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CENTRE FOR THE STUDY OF LIVING STANDARDS

The Productivity Performance of New Brunswick Manufacturing: A Detailed Analysis, 1997-2019

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Executive Summary

Manufacturing can be the driving force of a modern economy. Unlike most services industries, much if not most of the output of the manufacturing sector is exported, increasing income and employment through the multiplier effects arising from the revenue generated by the exports. The economic performance of the sector is thus crucial for the overall health of the economy. A key metric of this economic performance is productivity.

The objective of this report is to provide a detailed analysis of the productivity performance of manufacturing in New Brunswick. The report is divided into two major parts. Part one provides a detailed overview of the manufacturing productivity in New Brunswick from 1997 to 2019, the period for which comprehensive industry data are available. A major turning point in the province's manufacturing labour productivity performance is identified in 2004, after which output per hour in the sector plummeted, falling from 109 per cent of the national average to 75 per cent by 2019. Part two of the report attempts to shed light on this important development from different angles.

Part one has six sections. It first provides an overview of the size of the manufacturing sector in New Brunswick over time, relative to both the overall New Brunswick economy and to the Canadian manufacturing sector. It then reviews the data on manufacturing labour productivity in the province, looking at both growth rates and levels expressed in real and nominal terms with comparisons to the national performance. The focus of the analysis is the 1997-2019 period, with some attention to cyclically neutral (peak to peak of the business cycle) sub-periods. Part one also includes sections on the cost competitiveness implications of New Brunswick's manufacturing productivity performance, a comparison of New Brunswick's manufacturing productivity with that of other provinces, an industry perspective on the province's manufacturing productivity, and a growth accounting perspective on the sources of manufacturing labour productivity growth in the province.

Part two, on the reasons for the post-2004 fall-off in manufacturing productivity growth in New Brunswick, has four sections. The first section provides a growth accounting perspective on the fall-off and the second section an industry perspective. The first section looks at whether labour shortages have played a role in the fall-off. The fourth section discusses additional explanations for the fall-off, namely weak investment, exchange rate movements, R&D developments, and economies of scale.

Key findings from part one include the following:

- The relative importance of manufacturing in the New Brunswick economy in terms of both output and employment has fallen over time. The sector's share of nominal total economy GDP fell from 13.1 per cent on 1997 to 10.0 per cent in 2016. The share for real output fell from 11.9 per cent in 1997 to 9.5 per cent in 2019. The

share of manufacturing in total economy employment experienced a smaller fall from 9.2 per cent in 1997 to 8.2 per cent in 2019. This was the second smallest decline among the provinces.

- Manufacturing in New Brunswick experienced faster growth in nominal output than the national average since 1997, resulting in its share of Canada's nominal manufacturing output rising from 1.44 per cent in 1997 to 1.55 per cent in 2016. This faster nominal growth is due to manufacturing prices rising faster in New Brunswick than at the national average (2.0 per cent versus 1.3 per cent per year).

- In terms of real output, however, New Brunswick's manufacturing share fell from 1.54 per cent of the national total in 1997 to 1.45 per cent in 2019, reflecting slower growth than at the national level (0.48 per cent per year versus 0.75 per cent).

- In contrast to developments at the national level, and in almost all other provinces, New Brunswick's manufacturing employment increased between 1997 and 2019 in absolute terms, rising 0.08 per cent per year compared to a 0.65 decline for Canada. This resulted in the province's share of Canada's manufacturing employment increasing from 1.53 per cent in 1997 to 1.79 per cent in 2019.

- The faster growth of employment (and total hours) and slower real output growth in New Brunswick compared to Canada explains the province's considerably weaker labour productivity growth over the 1997-2019 period: 0.36 per cent versus 1.61 per cent per year.

- The 1.25 percentage point gap in labour productivity growth between New Brunswick and Canada over the 1997-2019 period resulted in the province's level of real output per hour in manufacturing falling from 98.9 per cent of the national average in 1997 to 75.4 per cent in 2019, a massive deterioration. New Brunswick went from fifth to ninth place in terms of provincial ranking for the level of manufacturing labour productivity.

- Labour compensation in New Brunswick manufacturing has historically been below the national average and this cost advantage for the province has increased since 1997. Hourly labour compensation in manufacturing grew 2.36 per cent per year in the province between 1997 and 2019, compared to 2.91 per cent at the national level. This resulted in the sector's level of hourly labour compensation falling from 83.1 per cent of the national average in 1997 to 73.9 per cent in 2019.

- Unit labour costs (ULC) are an indicator of the cost competitiveness of the manufacturing sector and are determined by trends in labour productivity and labour compensation. While labour compensation trends in New Brunswick manufacturing lowered ULC relative to the national average, productivity development had the opposite, and stronger, effect. The result was that ULC in New Brunswick manufacturing rose from 84.0 per cent of the national average in 1997

to 97.9 per cent in 2019. In other words, the poor labour productivity performance in New Brunswick manufacturing contributed to a significant fall in the sector's cost competitiveness despite the decline in relative compensation.

- New Brunswick's manufacturing labour productivity performance varies greatly by industry. Three of the 19 three-digit NAICS manufacturing industries in New Brunswick had higher levels of output per hour than Canada in 2019: paper (151.4 per cent of the national average), primary metals (114.3 per cent) and plastics and rubber (108.8 pr cent).

- The growth rates of labour productivity also greatly varied by industry in New Brunswick over the 1997-2019, from a high of 4.26 per cent per year in electrical equipment to a low of -7.41 per cent on petroleum and coal products.

- Despite the slower labour productivity growth in the overall manufacturing sector in New Brunswick compared to Canada in 1997-2019, six of the 19 manufacturing industries experienced stronger growth.

Output per hour in New Brunswick manufacturing advanced at a robust pace from 1997 to 2004, exceeding the national average and boosting the level of real output per hour to 108 per cent of the national average by 2004 from 98.9 per cent in 1997. Manufacturing labour productivity then fell, and by 2019 the 2004 level had still not been regained. With positive productivity growth at the national level, New Brunswick's relative level of manufacturing productivity fell to 75 per cent of the national average by 2019, the second lowest among the ten provinces. This 33 percentage point fall in the province's relative manufacturing productivity level represents an unprecedented deterioration in long-term manufacturing productivity performance among the ten provinces.

Part two of the report focuses on the factors that can explain this fall-off in productivity growth. Key findings are highlighted below.

- Growth accounting estimates produced by Statistics Canada show the fall-off in total factor productivity growth (TFP) accounts for around three quarters of the fall in labour productivity growth in New Brunswick manufacturing, with much smaller but positive roles played by weaker growth in capital intensity and labour quality. Unfortunately, TFP is a measure of our ignorance and represents a starting point to explain the underlying reasons for productivity decline.

- Official figures may be underestimating the role of capital intensity in the fall-off because of definitional issues and methodological weaknesses associated with growth accounting. Use of capital stock instead of capital servicers as capital input boosts the contribution of capital intensity to one third of the fall-off. Use of the

capital's income share to weight capital intensity growth share may underestimate the contribution of this factor since technological change is largely embodied in capital equipment. But perhaps surprisingly, the industries with the largest fall-off in capital intensity growth were not necessarily the ones with the largest productivity growth fall-off.

- The report uses a number of methodologies to estimate the contribution of a manufacturing industry to overall manufacturing productivity growth. The results point to six of the 19 manufacturing industries accounting for the lion's share of the fall-off: petroleum, food, paper, wood, primary metals, and miscellaneous manufacturing. The contribution of petroleum industry to productivity is much larger when output weights are used rather than employment weight because of the extremely high level of labour productivity in the sector.

- Shifts in the relative importance of industries with different productivity levels and growth rates can impact aggregate productivity growth. Resource reallocation boosted productivity growth more in 1997-2004 than in 2004-2019. It is estimated that decline in productivity gains from resources reallocation accounted for 13 per cent of the post-2004 fall-off in manufacturing labour productivity growth in New Brunswick.

- No evidence is found that labour shortages contributed to the fall-off in labour productivity growth in New Brunswick after 2004. Indeed, the continued high unemployment rate and a relatively low unemployment-vacancy ratio in the sector suggest that labour slack may be a more important factor. Labour compensation levels in New Brunswick manufacturing are well below the national average and on a long-term basis have failed to keep up with the national rate of increase. This gives manufacturers less incentive to substitute capital for labour, slowing labour productivity growth.

- While exchanges rates can affect productivity growth in the short to medium term, there appears to be no link between developments in the value of the Canadian dollar expressed in US dollars and the evolution of manufacturing labour productivity in New Brunswick. One possible exception was the late 1990s and early 2000s when the Canadian dollar was depreciating and manufacturing productivity soaring.

- Innovation is key to productivity growth and R&D is an important component of innovation. However, New Brunswick manufacturers undertake little R&D. The adoption of best practices technologies developed in other jurisdictions plays a

much more important role in the province's innovation picture than domestic. This suggest that R&D it is unlikely to have been an important factor in explaining the post-2004 manufacturing productivity fall-off in the province. In addition, business sector R&D intensity increased after 2004 at the same time that productivity was falling, not the relationship one would expect.

This report represents a first attempt at developing an explanation for the drastic fall-off in labour productivity growth in New Brunswick manufacturing after 2004. Undoubtedly, many possible hypotheses have not been explored and can be examined in future work.

The Productivity Performance of New Brunswick Manufacturing: A Detailed Analysis, 1997-2019[1]

Introduction

Manufacturing can be the driving force of a modern economy. Unlike most services industries, much if not most of the output of the manufacturing sector is exported, increasing income and employment through the multiplier effects arising from the revenue generated by the exports. The economic performance of the sector is thus crucial for the overall health of the economy. A key metric of this economic performance is productivity.

The objective of this report is to provide a detailed analysis of the productivity performance of manufacturing in New Brunswick. The report is divided into two major parts. Part one provides a detailed overview of the manufacturing productivity in New Brunswick from 1997 to 2019[2], the period for which comprehensive industry data are available. A major turning point in the province's manufacturing productivity performance is identified in 2004, after which output per hour in the sector plummeted, falling from 108 per cent of the national average to 75 per cent by 2019. Part two of the report attempts to shed light on this important development from different angles.

Part one has six sections. It first provides an overview of trends in the importance of manufacturing in New Brunswick, relative to both the overall New Brunswick economy and to the Canadian manufacturing sector. It then reviews the data on manufacturing in the province, looking at both growth rates and levels expressed in real and nominal terms with comparisons to the national performance. The focus of the analysis is the 1997-2019 period, with some attention to cyclically neutral (peak to peak of the business cycle) sub-periods. This part also includes sections on total hours worked, productivity by province, productivity by industry, sources of productivity by industry and sources of productivity growth by growth accounting categories.

Part two on the reasons for the post-2004 fall-off in manufacturing productivity growth in New Brunswick has four sections. The first section provides a growth accounting perspective on the fall-off and the second section an industry perspective. The first section looks at whether labour shortages have played a role in the fall-off. The fourth section discusses additional explanations for the fall-off, namely weak investment, exchange rate movements, R&D developments, and economies of scale.

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[1] This report was written by Andrew Sharpe, with contributions from Gratiela-Catalina Ciorica. The author would like to thank Herb Emery and Bert Waslander for very useful comments and the Atlantic Institute for Policy Research at the University of New Brunswick for financial support. Email: andrew.sharpe@csls.ca

[2] Unfortunately, there is some inconsistency throughout the report in the dating of the periods because of data availability issue. Most time series are available for the 1997-2019 period from Statistics Canada's Canadian Productivity Accounts (Table 36-10-0480-01). However, estimates of nominal output from this source are currently available only to 2016. Statistics Canada's growth accounting estimates (Table 36-10-0211-01 and Table 35-10-0208-01) are only available to 2018.

Part One: An Overview of Manufacturing Productivity Performance in New Brunswick, 1997-2019

I. Size of the Manufacturing Sector

To provide context for the productivity analysis, this section briefly overviews trends in the absolute and relative importance (relative to both New Brunswick and Canada) of manufacturing in New Brunswick in terms of output, expressed both in real (constant dollars) and nominal terms, and labour input, measured by both employment or jobs and hour worked. The actual data upon which this discussion is based are found in the Appendix Tables that accompany this report.[3]

A. Nominal Output

Nominal output in manufacturing in New Brunswick, defined as value added expressed in current dollars, was $2,087 million in 1997 (Panel A of Chart 1 and Appendix Table 4). By 2016, it had risen to $3,119 million, although this was barely above the 2004 level of $3,072 million. Unfortunately, 2016 is the most recent year for which estimates of nominal output at the industry level are available from Statistics Canada, even though estimates in real terms are available to 2019.

