timber, forest fire fighting services, log hauling in the bush (i.e., within the logging limits), forestry pest control services, reforestation services, timber cruising, and timber valuation.

484 Truck Transportation

Within this subsector, the following two industries are not included in the forest products sector as defined in this report.

484223 Forest Products Trucking, Local [CAN]

This Canadian industry comprises establishments primarily engaged in the local trucking of forest products, including logs, wood chips and lumber. **Exclusion(s):** Establishments primarily engaged in: - trucking forest products in the bush (i.e., within logging limits) (115310, Support Activities for Forestry). Example activities include forest products trucking, local, log trucking, local (i.e., to the mill), pulpwood trucking, local (i.e., to the mill), timber trucking, local (i.e., to the mill).

484233 Forest Products Trucking, Long Distance [CAN]

This Canadian industry comprises establishments primarily engaged in the long distance trucking of forest products, including logs, wood chips and lumber. Example activities include forest products trucking, long-distance, and log trucking, long-distance.

Appendix II: Forest Products Sector Productivity in the United States

This appendix investigates in further detail the productivity performance of the US forest products sector. Unfortunately, neither the Bureau of Labor Statistics nor the Bureau of Economic Analysis publishes series for output, inputs, or productivity for the forestry and logging subsector.[28] As a result, this section only presents series for wood product manufacturing and paper manufacturing.

This section first examines the relative importance of the US wood products and paper manufacturing subsectors. It then examines trends in the real output of these sectors.

i. Wood Products and Paper Manufacturing in the United States

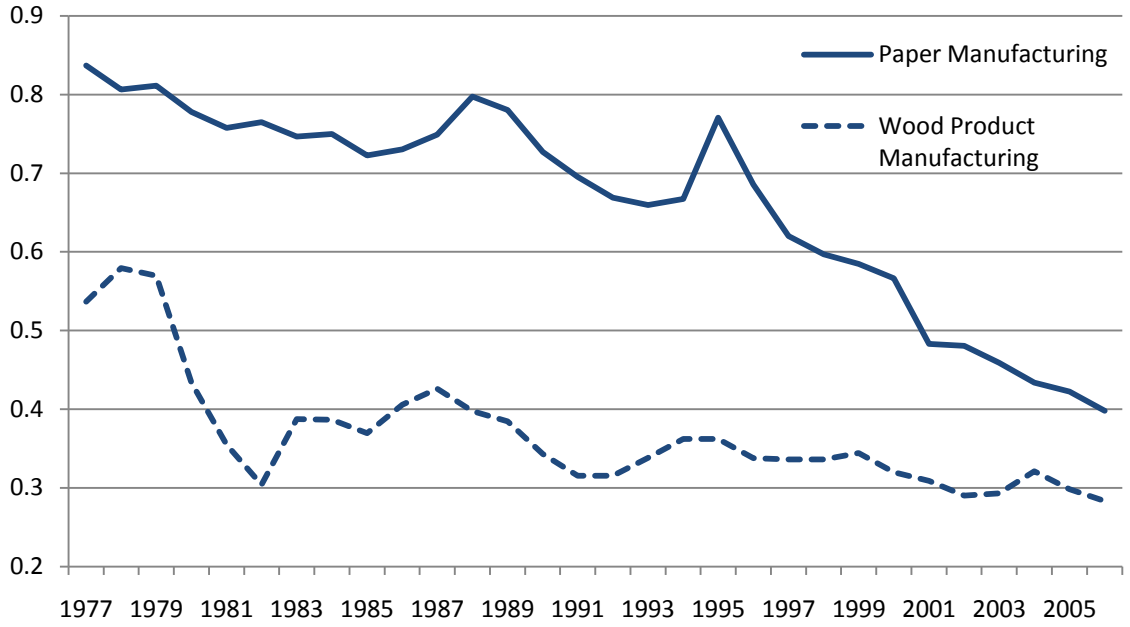
Both the wood products manufacturing subsector and the paper manufacturing subsector have declined in importance, in terms of share of total economy GDP, since the late 1970s (Appendix Chart 1). Paper manufacturing has fallen considerably in its relative importance in the US economy. From more than 0.8 per cent of total economy GDP in 1977, the GDP of the paper manufacturing subsector slowly declined up to the mid-1990s. After that, the decline in relative importance was precipitous, as other sectors of the economy grew much more quickly.