Between 1997 and 2016 nominal output in manufacturing in New Brunswick increased 49.4 per cent, with virtually all the increase taking place before 2004, as shown in Panel B of Chart 1. The province's performance exceeded that at the national level where nominal output was only up 38.2 per cent over the period. New Brunswick's superior performance occurred in the pre-2004 period as after that year nominal output growth in the province lagged behind that of Canada. New Brunswick's faster nominal output growth in manufacturing relative to Canada over the 1997-2016 period resulted in the province's share of national manufacturing output rising from 1.44 per cent in 1997 to 1.61 per cent in 2004 and then falling to 1.55 per cent in 2016 (Panel D of Chart 1 and Appendix Table 4).[4]

With the rise of the service sector, it is often observed that an important structural characteristic of advanced economies is the falling relative importance of manufacturing. This was certainly the case in New Brunswick, where the share of manufacturing output in total nominal GDP fell from 13.1 per cent in 1997 to 10.7 per cent in 2016, with all the fall taking place after 2000 (Panel C of Chart 1). Indeed, manufacturing's share of total output increased between 1997 and 2000, peaking at 15.0 per cent that year. This trend was also found at the national level, with the manufacturing share of nominal output in Canada falling from 17.4 per cent in 1997 to 10.7 per cent in 2016.

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[3] The Appendix Tables are posted with this report under the research reports.

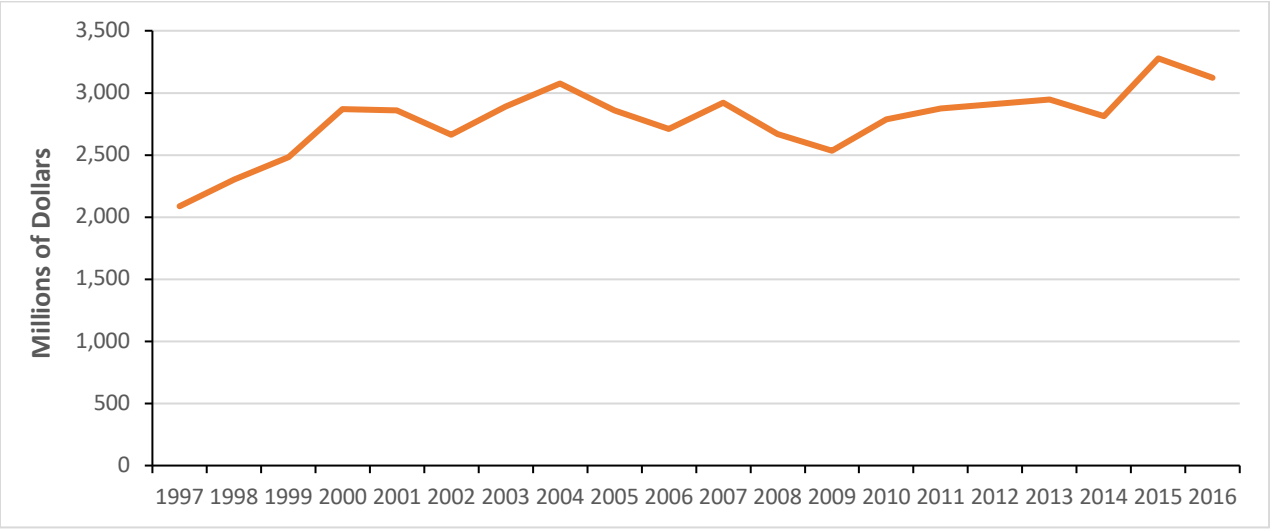
[4] It can be noted that New Brunswick's share of national nominal GDP in manufacturing at 1.65 per cent in 2015 (and 1.67 per cent in 2010) was above the 2016 share and even the 2004 share. This reflected a large fall in nominal GDP in manufacturing in 2016 in New Brunswick (-4.8 per cent), compared to a 1.3 per cent increase at the national level.

New Brunswick has historically not been manufacturing-intensive, defined as the share of manufacturing GDP in total economy GDP, below the national average.[5] This was certainly the case in 1997, when the province's manufacturing share of nominal provincial GDP output was 4.3 percentage points less than the national average (13.1 per cent versus 17.4 per cent). But by 2016, with New Brunswick's faster nominal manufacturing output growth, combined with Canada's faster total economy growth (115.3 per cent versus 95.4 per cent), the gap has been significantly reduced. Now, the province's manufacturing share of nominal output was only 0.7 percentage points below that of Canada (10.0 per cent versus 10.7 per cent). From the point of view of nominal output, in 2016 manufacturing was nearly as important in New Brunswick as at the national level.

[5] Despite being below the national average for manufacturing output intensity, which is largely determined by Ontario and Quebec, New Brunswick has been in the top half of the provinces for this indicator. See Appendix Table 56 for provincial shares of manufacturing GDP in total economy GDP in nominal terms for 1997 and 2016 and in real terms for 1997 and 2019. In 1997, New Brunswick ranked fourth in terms of manufacturing intensity for both nominal and real GDP, behind Ontario, Quebec, and Manitoba. In 2016, for nominal GDP New Brunswick still ranked fourth, although Prince Edward Island had replaced Manitoba as third. (Prince Edward Island is the only province's whose manufacturing nominal output intensity increased between 1997 and 2016). In 2019, for real GDP New Brunswick had fallen to fifth, with both Manitoba and Prince Edward Island above New Brunswick as well as Ontario and Quebec.

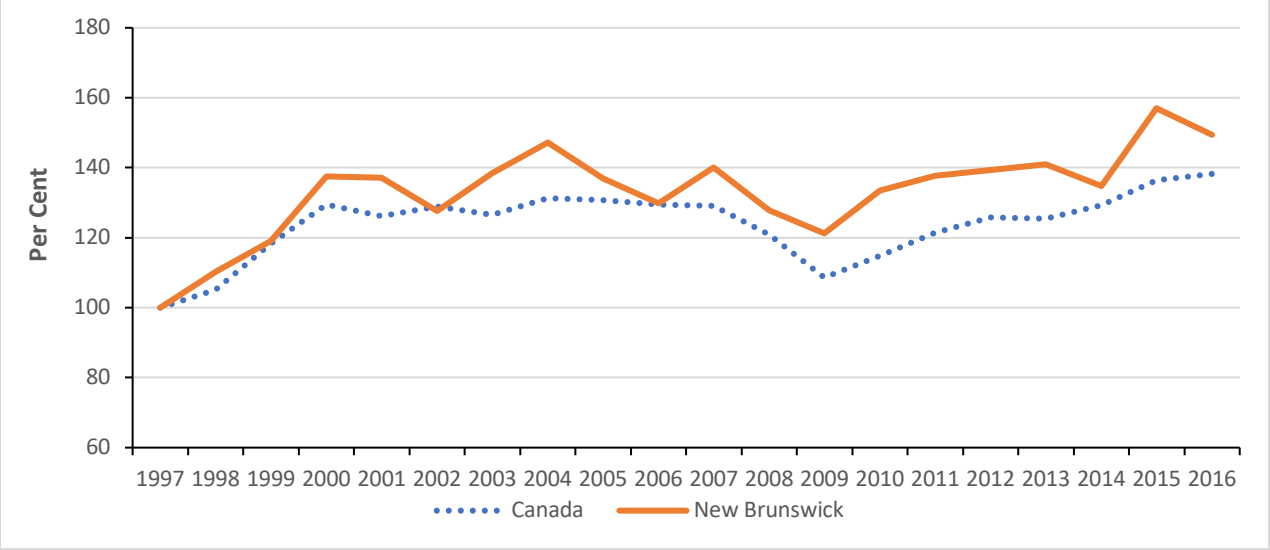
Chart 1: Trends in Nominal Value Added in Manufacturing

Panel A: Absolute Level of Nominal Value Added in New Brunswick



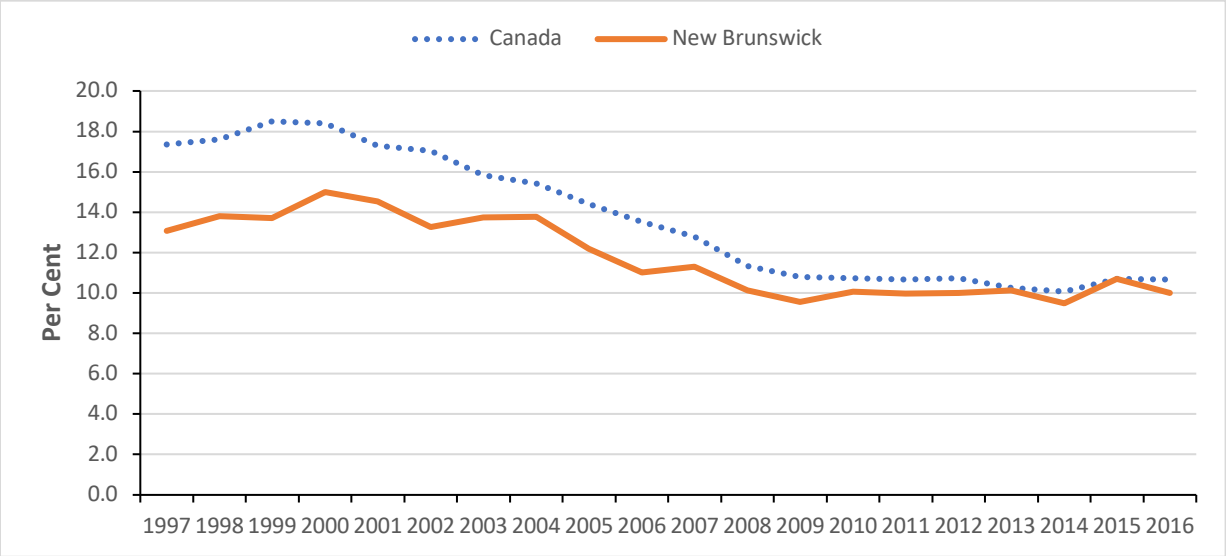
Source: Statistics Canada, Table: 36-10-0480-01

Panel B: Growth in Nominal Value Added in Manufacturing (1997 = 100) in New Brunswick and Canada



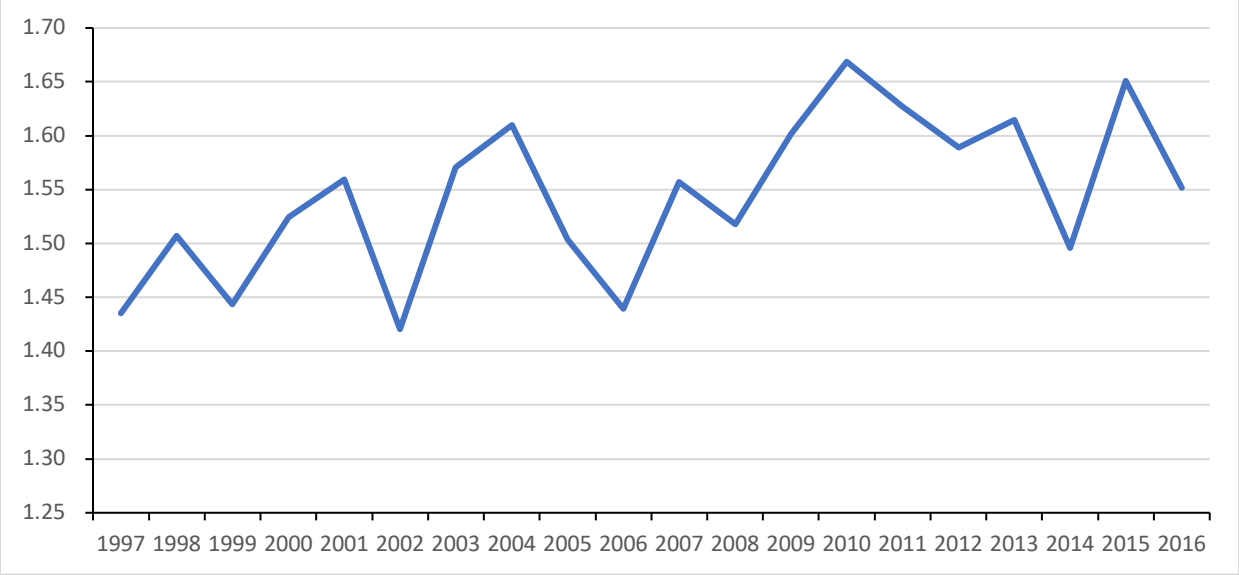
Source: Statistics Canada, Table: 36-10-0480-01

Panel C: Share of Manufacturing Nominal GDP as a Per Cent of Total Economy's GDP in New Brunswick and in Canada