The pattern was somewhat different in wood product manufacturing. After a sharp decline in the late 1970s, the relative importance of wood product manufacturing has remained roughly stable at just over 0.3 per cent of US total economy GDP. It is also interesting to note in Appendix Chart 1 that in the late 1980s paper manufacturing was around twice the size of the wood products manufacturing subsector in terms of nominal value added. By 2006, paper manufacturing was only one-third larger.

As was noted in the body of the report, the forest products sector in the United States accounts for a considerably smaller share of GDP than in Canada, Finland, or Sweden. Similarly, the wood products manufacturing subsector in the United States is much less important than in Canada, where it made up 0.9 per cent of GDP in 2007. Paper manufacturing was also much less important in the United States than in Canada, where it accounted for 0.8 per cent of GDP in 2007.

[28] Only data for the subsector called "forestry, fishing, and related activities" are available. Because "fishing and related activities" is also included, using these series as estimate productivity in the forestry and logging subsector could be misleading.

Appendix Chart 1: Wood Product and Paper Manufacturing GDP as a share of the GDP of all industries, United States, Total Economy, per cent, 1977-2006



Source: Appendix Table 901b

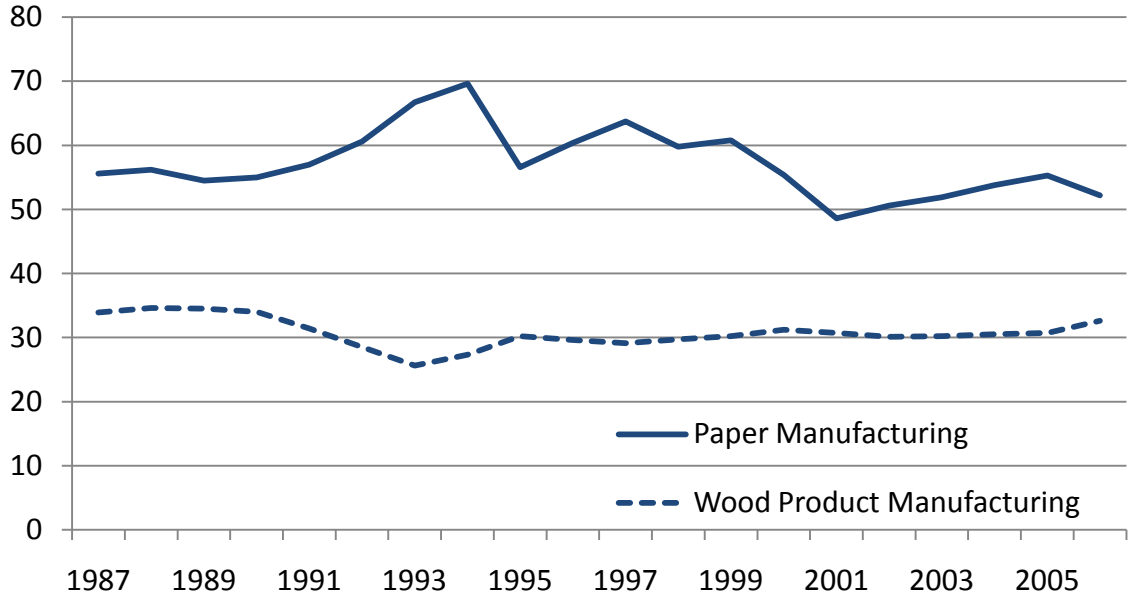
ii. Real Output

Real GDP in the wood product and paper manufacturing subsectors of the US economy was fairly stable from 1987 to 2006 (Appendix Chart 2). Paper manufacturing did see significant growth in the early 1990s followed by a decline in the latter half of that decade. Since 2001, there has been a notable increase in output. Wood product manufacturing exhibited much less variability and real GDP was around $30 billion per year from 1995 to 2005.

iii. Hours Worked

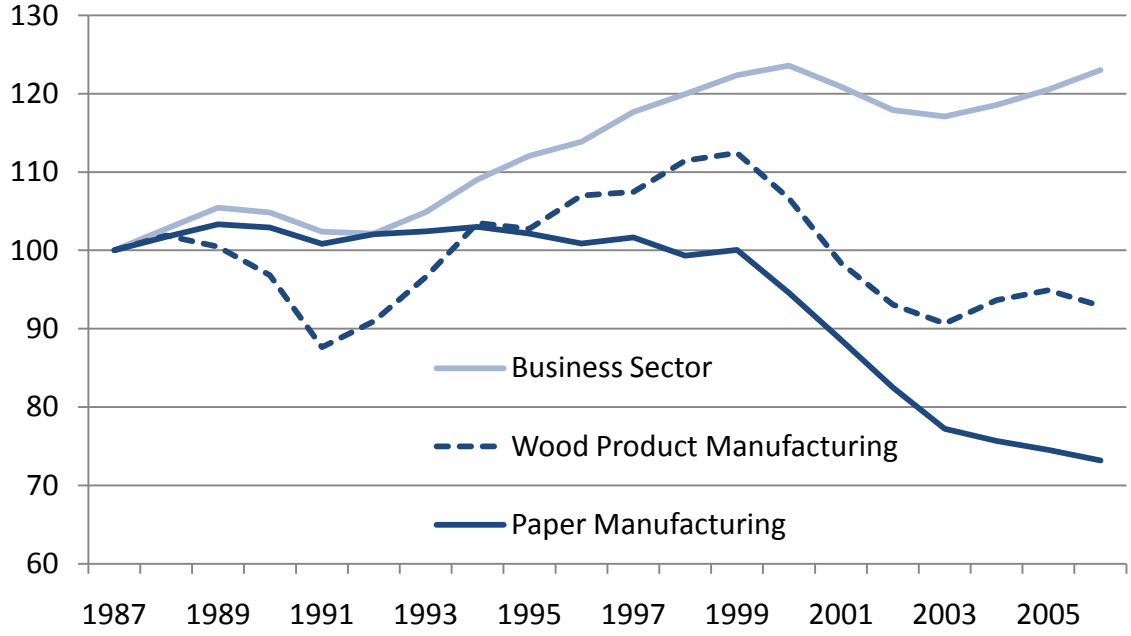
Wood product manufacturing saw a decline in total hours worked in the early 1990s, followed by steady growth in this measure of labour input from 1992 to 1999 (Appendix Chart 3). After that, hours worked fell precipitously, but have been fairly stable, somewhat above the level of 1991, since 2002. In paper manufacturing, hours worked were stable from 1987 to 1999, but then fell even more sharply than in wood product manufacturing, reaching a low in 2006, 22.6 per cent below the level of 2000. By way of comparison, total hours worked in the business sector as a whole increased by 23 per cent from 1987 to 2006, substantially more than in either wood product or paper manufacturing.

Appendix Chart 2: Real GDP, Wood Product and Paper Manufacturing, United States, Billions of Chain 2000 Dollars, 1987-2006



Source: Appendix Table 901a

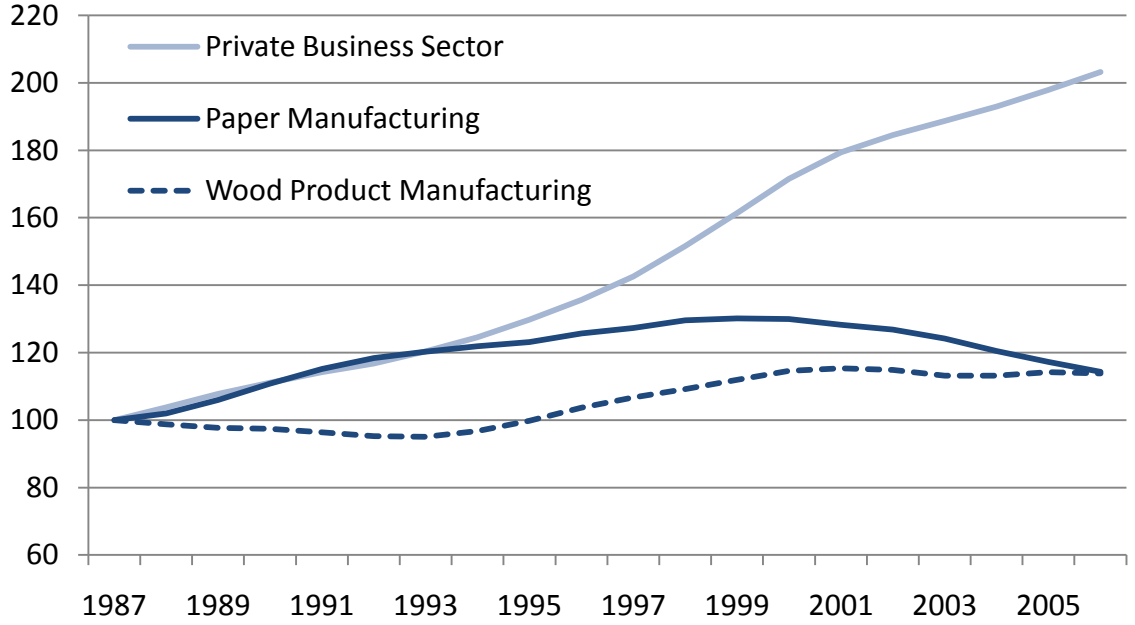
Appendix Chart 3: Total Hours Worked in Wood Product and Paper Manufacturing, United States, Index 1987 =100, 1987-2006