Source: Statistics Canada, Table: 36-10-0480-01

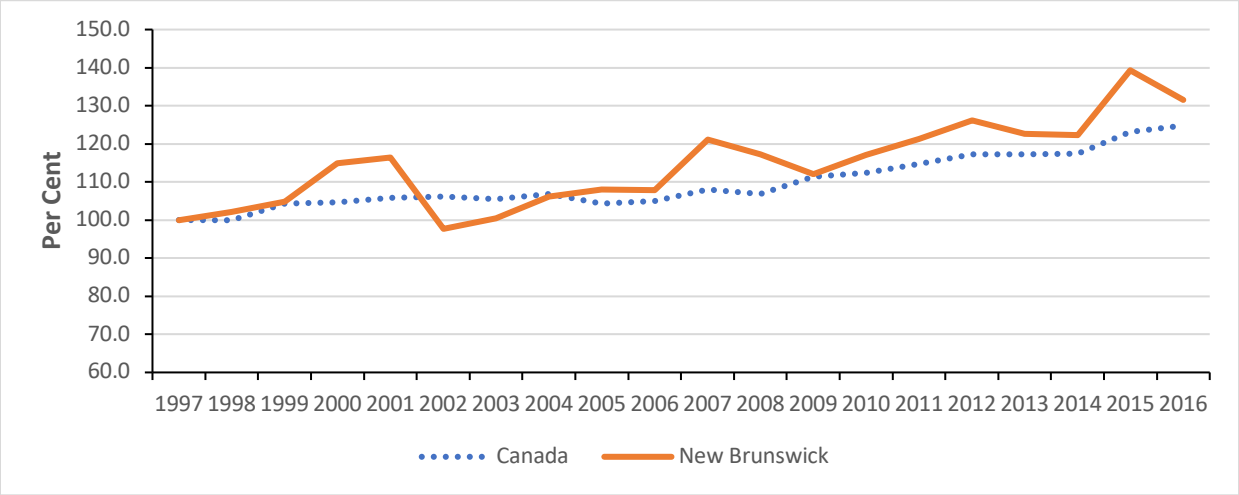
Panel D: New Brunswick's Manufacturing Nominal GDP over Canada's total Manufacturing GDP



Source: Statistics Canada, Table: 36-10-0480-01

B. Price Trends in Manufacturing

Chart 2: Deflator Growth (1997 = 100) for Manufacturing in New Brunswick and in Canada



Source: Statistics Canada, Table: 36-10-0480-01

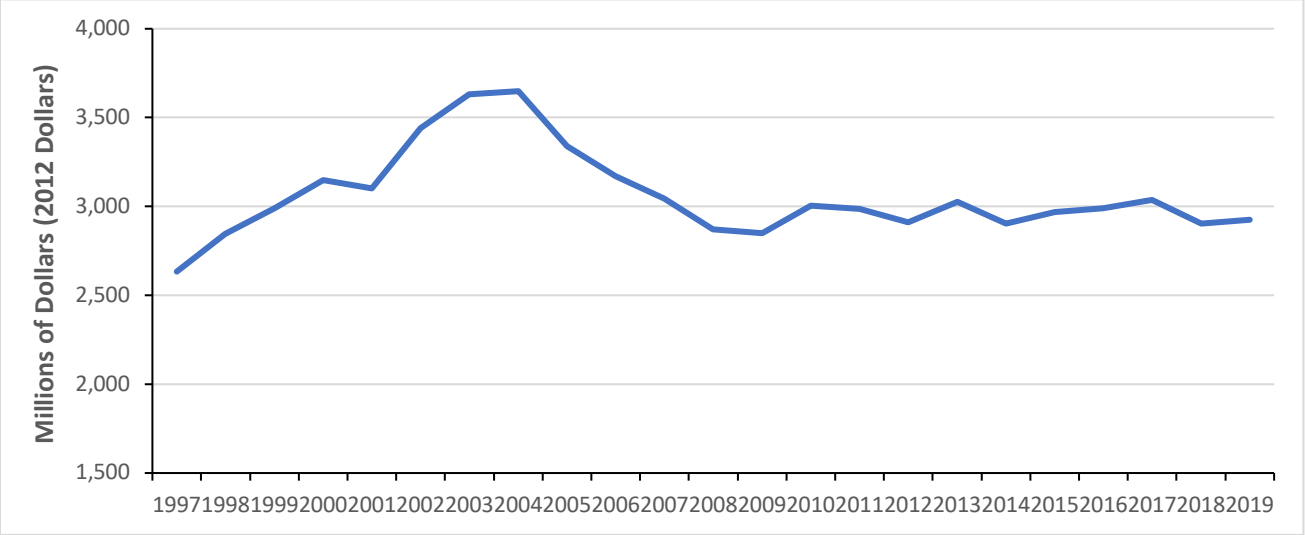
Nominal output growth must be adjusted by price changes to obtain real output growth, which is a proxy for changes in the volume or physical quantity of output. It is real output, not nominal output, that is used to calculate productivity growth.

Chart 2 and Appendix Table 6 shows the price index or implicit price deflator (nominal GDP/real GDP) for manufacturing output for New Brunswick and Canada for the 1997-2016 period. Between 1997 and 2016, the prices of manufacturing output increased 31.6 per cent in New Brunswick, above the 24.8 per cent increase in Canada, with all the greater increase taking place after 2004. This means that the difference in real output growth between the two jurisdictions will be smaller than nominal output growth because of the greater inflationary component in New Brunswick.

This higher rate of increase for the prices of manufacturing goods produced in New Brunswick does not necessarily mean that the CPI increased more in the province. Indeed, the CPI rose by the same amount (42 per cent) in New Brunswick and Canada between 1997 and 2016. Rather it may reflect composition differences in manufacturing output between New Brunswick and Canada, with the former have greater shares of output in industries experiencing strong prices increases.

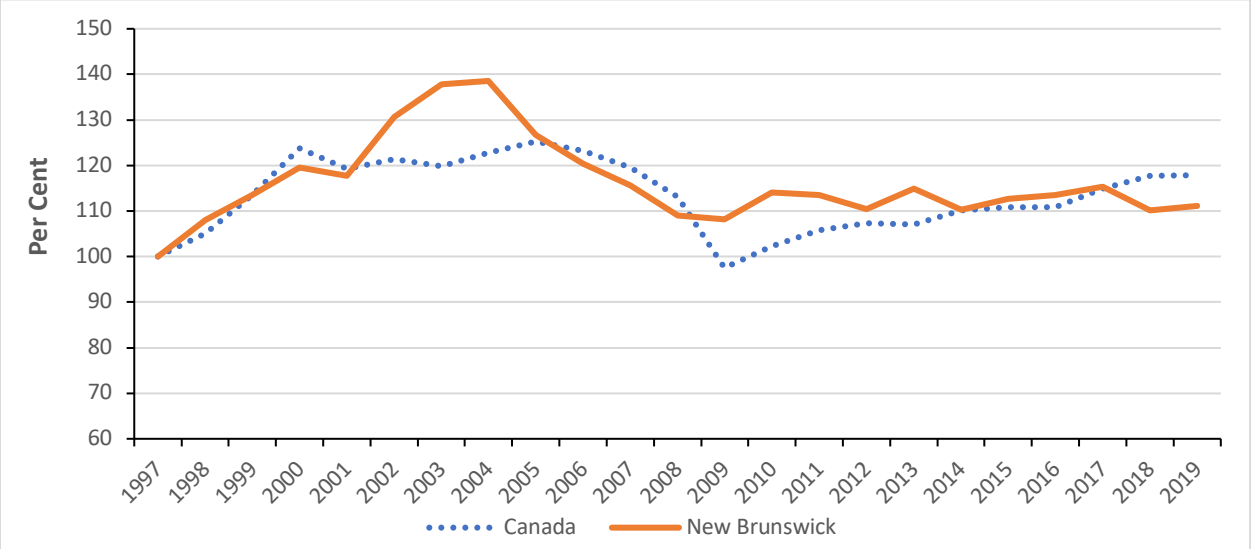
Chart 3: Trends in Real Value Added for Manufacturing

Panel A: Real Value Added in New Brunswick



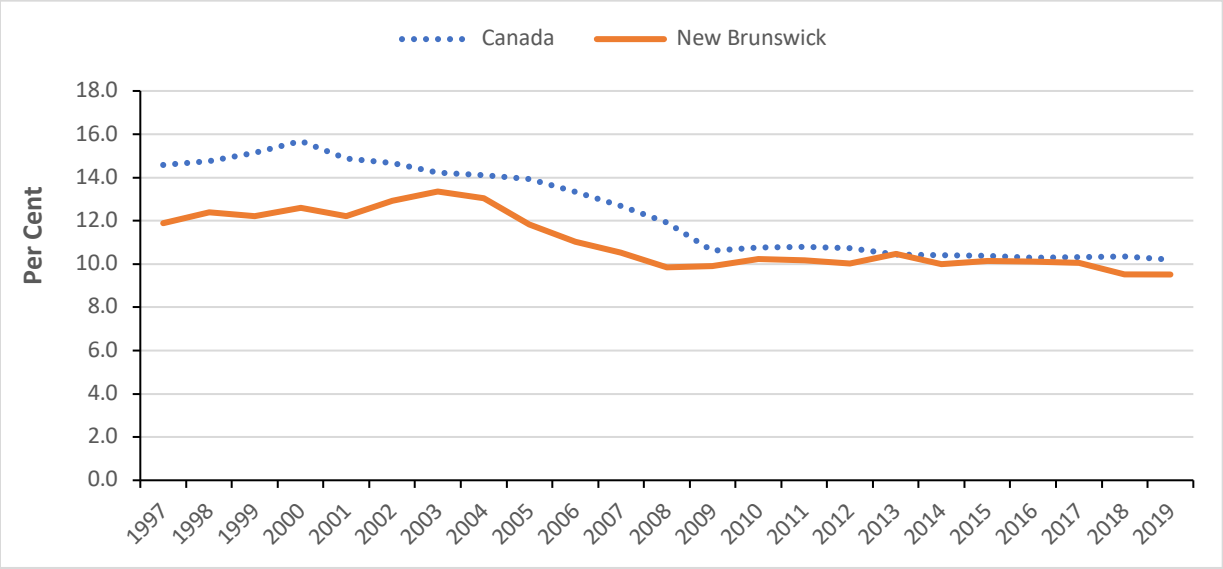
Source: Statistics Canada, Table: 36-10-0480-01

Panel B: Growth in Real Value Added in Manufacturing (1997 = 100) in New Brunswick and Canada



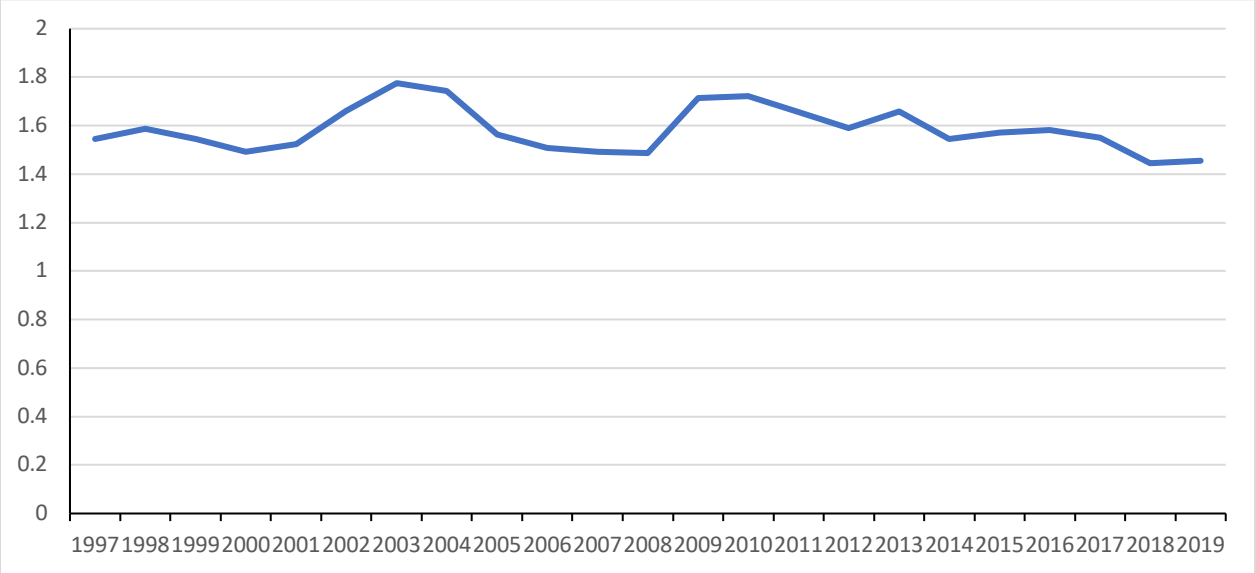
Source: Statistics Canada, Table: 36-10-0480-01

Panel C: Share of Manufacturing Real GDP as a Per Cent of Total Economy's GDP in New Brunswick and in Canada



Source: Statistics Canada, Table: 36-10-0480-01

Panel D: New Brunswick's Manufacturing Real GDP as a share of Canada's total Manufacturing GDP



Source: Statistics Canada, Table: 36-10-0480-01

C. Real Output

Real output in manufacturing, defined as value added expressed in constant 2012 dollars, was $2,633 millions in New Brunswick in 1997 (Panel A of Chart 3 and Appendix Table 1). By 2019, it had risen to $2,925 million, although this was down from the 2004 peak level of $3,648 million.