Source: Appendix Tables 910-910a and 905b

iv. Capital Input

Appendix Chart 4: Capital Services in Wood Product and Paper Manufacturing, United States, Index 1987 = 100, 1987-2006



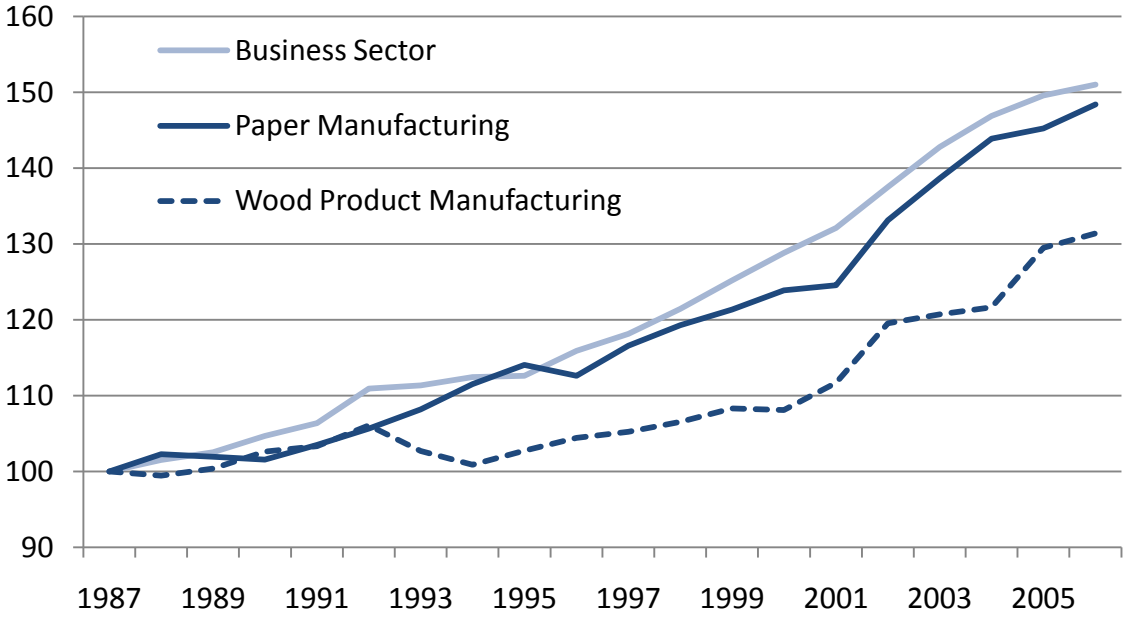
Source: Appendix Tables 910-910b

Capital services, which represents the value of the services provided by the capital stock (i.e. influenced by both the level and the composition of the capital stock), in the wood product and paper manufacturing subsectors in the United States generally increased between 1987 and 2006 (Appendix Chart 4). Capital services in paper manufacturing increased steadily from 1987 to 1999 and have declined ever since. In contrast, capital services in wood product manufacturing declined slowly from 1987 to 1993, then increased steadily to 1999. They have remained at this level since that time. The rate of growth observed in both subsectors over the 1987-2006 period was much smaller than the one observed in the economy as a whole.

v. Labour Productivity

Since 1987, labour productivity has grown more quickly in paper manufacturing than in wood product manufacturing (Appendix Chart 5). Over the period 1987 to 2006, labour productivity in paper manufacturing improved by 148.8 per cent, or 2.10 per cent at an average annual rate. Wood product manufacturing saw labour productivity growth of 131.4 per cent over the same period, an annual average of only 1.45 per cent. Neither of the two subsectors saw labour productivity growth as fast as that experienced by the business sector as a whole, where labour productivity grew 151 per cent, or 2.19 per cent per year. However, since 2000, both wood product manufacturing (3.30 per cent per year) and paper manufacturing (3.05 per cent per year) have experienced labour productivity growth in excess of the business sector average (2.68 per cent per year) (Summary Table A1).

Appendix Chart 5: Labour Productivity in Wood Product and Paper Manufacturing, United States, Index 1987 = 100, 1987-2006



Source: Appendix Tables 905-905b

The Bureau of Labor Statistics publishes detailed estimates of labour productivity growth for the industries that make up wood product and paper manufacturing (Summary Table A1). The post-2000 productivity performance of these subsectors has been driven by a number of industries. In wood product manufacturing, strong labour productivity growth in sawmills and wood preservation (3.51 per cent per year), veneer plywood and engineered wood product manufacturing (2.92 per cent per year), and other wood product manufacturing (3.32 per cent per cent), have contributed to the above average performance of the subsector. Labour productivity growth was notably weak in engineered wood product manufacturing (1.60 per cent per year) and all other wood product manufacturing (0.39 per cent per year).

In paper manufacturing, the pulp, paper and paperboard mills industry group accounted for the above (business sector) average performance of the subsector. In the converted paper product manufacturing industry group, which saw labour productivity grow by only 2.41 per cent per year, paperboard container manufacturing (1.49 per cent per year) and coated and laminated paper and packaging manufacturing (0.84 per cent per year) were notably weak.

A note of caution regarding this detailed examination of US wood product and paper manufacturing labour productivity growth is in order. Because of the absence of data on output or employment at the same level of detail as these productivity estimates, it is difficult to judge the importance of the different industry groups and industries. For

Summary Table A1: Labour Productivity in Wood Product and Paper Manufacturing, Compound Annual Growth Rate, per cent, 1987-2006

	1987-2006	1987-2000	2000-2006
Business Sector	2.19	1.97	2.68
Wood Product Manufacturing	1.45	0.60	3.30
Sawmills and Wood Preservation	2.74	2.39	3.51
Veneer, Plywood and Engineered Wood Product Manufacturing	0.86	-0.07	2.92
Reconstituted Wood Product Manufacturing	2.15	1.32	3.96
Veneer and Plywood Manufacturing	0.82	-1.10	5.09
Engineered Wood Product Manufacturing	1.24	1.07	1.60
Other Wood Product Manufacturing	1.04	0.00	3.32
Millwork	1.24	-0.28	4.61
Wood Container and Pallet Manufacturing	2.41	0.87	5.82
All Other Wood Product Manufacturing	0.46	0.49	0.39
Manufactured Home (Mobile Home) Manufacturing	-0.82	0.25	-3.09
Paper Manufacturing	2.10	1.66	3.05
Pulp, Paper, and Paperboard Mills	3.29	2.75	4.46
Paperboard Mills	1.99	2.35	1.21
Converted Paper Product Manufacturing	1.44	0.99	2.41
Paperboard Container Manufacturing	1.00	0.78	1.49
Paper Bag and Coated and Treated Paper Manufacturing	1.21	0.76	2.20
Coated and Laminated Paper and Packaging Manufacturing	1.56	1.90	0.84
Coated, Uncoated, and Multiwall Bag and Packaging Manufacturing	0.43	-1.49	4.71
Stationery Product Manufacturing	2.73	2.46	3.32
Other Converted Paper Product Manufacturing	2.42	1.05	5.43