Between 1997 and 2019 real output in manufacturing in New Brunswick increased 11.1 per cent, well below the much larger (49.8 per cent to 2016) rise in nominal output due to inflation. All the increase took place before 2004 (Panel B of Chart 3), as was the case for nominal output. The province's performance was inferior to that at the national level where real output was up 17.9 per cent over the period. This reversal reflected two factors, the greater inflation in New Brunswick and the change in the comparison period from 1997-2016 to 1997-2019 due to the three additional years of real output data. From 2016 to 2019 real output fell 2.2 per cent in New Brunswick, compared to a 6.5 increase in Canada.

New Brunswick's slower real output growth in manufacturing relative to Canada over the 1997-2019 period resulted in the province's share of national manufacturing output falling from 1.54 per cent in 1997 to 1.45 per cent in 2019, with a peak of 1.78 per cent in 2004 (Panel D in Table 3 and Appendix Table 1).

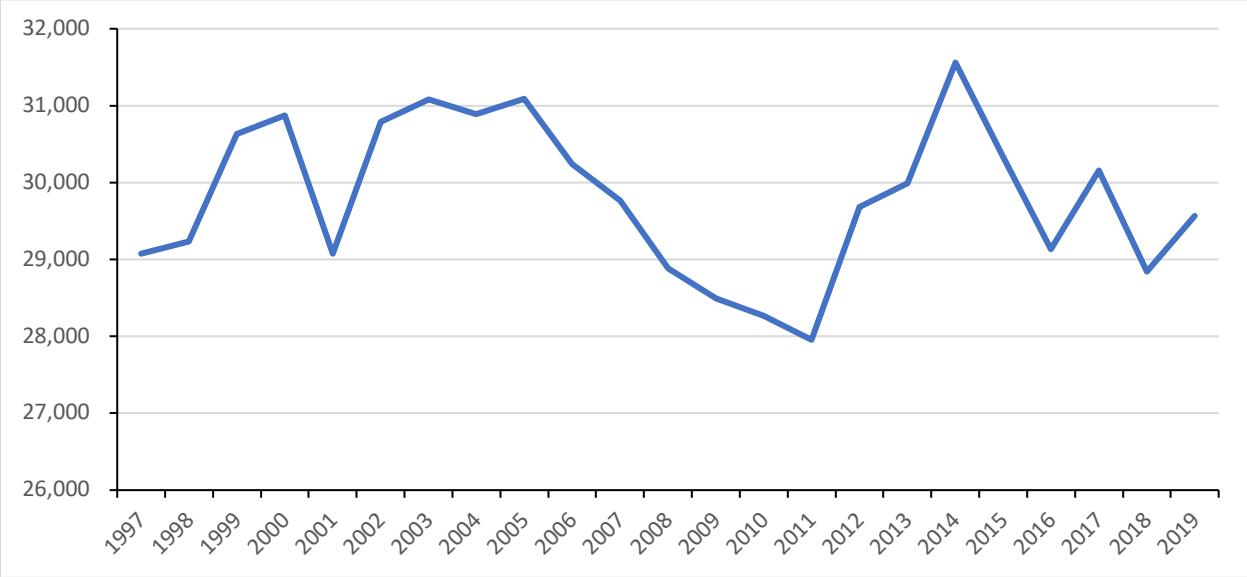
The falling relative importance of manufacturing in the total economy observed for nominal output was found for real output, although to a somewhat lesser extent due to falling price of manufactured goods relative to services. In New Brunswick, the share of manufacturing output in real GDP fell from 11.9 per cent in 1997 to 9.5 per cent in 2019, with all the fall taking place after 2003 (Panel C of Chart 3). Indeed, manufacturing's share of total output increased between 1997 and 2003, peaking at 13.4 per cent that year. This trend also obtained at the national level, with the manufacturing share of real output in Canada falling from 14.6 per cent in 1997 to 10.2 per cent in 2016.

Like nominal output, the relative importance of manufacturing real GDP in the total economy in New Brunswick has historically been below the national average. In 1997, the province's manufacturing share of real provincial GDP output was 2.7 percentage points less than the national average (11.9 per cent versus 14.6 per cent). But by 2019, New Brunswick's share of real manufacturing in total output was only 0.7 points less than the Canadian average, 9.5 per cent versus 10.2 per cent (Panel C in Table 3). From the point of view of real output, in 2019, there was not a significant difference in the relative importance of manufacturing between New Brunswick and Canada.

This narrowing of the gap in manufacturing output shares reflected the faster growth of the total economy relative to manufacturing in Canada compared to New Brunswick. Between 1997 and 2019, in Canada, total economy real output increased 68.5 per cent and manufacturing real output rose 17.9 per cent, a difference of 50.6 points. In contrast in New Brunswick, total economy real output was up 38.7 per cent and manufacturing real output 11.0 per cent, a difference of 27.7 points.

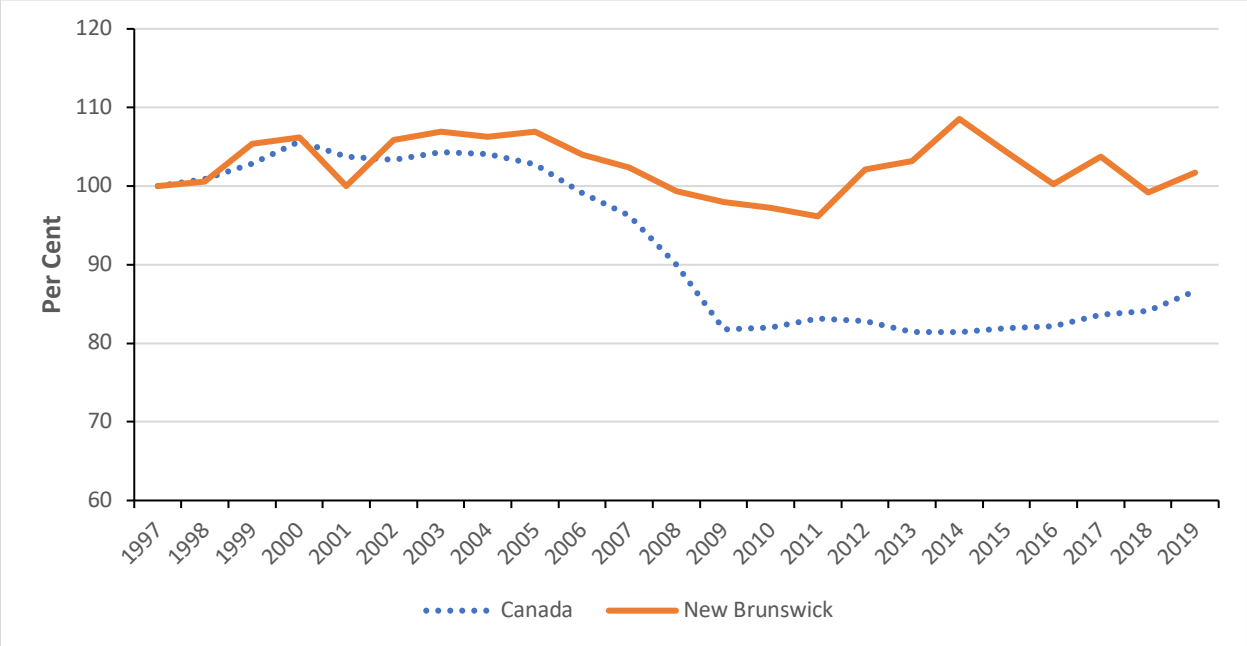
Chart 4: Trends in Jobs for Manufacturing

Panel A: Jobs for Manufacturing in New Brunswick



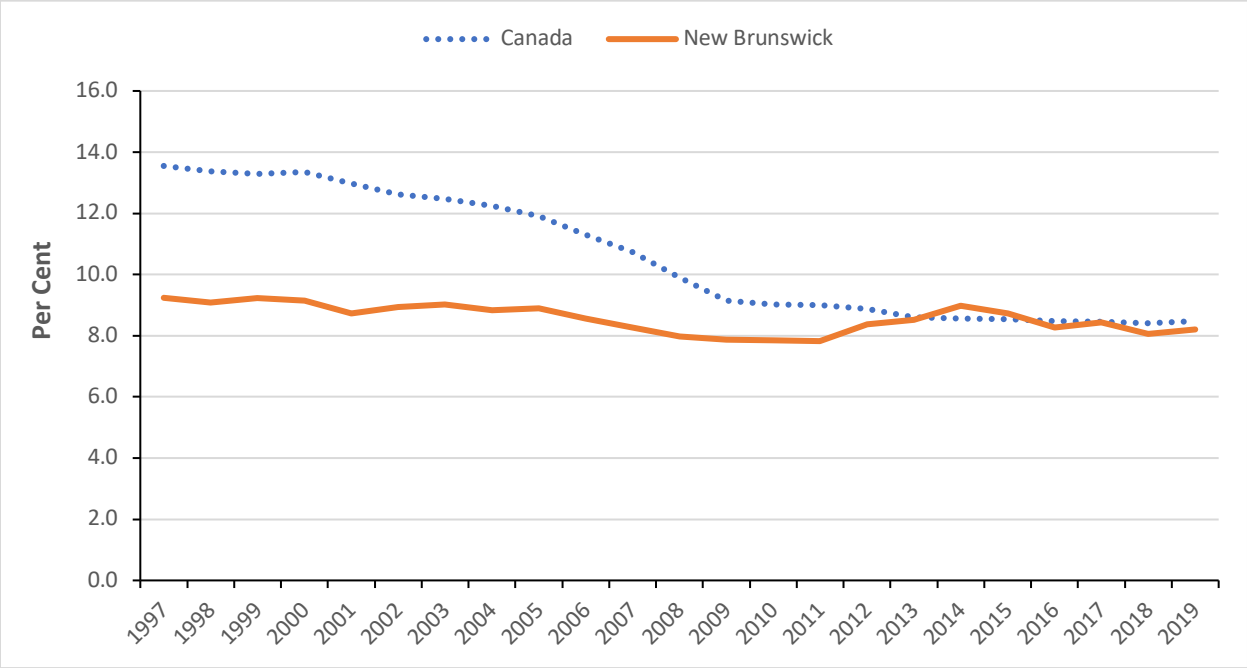
Source: Statistics Canada, Table: 36-10-0480-01

Panel B: Growth in Jobs for Manufacturing (1997 = 100) in New Brunswick and Canada



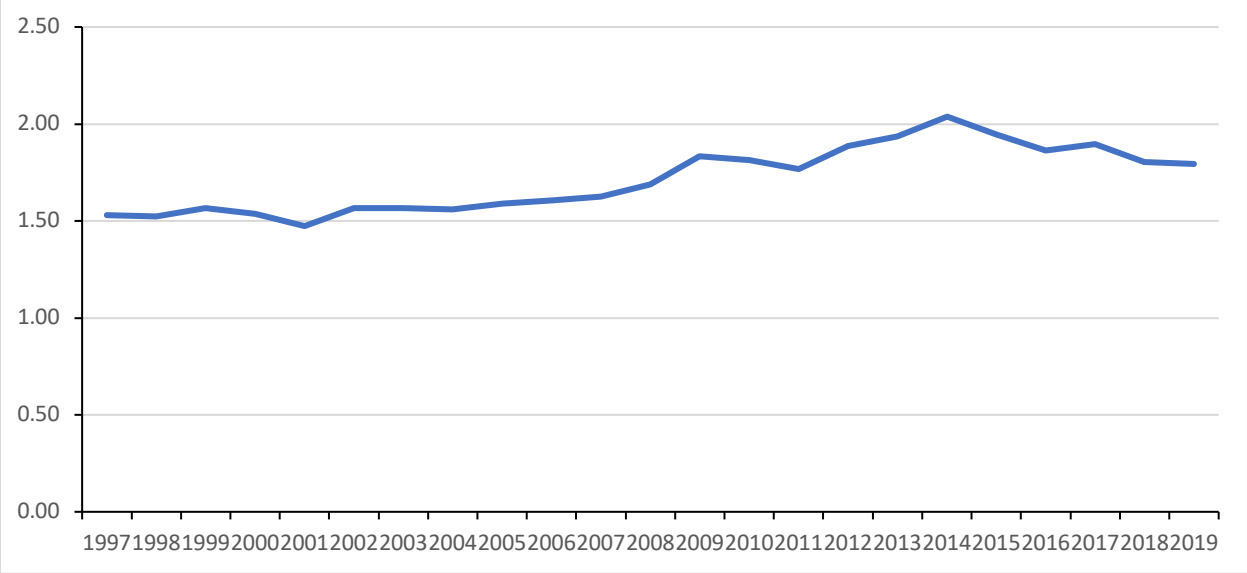
Source: Statistics Canada, Table: 36-10-0480-01

Panel C: Share of Manufacturing Jobs as a Per Cent of Total Economy's Jobs in New Brunswick and in Canada



Source: Statistics Canada, Table: 36-10-0480-01

Panel D: New Brunswick's Manufacturing Employment as a share of Canada's total Manufacturing Employment



Source: Statistics Canada, Table: 36-10-0480-01

D. Jobs

The number of manufacturing jobs in New Brunswick, as estimated by the Canadian Productivity Accounts based on data from both the Labour Force Survey (LFS) and the Survey of Employees, Payrolls and Hours (SEPH) was 29,075 in 1997 (Panel A of Chart 4 and Appendix Table 7). By 2019, it had risen to 29,565.