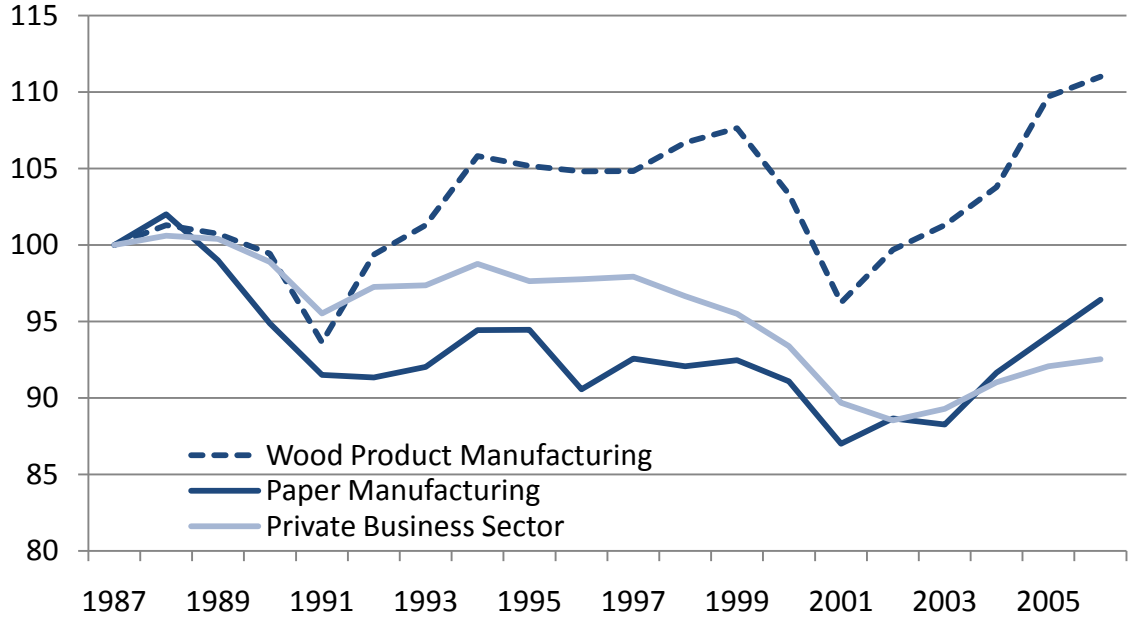
Source: Appendix Tables 905 and 905a

instance, a high rate of growth in a very small industry, measured either in terms of labour input or output, will not have a large effect on aggregate estimates.

vi. Capital Productivity

Since 1987 capital productivity has increased by more than 10 per cent in wood product manufacturing, an annual rate of 0.55 per cent (Appendix Chart 6). In paper manufacturing capital productivity declined by almost 14 per cent from 1987 to 2001, but has since recovered somewhat. However, it remains more than three per cent below the level of 1987.

Appendix Chart 6: Capital Productivity in Wood Product and Paper Manufacturing, United States, Index 1987 = 100, 1987-2006

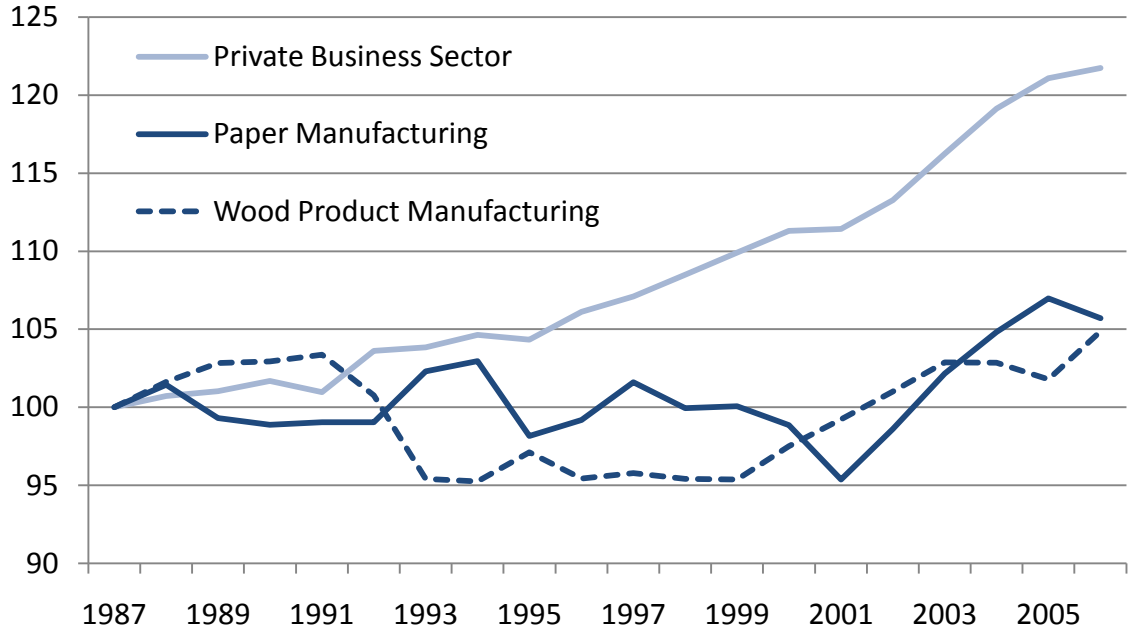


Source: Appendix Tables 910-910a

vii. Multifactor Productivity

Multifactor productivity in both wood product and paper manufacturing has increased in the 2000s (Appendix Chart 7). In both cases multifactor productivity fell below the level of the late 1980s during the 1990s. Overall, since 1987, multifactor productivity in wood product manufacturing was up by 5.7 per cent, while multifactor productivity in paper manufacturing advanced by 4.9 per cent. This multifactor productivity performance lagged far behind that of the business sector as a whole, which saw multifactor productivity grow by almost 22 per cent from 1987 to 2006.

Appendix Chart 7: Multifactor Productivity in Wood Product and Paper Manufacturing, Index 1987 = 100, 1987-2006



Source: Appendix Tables 910-910a

viii. Key Findings

This subsection summarizes key findings about the productivity performance of the US wood product and paper manufacturing subsectors.

- Wood product and paper manufacturing are subsectors of declining importance in the US economy. Neither subsector has seen substantial growth in real output since the late 1980s.

- Between 1987 and 2006, both subsectors have seen declines in total hours worked, but have experienced small increases in capital services.

- Over the entire 1987-2006 period, relative to the aggregate business sector, labour productivity growth in wood product and paper manufacturing has been slow, especially in wood product manufacturing.

- When the subsectors are examined in terms of their constituent industry groups and industries, the sawmills and wood preservation and the pulp, paper, and paperboard mills industry groups stand out as areas where productivity growth has been above (business sector) average over both the 1987-2006 and 2000-2006 periods.

- In contrast to labour productivity, capital productivity growth in the wood products subsector has been relatively strong in comparison with capital

productivity in paper manufacturing or the aggregate business sector, both of which saw decline in capital productivity from 1987-2006.

- Both wood product and paper manufacturing experienced very weak multifactor productivity growth between 1987 and 2006; neither subsector kept up with the business sector.

- However, between 2000 and 2006 the productivity performance of both wood product and paper manufacturing has improved considerably. Both subsectors experienced higher rates of labour and capital productivity growth than the aggregate business sector.

Appendix III: The Contribution of the Forest Products Sector to Aggregate Productivity Growth in Canada

This appendix provides estimates of the contribution of the forest products sector to aggregate labour productivity growth in Canada. To do so, it uses the methodology developed by Tang and Wang (2004). An advantage of using Tang and Wang's methodology is that it can be applied to chained-Fisher index real GDP even though this chained-dollar GDP is not additive across industries.

The methodology developed by Tang and Wang (2004) provides a way to decompose aggregate (all-industries) labour productivity growth into components (e.g. sectors or industries). Wang and Tang's method traces labour productivity growth to three sources. First, pure productivity growth, as its name implies, is the effect on aggregate labour productivity growth of labour productivity growth in a constituent sector, holding constant the relative size of that sector. Second, the change in relative size of a sector is a composite measure of the price of the sector's output relative to the price of aggregate output and the sector's share of all labor input (hours worked) in the economy. Third, the interaction effect is simply the effect of the interaction between the other two effects.

The contributions of these three sources are quantified in three components: the pure productivity growth effect, the relative size change effect and the interaction of the first two. The pure productivity growth effect is an industry's labour productivity growth rate weighted by its nominal output share at the beginning of the period. The relative size of an industry is defined as the labour share of the industry multiplied by the relative implicit deflator of the industry. The relative size change effect is weighted by the relative labour productivity of the industry at the beginning of the period. The interaction effect captures the interaction between industry labour productivity growth and the relative industry size, weighted by relative labour productivity.

It is important to note that according to Tang and Wang's methodology, even though an industry has negative productivity growth, the industry may make a positive contribution to aggregate productivity growth due to the relative size change effect. This effect captures the impact of reallocating labour between activities with differing labour productivity levels. To calculate the relative size change effect, the change in the relative size of an industry, which encompasses both the change in its employment share and the change in relative prices, is weighted by the relative labour productivity level of the industry.

Summary Table A2 shows the contribution of the forest products sector to aggregate labour productivity growth in Canada and the contribution of each of the three forest products subsectors to labour productivity growth in the forest products sector as a whole from 1986-2004. Between 1986 and 2004, labour productivity growth in the forest products sector (41 per cent) exceeded the average of the total economy (24 per cent). The forest products sector explained only 1.13 per cent of this aggregate labour

productivity growth. Because labour productivity growth in the forest products sector was significantly above average, the pure labour productivity growth effect contributed 5.10 per cent to aggregate labour productivity growth. However this contribution was partially offset by a decline in the forest products sector's share of total labour hours worked from 2.8 per cent to 2.1 per cent. This decline in labour input share was sufficient offset an increase in the relative price of the sector's output from 1986 to 2004. This decline in labour input share led to a decline in the relative size of the industry. Finally, there was strong interaction between the decline in the relative size of sector and the strong labour productivity growth which also reduced the impact that the sector strong pure productivity growth had on aggregate labour productivity growth.