New Brunswick's 1.7 per cent increase in manufacturing employment between 1997 and 2019 may seem a very poor jobs performance, but it greatly exceeded that at the national level, where manufacturing employment fell 13.4 per cent over the same period as shown in Panel B of Chart 4. Both New Brunswick and Canada experienced large declines in manufacturing employment in the second half of the 2000s. But New Brunswick, unlike Canada, saw a strong rebound in manufacturing employment in the early 2010s and surpassed the pre-recession level by 2014.

New Brunswick's faster jobs growth in manufacturing relative to Canada over the 1997-2016 period resulted in the province's share of national manufacturing employment rising from 1.53 per cent in 1997 to 1.79 per cent in 2019, with a peak of 2.04 per cent in 2014 (Panel D of Chart 4 and Appendix Table 7).

As noted, with the rise of the service sector, there have been large declines in advanced economies in the relative importance of manufacturing in total employment. Perhaps surprisingly, this has not been the case in New Brunswick, where the share of manufacturing employment in total economy employment has fallen only slightly from 9.2 per cent, in 1997, to 8.2 per cent in 2019 (Panel C of Chart 4). This in part reflects the failure of the New Brunswick economy to generate employment opportunities outside manufacturing. Total employment only rose 14.6 per cent from 1997 to 2019, with all the increase taking place by 2009. In contrast, total employment was up 38.5 per cent in Canada in 1997-2019.

New Brunswick's relatively stable manufacturing employment share, down only 1.0 percentage points between 1997 and 2019, lies in contrast to the 5.0 percentage point fall in the manufacturing employment share at the national level, from 13.5 per cent in 1997, to 8.5 per cent in 2019 (Panel C in Chart 4). Among the provinces, New Brunswick recorded the smallest fall in its manufacturing employment share between 1997 and 2019. Prince Edward Island was the only province that saw its manufacturing employment share rise (Appendix Tables 8 and 57).

New Brunswick has historically been below the national average in terms of the employment intensity of manufacturing, defined as the share of manufacturing employment in total economy employment.[6] This was certainly the case in 1997, when the province's

[6] Despite being below the national average for manufacturing employment intensity, which is largely determined by Ontario and Quebec, New Brunswick has been ranked near the middle among the provinces for this indicator. See Appendix Table 57 for provincial shares of manufacturing employment in total economy employment for 1997 and 2019. In 1997, New Brunswick ranked sixth in terms of manufacturing employment intensity, behind (in order) Ontario, Quebec, Manitoba, Nova Scotia, and British Columbia. In 2019, the ranking had improved to fourth, behind Ontario, Quebec, and Manitoba. An identical ranking was obtained for the share of hours worked in manufacturing in total economy hours worked in the two years.

manufacturing share of provincial employment output was 4.3 percentage points less than the national average (9.2 per cent versus 13.5 per cent). But by 2019, with New Brunswick's faster manufacturing employment growth relative to Canada (1.7 per cent versus -13 per cent), combined with Canada's faster total economy employment growth relative to New Brunswick (38.5 per cent versus 14.6 per cent) the gap has been significantly reduced and the province's manufacturing employment share was now only 0.3 percentage points below that of Canada (8.2 per cent versus 8.5 per cent). From the point of view of employment, manufacturing is as important in New Brunswick as at the national level because of the greater deindustrialization at the national level.

The constancy of the level of manufacturing employment in New Brunswick over the 1997-2019 period, as well as the relative stability of the sector's share of total economy employment, are key structural characteristics of the New Brunswick economy that differentiates it from Canada and other provinces.

E. Total Hours Worked

The measure of labour input used for labour productivity calculations is total actual hours worked, which, unlike employment, captures changes in average hours. Total hours worked is of course the product of average hours and the number of jobs. Average hours are relatively stable over time, as least compared to employment, so there are not major differences in growth rates of employment and total hours worked, and hence growth rates for the two measures of labour productivity, the preferred metric of output per hour and the second measure of output per person employed. Still there are differences that need to be recognized.

Chart 5 highlights two differences related to hours worked in manufacturing between New Brunswick and Canada. First, the average annual number of hours worked over the 1997-2019 period in New Brunswick has been consistently above the Canadian average. In 2019, the average person employed in manufacturing worked 2,055 hours in New Brunswick, 7.4 per cent above the national average of 1,913 hours. Second, average hours worked in manufacturing in New Brunswick have increased over time, while they have fallen in Canada. Between 1997 and 2019, average hours increased 0.8 per cent in New Brunswick and fell 4.1 per cent in Canada.

There are two implications of these trends. First, the higher average hours worked in New Brunswick than in Canada means that the province will performance better in terms of output per person employment than output per hour worked relative to Canada. Indeed, in 2019 output per person employed in manufacturing in New Brunswick was 81.0 per cent of the national level, compared to 75.4 per cent for output per hour. Second, the 0.04 per cent average annual increase in average hours in manufacturing in New Brunswick between 1997 and 2019 (Table 1) compared to the 0.19 per cent annual fall in Canada means that there will be a difference between the growth rates for total employment and total hours worked between the two jurisdictions, with implications

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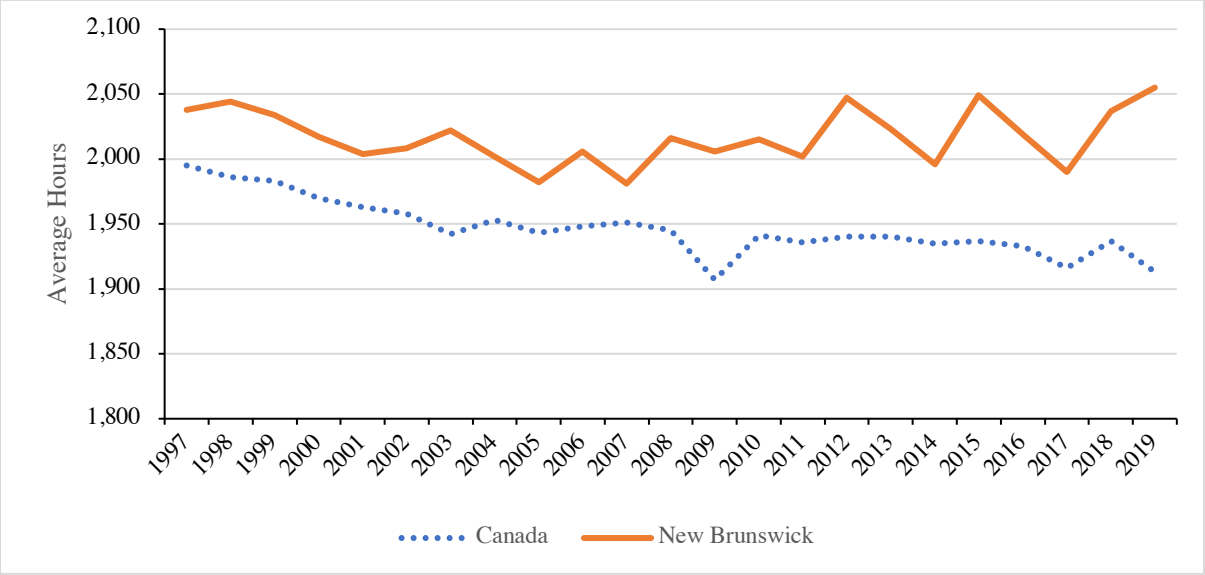
for productivity trends. Total hours worked grew 0.95 percentage points per year faster in New Brunswick (0.11 per cent versus -0.84 per cent) over the 1997-2019 period, compared to 0.73 percentage points faster (0.08 per cent versus -0.65 per cent) for employment. This translates directly into a 0.22 percentage point greater output hours growth in New Brunswick than in Canada, resulting in output per hour being 0.22 percentage points weaker than output per person employed compared to Canada.

Table 1: Total Number of Jobs, Annual Average of Hours for all Jobs and Total Hours Worked for Manufacturing in Canada and in New Brunswick, 1997-2019, (Compound Annual Growth Rate)

Variables	**Total Number of Jobs**		**Annual Average of Hours for All Jobs**		**Total Hours Worked**	
Compound annual growth rate	Canada	New Brunswick	Canada	New Brunswick	Canada	New Brunswick
1997-2019	-0.65	0.08	-0.19	0.04	-0.84	0.11
1997-2016	-1.03	0.01	-0.17	-0.05	-1.19	-0.04
1997-2000	1.86	2.02	-0.42	-0.34	1.42	1.66
1997-2004	0.57	0.87	-0.30	-0.25	0.26	0.61
2004-2019	-1.22	-0.29	-0.14	0.17	-1.35	-0.12
2000-2008	-1.99	-0.83	-0.16	-0.01	-2.14	-0.83
2008-2019	-0.35	0.21	-0.15	0.17	-0.50	0.39
2008-2014	-1.66	1.49	-0.09	-0.17	-1.75	1.33
2014-2019	1.24	-1.30	-0.23	0.58	1.02	-0.72

Source : Statistics Canada, Table : 36-10-0480-01

Chart 5: Annual Average of Hours Worked for All Jobs for Manufacturing in Canada and in New Brunswick, 1997-2019



Source: Statistics Canada, Table: 36-10-0480-01

II. Labour Productivity in Manufacturing in New Brunswick, 1997-2019

This section looks at the levels and the growth rate of labour productivity, defined as real value added per hour, and labour productivity levels in nominal terms, in New Brunswick with comparison to Canada. Labour productivity growth is the difference between real output growth and labour input growth, measured by total hours worked.

We use the Statistics Canada data found in the Canadian Productivity Accounts (CPA), as found in Table 36-10-0480-01.[7] Among the estimates presented in this section, we will focus our attention on data for labour productivity, real value added, nominal value added (available until 2016), and total hours worked for the manufacturing sector.

A. Labour productivity in terms of real value added

1. Labour productivity growth

In Canada, labour productivity in the manufacturing sector grew at a rate of 1.61 per cent per year between 1997 and 2019 (Table 2). This development reflected average annual growth in real value added of 0.75 per cent and negative growth in total hours of 0.84 per cent per year.

[7] This table contains estimates for all ten provinces for all three-digit NAICS industries for the following variables: total number of jobs, hours worked for all jobs, annual average number of hours worked for all jobs, total compensation for all jobs, nominal value added, real value added, labour productivity defined as real GDP per hour worked, total compensation per hour worked, unit labour cost, unit labour cost in US dollars and labour share.

New Brunswick had much weaker growth in manufacturing labour productivity between 1997-2019: 0.36 per cent per year, a difference with Canada's growth of 1.25 percentage points. The province's growth in real value added was 0.48 per cent per year. Unlike at the national level where hours worked in manufacturing fell, in New Brunswick, hours worked in manufacturing increased slightly at a rate of 0.11 per cent per year. The slower growth in real value added, combined with the increase in hours worked accounts for New Brunswick's considerably slower manufacturing labour productivity growth.

In contrast to manufacturing, the labour productivity performance of the business sector in New Brunswick over the 1997-2019 period was comparable to the national average. Output per hour advanced 1.17 per cent per year, only 0.10 percentage points less than the 1.27 per cent growth rate for Canada.[8] In other words, the province's aggregate productivity growth performance was much better in absolute and relative terms than that of manufacturing. Since real wages and incomes are driven by aggregate labour productivity trends, not those of a particular sector, this aggregate performance is much more important than that of manufacturing for the real incomes and economic well-being of New Brunswickers.[9]

Table 2: Real Value Added, Total Hours Worked and Labour Productivity (2012 dollars) for Manufacturing for Canada and New Brunswick, 1997-2019, (Compound Annual Growth Rates)

Variables	**Real Value Added**		**Total Hours Worked**		**Labour Productivity**	
Compound annual growth rate	Canada	New Brunswick	Canada	New Brunswick	Canada	New Brunswick
1997-2019	0.75	0.48	-0.84	0.11	1.61	0.36
1997-2016	0.54	0.67	-1.19	-0.04	1.76	0.72
1997-2000	7.35	6.14	1.42	1.66	5.88	4.45
1997-2004	2.98	4.77	0.26	0.61	2.73	4.15
2004-2019	-0.27	-1.46	-1.35	-0.12	1.09	-1.35
2000-2008	-1.11	-1.15	-2.14	-0.83	1.04	-0.32
2008-2019	0.38	0.17	-0.50	0.39	0.89	-0.22
2008-2014	-0.44	0.19	-1.75	1.33	1.34	-1.11
2014-2019	1.37	0.15	1.02	-0.72	0.35	0.85

Source : Statistics Canada, Table : 36-10-0480-01

Between 1997-2019, there were business cycle peaks in 2000, 2008 and 2019, with two fully cyclically neutral peak-to-peak periods and the initial three years of the times series for 1997-2000. In all three periods, the labour productivity growth in New Brunswick lagged that of Canada,

[8] In 2021, the Centre for the Study of Living Standards plans to release a study on the aggregate productivity developments in New Brunswick in 1997-2019.