Summary Table A2: The Contribution of the Forest Products Sector to Aggregate Labour Productivity Growth, Canada, 1986-2004

	Labour Productivity Growth	Contribution			
		Total	Pure Productivity Growth	Relative Size	Interaction Term
	(per cent)				
All Industries, Total Economy	23.90	100.00	100.00	0.00	0.00
Contribution to Labour Productivity Growth in All Industries					
Forest Products Sector	41.07	1.13	5.10	-2.81	-1.15
Of which					
Contribution to Labour Productivity Growth in the Forest Products Sector					
Forestry and Logging	46.96	19.10	22.19	-2.10	-0.98
Wood Product Manufacturing	48.25	81.77	35.00	31.55	15.22
Paper Manufacturing	39.56	-2.08	49.41	-36.89	-14.59

Source: Appendix Tables 7a, 7b, 7c, 7d, and 7e

Turning now to the subsectors that make up the forest products sector, the contributions were highly variable. Wood product manufacturing accounted for 82 per cent of the labour productivity growth of the forest products sector over the period from 1986 to 2004. This contribution resulted from strong labour productivity growth (48 per cent between 1986 and 2004) and a significant increase in the relative size of the subsector both in terms of its relative output price and its share of labour hours worked in the forest products sector, which increased from 36 per cent in 1986 to 43 per cent in 2004 (Summary Table A3). Strong labour productivity growth combined with a substantial increase in the relative size of wood product manufacturing, within the forest products sector, explains this considerable contribution to the labour productivity growth of the sector as a whole.

Forestry and logging also made a positive contribution to the labour productivity growth of the forest products sector, though to a much smaller extent than wood product manufacturing. Forestry and logging contributed 19 per cent of the aggregate labour productivity growth of the sector from 1986 to 2004. This contribution resulted entirely from the strong positive labour productivity growth. The relative size of the subsector hardly had any impact, reflecting the offsetting effects of a reduction in the share of hours worked (from 23.7 per cent of the forest products sector total in 1986 to 19.2 per cent in 2004) and an increase in the relative price of the subsector's output (from 82 per cent of the sector's average in 1986 to 96 per cent in 2004).

Summary Table A3: Components of Relative Size, Forest Products Sector, Canada, 1986-2004

	Relative (Real) Output Price		Labour Input Share	
	1986	2004	1986	2004
	Index, All Industries = 100.0			
All Industries, Total Economy	100.0	100.0	100.0	100.0
Forest Products Sector	91.5	95.3	2.84	2.11
	Index, Forest Products Sector = 100.0			
Forestry and Logging	81.6	96.2	23.7	19.2
Wood Product Manufacturing	91.3	109.6	36.1	43.2
Paper Manufacturing	117.6	91.9	40.2	36.3

Source: Appendix Tables 7a, 7b, 7c, 7d, and 7e.
Note: Figures may not add due to rounding.

Paper manufacturing had a small negative effect on labour productivity growth in the forest products sector (-1.56 per cent) between 1986 and 2004. This small net negative effect was the result of a strong pure labour productivity growth effect coupled with a significant decline in the relative size of the subsector. This decline was the result of both falling relative output prices (from 118 per cent of the forest products sector average in 1986 to just 92 per cent of the average in 2004) and a fall in paper manufacturing's share of hours worked in the forest products sector (from 40 per cent to 36 per cent). Ironically, as was seen in part III, paper manufacturing saw the greatest improvement in labour productivity of the three forest products subsectors. However, paper manufacturing also saw the most significant decline in relative size of any of the subsectors.

In sum, several observations are worth noting in regard to the contribution of the forest products sector to aggregate labour productivity growth in the total economy and the contribution of each of the three subsectors to labour productivity growth in the forest products sector:

- Looking at the productivity performance of the forest products sector conceals very different impacts from each of the three constituent subsectors;

- Forestry and logging accounted for 20 per cent of the labour productivity growth in the forest products sector. Rising relative output prices were offset by a decline in the relative amount of hours worked in forestry and logging.

- Wood product manufacturing contributed over 81 per cent of the labour productivity growth in the forest products sector. Both relative output prices and share of hours worked grew significantly.

- Paper manufacturing made a slight negative contribution to labour productivity growth in the forest products sector. Strong productivity growth in this subsector was offset by price declines relative to other forest products subsectors and a decline in the subsector's share of the forest products sector's labour input.