[9] In 2021, the Centre for the Study of Living Standards (CSLS) plans to release a study on trends in economic well-being, as measured by the CSLS Index of Economic Well-being in New Brunswick from 1981 to 2019 and a study on income developments in the province.

although in absolute terms the productivity growth rates were very different in the three periods. The most recent period, from 2008 to 2019 is the longest. Because of the length, we break it into two sub-periods at 2014. This year changes the story, after with faster labour productivity growth in for New Brunswick than Canada in the last five years. Let us now focus on the selected sub-periods, between 1997-2019, to analyze the evolution of the growth rates (Table 2) of labour productivity for manufacturing in Canada and in New Brunswick.

The beginning of the period, from 1997-2000, was marked by an impressive increase in the growth rate of labour productivity for both the country (5.88 per cent per year) and the province (4.45 per cent per year). Both Canada and New Brunswick had strong increases in real value added, 7.35 per cent per year and 6.14 per cent per year, respectively. To support this increase in production, the total hours worked in the manufacturing sector also increased by 1.42 per cent per year for Canada and 1.66 per cent per year for New Brunswick, slightly reducing the impact of the annual growth rate of real value added on labour productivity. This three-year period was the last period of very solid output and productivity growth enjoyed by both New Brunswick and Canada. Economists believe that the late 1990s boom in both Canada and the United States was linked to the introduction of information and communications technologies (ICT) and their positive impact on productivity.

During the sub-period 2000-2008, labour productivity growth in Canadian manufacturing fell to 1.04 per cent per year. This slowdown was caused by the massive fall in real value added growth to -1.11 per cent per year, a major turnaround of 8.46 percentage points from the 7.35 per cent average annual increase in 1997-2000. The growth rate of hours worked fell 3.56 percentage points from 1.42 per cent per year in 1997-2000 to -2.14 per cent per year in 2000-2008. The larger decline in hours than in output in 2000-2008 explains the increase in labour productivity. The 2000s were a dismal period for Canadian manufacturers due to a number of factors, including increased competition from developing countries, especially China and an appreciation of the exchange rate.

New Brunswick experienced a 0.32 per cent average annual decrease in labour productivity from 2000 to 2008, in contrast to the increase at the national level. However, while the province closely followed Canada's output developments with a decline in real value added growth of 7.29 percentage points to -1.15 per cent per year from 6.14 per cent in 1997-2000. Growth in total hours worked in manufacturing decreased only 2.49 percentage points from 1.66 per cent in 1997-2000 to -0.83 per cent in 2000-2008. Given the similar declines in manufacturing real output in New Brunswick and Canada in 2000-2008 (-1.15 per cent and -1.11 per cent respectively), the smaller decline in hours worked in New Brunswick translated into a poorer labour productivity performance (-0.32 per cent versus 1.04 per cent).

As for the last cyclically neutral period, from 2008 to 2019, Canada's labour productivity improved at a rate of 0.89 per cent per year. This resulted from the increase in real value added of 0.38 per cent per year and a continuing decline in hours worked in manufacturing (-0.50 per cent per year). New Brunswick, on the other hand, had a further decline of 0.22 per cent per year in its labour productivity. The province's real value added increased at a pace of 0.17 per cent per year, approximately half of Canada's growth rate. Regarding hours worked, unlike Canada, New Brunswick has increased its hours by 0.39 per cent per year, well ahead Canada's rate.

Given the long duration of the business cycle from the 2008 peak to the 2019 peak, it is useful to analyse the growth rates for the 2008-2014 and 2014-2019 sub-periods. In the 2008-2014 sub-period, Canada had manufacturing labour productivity growth of 1.34 per cent per year, based on a fall in real value added of 1.75 per cent per year and a fall in hours worked of 0.44 per cent per year. On the other hand, New Brunswick saw a fall in labour productivity by 1.11 per cent per year, because the increase in hours worked (1.33 per cent per years) exceeded real value added growth (0.19 per cent per year).

Finally, in 2014-2019, the situation was reversed, and New Brunswick experienced faster labour productivity growth in manufacturing than Canada: 0.85 per cent versus 0.35 per cent per year. Canada enjoyed a strong rebound in real added growth of 1.81 percentage points from -0.44 per cent in 2008-2014 to 1.37 per cent per year in 2014-2019, compared to virtually no change in New Brunswick (0.15 per cent versus 0.19 per cent). But the most important difference in developments between New Brunswick and Canada relates to hours. The growth rates of hours worked in manufacturing was 2.77 percentage points faster in Canada in 2014-2019 than in 2008-2014 (1.02 per cent versus -1.75 per cent). In contrast, growth in hours worked for New Brunswick was 2.05 percentage points slower in 2014-2019 than in 2008-2014 (-0.72 per cent versus 1.33 per cent). Despite the slower output growth in New Brunswick, the much weaker hour growth than at the national level translated into a better productivity performance.

In conclusion, in terms of labour productivity, Canada experienced strong growth in 1997-2000 (5.88 per cent per year), followed by a slowdown in productivity growth in 2000-2008 (1.04 per cent per year) and a further reduction in growth in 2008-2019 (0.89 per cent per year). The first part of the post-2008 period (until 2014) had stronger productivity growth (1.34 per cent per year), while in the post-2014 period, productivity growth weakened to only 0.35 per cent per year.

New Brunswick also enjoyed strong growth rate (4.45 per cent per year) in 1997-2000. Unlike Canada, in 2000-2008 and in 2008-2019, New Brunswick experience negative productivity growth in manufacturing, (-0.32 per cent per year and -0.22 per cent per year, respectively). The fall in the post-2008 period was concentrated in 2008-2014 (-1.11 per cent per year) as the 2014-

2019 period saw a rebound in productivity growth to 0.85 per cent per year), greater than that of Canada[10].

2. Labour Productivity Levels

In 1997, the level of manufacturing labour productivity in New Brunswick was $44.40 per hour (2012 dollars), virtually identical with Canada's level of $44.90 per hour (Panel A in Chart 6 and Appendix Table 3). Manufacturing productivity in Canada reached its highest level at the end of the period, in 2018, at $64.8 per hour. In contrast, New Brunswick's manufacturing productivity level peaked in 2004 at $59.00 per hour, then fell more or less continuously, reflecting negative productivity growth. In 2019, Canada had a labour productivity of $63.80 per hour, 42.1 per cent higher than the 1997 level, while New Brunswick had a productivity of $48.1 per hour, an increase of only 8.3 per cent from its 1997 level.

Manufacturing labour productivity in Canada has experienced an upward trend over the 1997-2019 period. On the other hand, in New Brunswick, manufacturing productivity increased from 1997 to 2004, and then fell. After an increase of $14.60 per hour (2012 dollars) between 1997 and 2004, the province's productivity plunged $9.70 per hour over the next four years until 2008 and remained around this level for the next 11 years. By 2019, labour productivity in the province was 18.5 per cent less than the 2004 level.

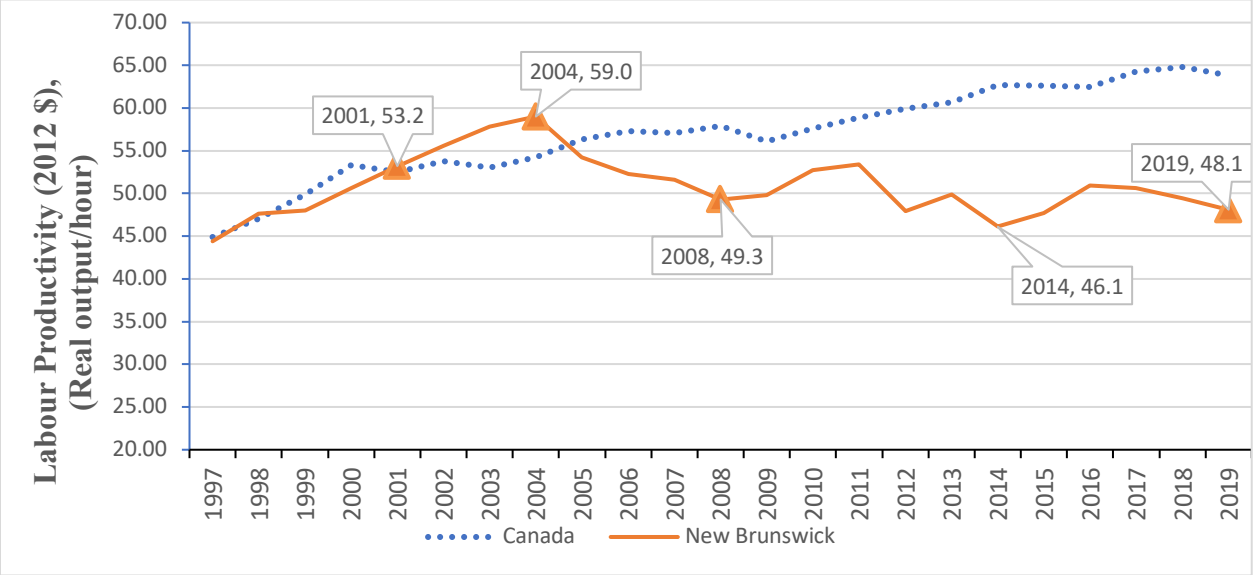
Another way to measure the deterioration in New Brunswick's labour productivity performance in manufacturing is to track its productivity level relative to the national average. In 1997, New Brunswick's manufacturing labour productivity was 98.9 per cent of Canada's level (Panel B in Chart 6 and Appendix Table 3). In 2001-2004, its labour productivity exceeded that of Canada, reaching 109.1 per cent in 2003 and 108.9 per cent in 2004. After 2004, the province's relative level fell more or less continuously until 2014, when it troughed at 73.5 per cent of the national level. Since then, it has increased slightly, and by 2019 was 75.4 per cent of the national level.

Trends in the province's relative manufacturing productivity level reflects differences in labour productivity growth between the country and the province. The deterioration since 2004 was due to faster manufacturing productivity growth in Canada than in New Brunswick. The second part of this report examines in detail the reasons for this post-2004 deterioration.

[10] The New Brunswick business sector saw significant differences in productivity growth in sub-periods, with similar patterns to manufacturing. Output per hour growth was most rapid in 1997-2000 at 2.88 per cent per year, fell off to 1.24 per cent in 2000-2008 and then to 0.65 per cent in 2008-2019. However, in the most recent sub-period (2014-2019) business sector productivity growth was higher than in 2008-2014 (0.95 per cent versus 0.41 per cent per year).

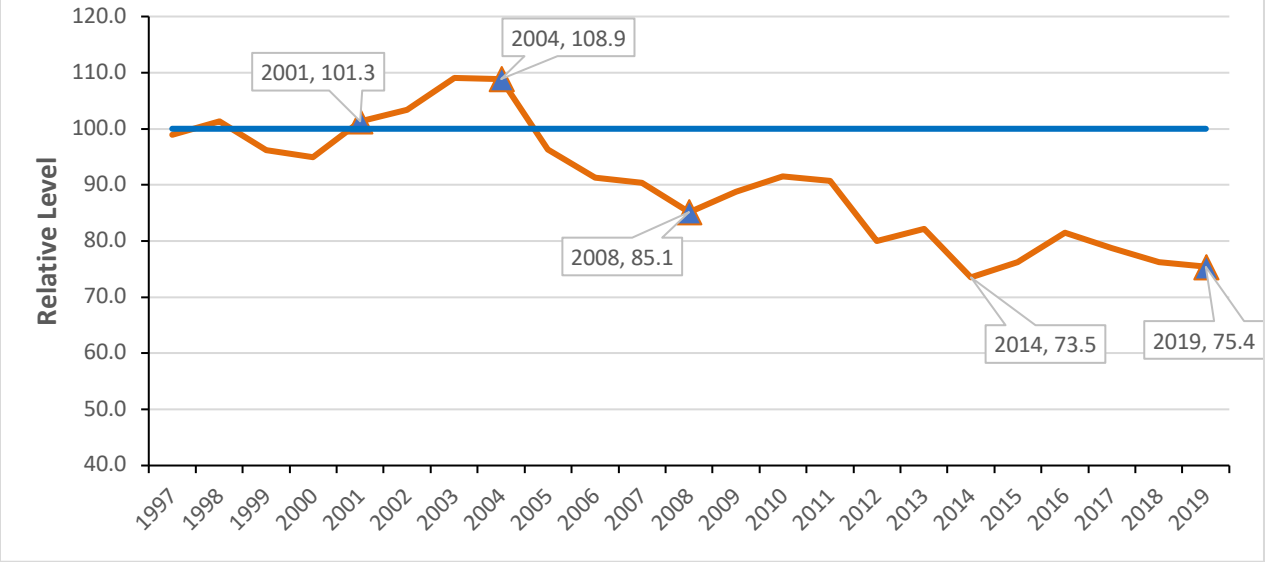
Chart 6: Labour Productivity (2012 dollars) for Manufacturing in Canada and in New Brunswick, 1997-2019

Panel A: Absolute Level of New Brunswick's Labour Productivity compared to Canada's Labour Productivity



Source: Statistics Canada, Table: 36-10-0480-01

Panel B: Relative Level for New Brunswick's Labour Productivity compared to Canada's Labour Productivity, (Canada = 100 for all years)



Source: Statistics Canada, Table: 36-10-0480-01

B. Nominal Value Added per hour worked

1. Growth in Nominal Value Added per hour worked

This section will analyze nominal value added per hour for the manufacturing sector in Canada and New Brunswick. Before proceeding, two points need to be made. First, changes in nominal value added per hour are not a productivity growth measure as it includes an inflation component. Productivity growth rates must be based on real or constant price output, which is a proxy for physical output. However, the level of nominal value added per hour is a measure of labour productivity as productivity levels can be measured in both real and value terms, the later including prices changes, both absolute and relative. Second, there is a three-year lag by Statistics Canada in the release on nominal output estimates. This means that the analysis of trends in nominal value added per hour ends in 2016.

A comparison of nominal and real value added per hour allows one to see the importance of inflation for the growth of nominal value added per hours worked. For the 1997-2016 period, the manufacturing nominal value added per hour worked increased 2.95 per cent per year in Canada compared to 1.76 per cent for real value added per hour worked (Table 3). The difference of 1.19 percentages points reflects the rate of increase in the prices of manufactured goods.

In New Brunswick, nominal value added per hour worked in manufacturing was 2.18 per cent per year over the 1997-2016 period, compared to 0.72 per cent for real value added. The difference of 1.46 percentage points is the rate of increased in manufacturing process in New Brunswick.

Two observations flow from these numbers. First, as already observed, inflation in manufacturing was higher in New Brunswick than Canada over the 1997-2016 period (0.29 percentage points). Second, this higher inflation boosted nominal value added per hour growth in New Brunswick relative to Canada so the gap between the growth rates of nominal value added per hour worked between Canada and New Brunswick was less than that between real value added per hour worked. Nominal value added per hour growth was 0.77 percentage points per year less in New Brunswick than in Canada (2.14 per cent versus 2.95 per cent) while real value added per hour worked was 1.04 per centage less (0.72 per cent versus 1.76 per cent). The difference is the difference in the rate of inflation between the two jurisdictions (0.27 per cent).

In other words, given the higher inflation for manufactured goods in New Brunswick, use of nominal value added per hour shows a less acute deterioration in the province's productivity performance relative to the national average. This point is relevant for comparison of productivity

levels, which can include relative price effects, but is not relevant for comparisons of productivity growth rates, which exclude price effects.

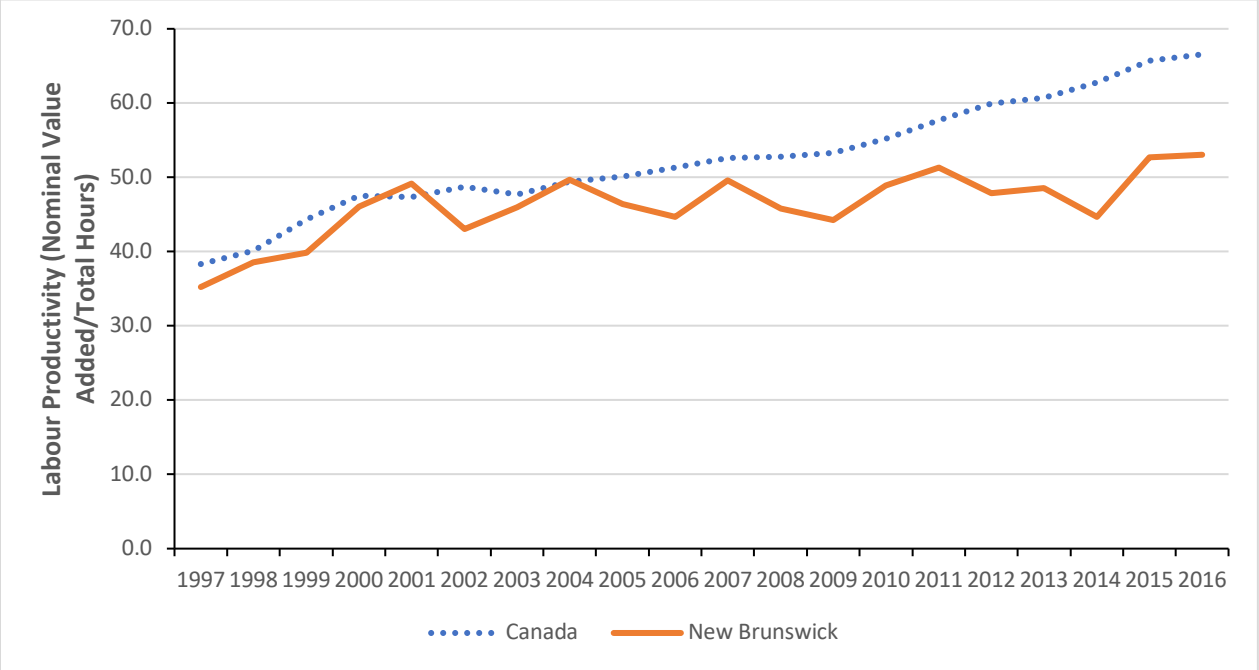
Table 3: Nominal Value Added per Total Hours Worked, Labour Productivity and the Deflator for Manufacturing in Canada and in New Brunswick, 1997-2016, (Compound Annual Growth Rate)

Variables	**Nominal Value Added per Total Hours Worked**		**Labour productivity**		**Deflator**	
Compound annual growth rate	Canada	New Brunswick	Canada	New Brunswick	Canada	New Brunswick
1997-2016	2.95	2.18	1.76	0.72	1.17	1.46
1997-2000	7.45	9.38	5.88	4.45	1.51	4.76
1997-2004	3.69	5.04	2.73	4.15	0.96	0.87
2004-2016	2.52	0.54	1.19	-1.22	1.30	1.80
2000-2008	1.32	-0.07	1.04	-0.32	0.27	0.25
2008-2016	2.94	1.84	0.96	0.40	1.96	1.45
2008-2014	2.92	-0.44	1.34	-1.11	1.57	0.69
2014-2016	3.00	9.01	-0.16	5.08	3.13	3.76

Source: Statistics Canada, Table: 36-10-0480-01

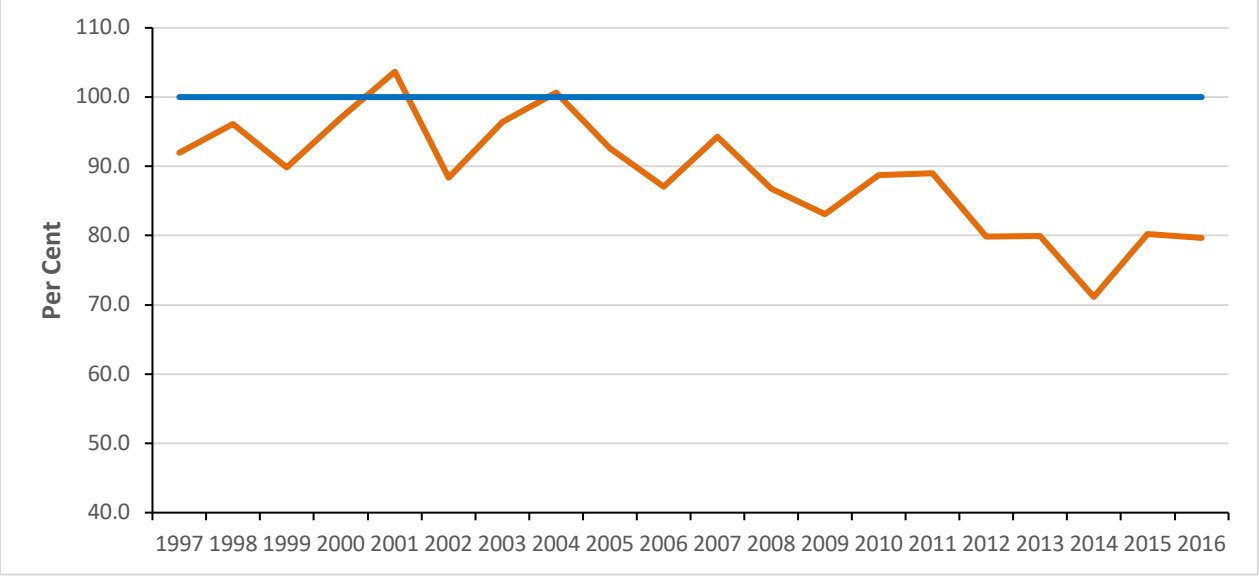
Chart 7: Nominal Value Added/Total Hours for Manufacturing in Canada and in New Brunswick, 1997-2016

Panel A: Absolute Level for New Brunswick's Nominal Value Added per Hour compared to Canada's



Source: Statistics Canada, Table: 36-10-0480-01

Panel B: Relative Level for New Brunswick's Nominal Value Added per Hour compared to Canada's, (Canada = 100 for all years)



Source: Statistics Canada, Table: 36-10-0480-01

2. Levels of Nominal Value Added per hour worked

The improvement in New Brunswick's relative manufacturing labour productivity level between 1997 and 2004 and massive deterioration from 2004 to 2019, expressed in 2012 dollars, was documented earlier in the report. These same developments were observed for the relative productivity level expressed in current or nominal dollars, although the deterioration was less pronounced because of the higher inflation in manufacturing goods produced in New Brunswick.

In 1997, New Brunswick's nominal value added per hour in manufacturing was $35.20 per hour, 91.9 per cent of the national level of $38.30 per hour (Panel A of Chart 7 and Appendix Table 5). By 2004, the nominal value added per hour in New Brunswick had reached $49.70, 100.6 per cent of the national level. This relative level was below the relative level of 108.9 for the real value added per hour series.

While the level of nominal value added per hour in New Brunswick manufacturing continued to increase after that and reached $53.00 per hour in 2016, the rate of advance was slower than in Canada, so the relative productivity level fell, reaching 79.7 per cent of the national level (Panel B, Chart 7). One notes that this relative level is similar to 81.4 productivity measured in terms of real value added.

Between 1997 and 2016 New Brunswick's nominal manufacturing productivity level fell 12. 2 percentage points from 91.9 per cent to 79.7 per cent of the national level. In contrast, the real manufacturing productivity level fell 17.2 percentage points from 98.9 per cent to 81.4 per cent in 2016 of the national level (75.4 per cent in 2019). This 5.0 percentage point difference is explained by the smaller gap between New Brunswick and Canada for annual nominal output per hour growth than real output per hour growth (0.27 points based on gaps of 1.04 points and 0.77 points).

III. Competitiveness Implications of the Labour Productivity Developments for New Brunswick Manufacturing

Unit labour costs (ULC), defined as nominal value added or output divided by total labour input or total hours, are an indicator of a sector's cost competitiveness. This cost competitiveness can be measured in level terms and in rate of change terms. The lower the level of ULC for a jurisdiction relative to another jurisdiction the more cost competitive it is.[11] The slower the rate of

[11] Of course, there are many other costs in additional to labour costs that affect the overall competitiveness of manufacturing. These costs include property taxes, payroll taxes, transport costs, raw material costs and energy costs. A full analysis of the cost competitiveness of the New Brunswick manufacturing sector would include these costs. Nevertheless, for the vast majority of manufacturing firms in the province, labour costs represent the largest component of overall costs.

increase in ULC in a jurisdiction relative to another, the more cost competitive or less uncompetitive it becomes. The rate of change in ULC is determined by the growth of hourly labour compensation and labour productivity. This section investigates the extent to which the cost competitiveness in New Brunswick manufacturing has been hurt by the province's poor labour productivity growth in the sector. Trends in total labour compensation per hour worked and the unit cost of labour are examined for the manufacturing sector in Canada and New Brunswick in 1997-2019. The growth rate for the unit labour cost is calculated as the difference between the growth rates of total labour compensation per hour worked and labour productivity.

Table 4: Total Labour Compensation per Hour Worked, Unit Labour Cost and Labour Productivity for Manufacturing in Canada and in New Brunswick, 1997-2019, (Compound Annual Growth Rate)

Variables	**Labour Compensation /Hour**		**Labour Productivity**		**Unit Labour Cost**	
Compound annual growth rate	Canada	New Brunswick	Canada	New Brunswick	Canada	New Brunswick
1997-2019	2.91	2.36	1.61	0.36	1.28	1.99
1997-2016	2.94	2.20	1.76	0.72	1.16	1.48
1997-2000	4.68	2.85	5.88	4.45	-1.08	-1.45
1997-2004	3.62	3.00	2.73	4.15	0.89	-1.09
2004-2019	2.58	2.06	1.09	-1.35	1.46	3.46
2000-2008	3.39	2.94	1.04	-0.32	2.31	3.28
2008-2019	2.08	1.80	0.89	-0.22	1.18	2.01
2008-2014	2.20	0.95	1.34	-1.11	0.84	2.07
2014-2019	1.93	2.84	0.35	0.85	1.59	1.93

Source: Statistics Canada, Table: 36-10-0480-01

A. Labour Compensation

Total compensation per hour worked for the manufacturing sector in New Brunswick was $18.64 in 1997, 83.1 per cent of the national average of $22.42 (Panel A of Chart 8 and Appendix Table 10). By 2019 it had increased 67.0 per cent to $31.12 but had fallen to 73.9 per cent of the national average ($42.11) as there was a larger increase (87.8 per cent) in labour compensation at the national level. As Table 4 shows, in terms of average annual growth rates in 1997-2019, labour compensation increased 2.36 per cent per year in New Brunswick, compared to 2.91 per cent in Canada, a difference of 0.55 percentage points.

The rate of labour compensation growth in New Brunswick manufacturing was less than at the national level in all sub-periods of the 1997-2019 period except for 2014-2019. In this most recent period, labour compensation advanced at faster pace in New Brunswick than in Canada

(2.84 per cent versus 1.93 per cent per year). In 2014, labour compensation in New Brunswick manufacturing had fallen to 70.3 per cent of the national level so some of the faster growth after 2014 reflects catch-up.

B. Unit Labour Costs

Unit labour costs (ULC) are calculated by dividing total labour compensation by total output expressed in real terms. ULC for the manufacturing sector in New Brunswick was $0.419 per unit of real output in 1997, 84.0 per cent of the national average of $0.499 (Panel B of Chart 8 and Appendix Table 12). This suggest that New Brunswick manufacturers had a 16 per cent cost advantage over manufacturers in other provinces.

By 2019, ULC in New Brunswick had increased to $0.646, and had risen to 97.9 per cent of the national average ($0.660). This represent a deterioration of the cost competitiveness of manufacturing in New Brunswick relative to the national average, although in absolute terms the New Brunswick manufacturing industry was still slightly more cost competitiveness than its Canadian counterpart. While low unit labour costs were a competitive advantage for New Brunswick manufacturing in the past, by 2019 this advantage had been almost completely eroded.

Both the level and trends in ULC are determined by hourly labour compensation and labour productivity. Over time, higher labour compensation increases unit labour costs while increases in output per hour reduces them. In 1997, New Brunswick's manufacturing cost competitiveness (84.0 per cent of the national average) was due almost exclusively to its lower hourly labour compensation (83.1 per cent of the national average). Its productivity level, which was just below the national average (98.9 per cent) raised the level of ULC slightly, reducing competitiveness.[12]
.

The 54.2 per cent rise in nominal ULC in New Brunswick manufacturing between 1997 and 2019 was the outcome of a 66.9 per cent rise in hourly labour compensation, offset by an 8.3 per cent increase in labour productivity. At the national level, the 32.3 per cent in ULC in 1997-2019 reflected a 87.8 per cent rise in hourly compensation, offset by a 42.1 per cent increase in productivity.

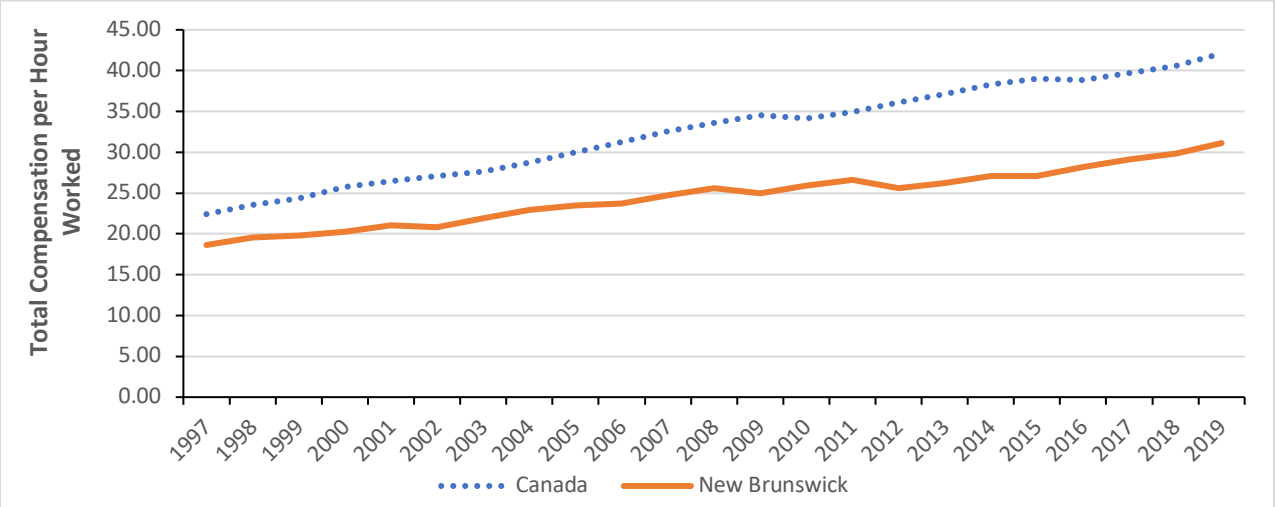
Given that hourly labour compensation advanced at a slower rate in New Brunswick than in Canada between 1997 and 2019, falling from 83.1 per cent to 73.9 per cent of the national level, the relative deterioration of ULC in New Brunswick manufacturing in 1997-2019 from 84.0 per cent to 97.9 per cent of the national average was completely explained by the deterioration of the

[12] The level of ULC in New Brunswick relative to the national average is the product of the relative levels of hourly labour compensation and the reciprocal of the relative productivity level. The numbers for 1997 were 84.0 = 83.1 * (1/0.989).

province's productivity from 98.9 per cent to 75.4 per cent of the national level. Indeed, had not labour compensation fallen relative to the national average, the decline in ULC would have been significantly worse.[13]

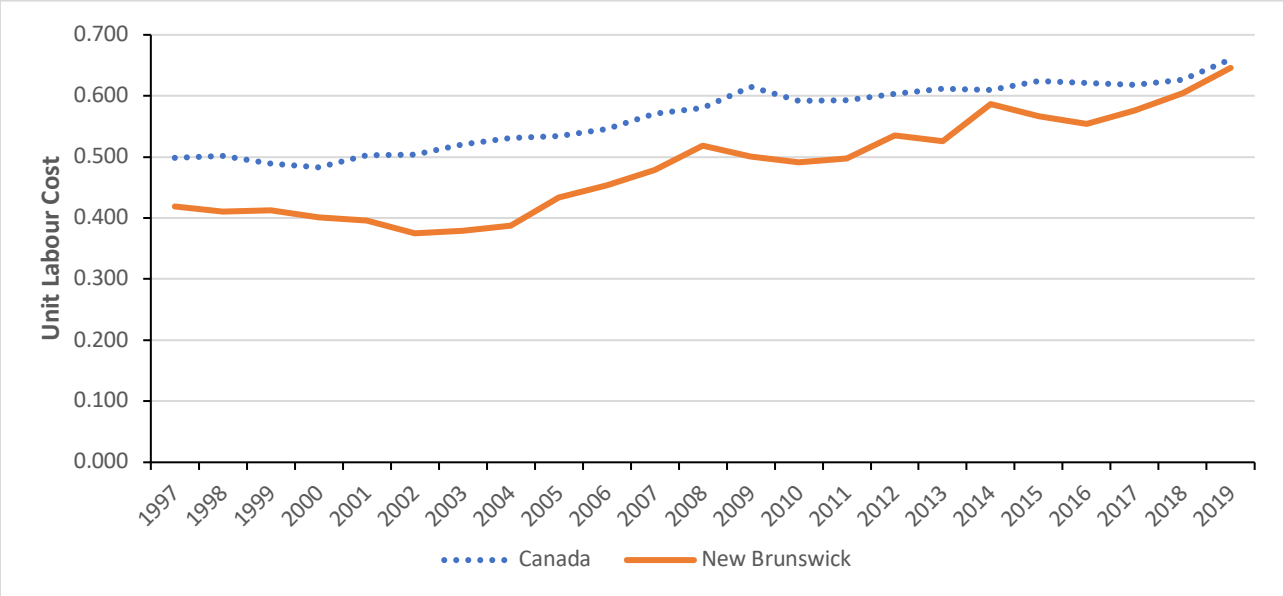
Chart 8: Total Labour Compensation per Hour Worked and Unit Labour Cost for Manufacturing in Canada and in New Brunswick, 1997-2019

Panel A: Total Compensation per Hour Worked



Source: Statistics Canada, Table: 36-10-0480-01

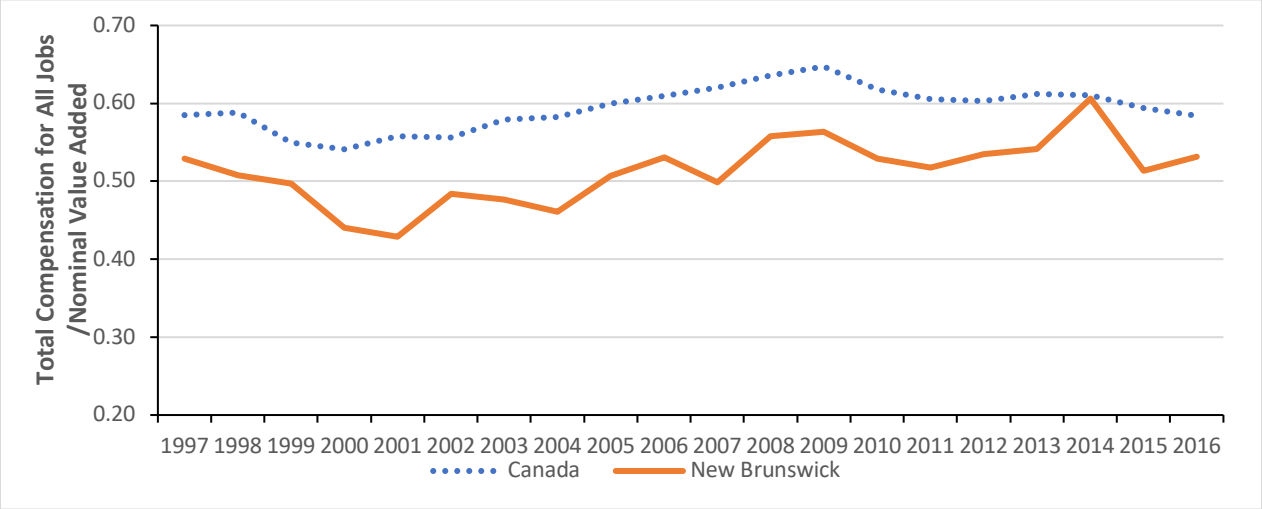
Panel B: Unit Labour Cost



[13] If labour compensation in New Brunswick manufacturing had remained at the 1997 level of 83.1 per cent of the national average in 2019 (compared to the actual 73.9 per cent), all the fall in relative labour productivity from 98.6 per cent of the national average in 1997 to 75.4 per cent in 2019 would have translated into a fall in ULC. Instead of rising from 84.0 per cent of the national average in 1997 to 97.9 per cent in 2019, ULC in New Brunswick manufacturing would have been 110.1 per cent of the national average in 2019.

Source: Statistics Canada, Table: 36-10-0480-01

Chart 9: Ratio of Total Compensation for all Jobs and Nominal Value Added for Manufacturing in Canada and in New Brunswick, 1997-2016



Source: Appendix Table 11

Table 5: Ratio of Total Compensation for all Jobs and Nominal Value Added for Canada and New Brunswick

Compound annual growth rate	Canada	New Brunswick
1997-2016	-0.01	0.02
1997-2000	-2.57	-5.96
2000-2008	2.05	3.01
2008-2016	-1.07	-0.61
2008-2014	-0.70	1.39
2014-2016	-2.18	-6.38

Source: Statistics Canada, Table: 36-10-0480-01

The labour share (Chart 9) is defined as the ratio between the total compensation for all jobs in manufacturing and the nominal value added. In 1997, the labour share in manufacturing was 53 per cent in New Brunswick, 90 per cent of the share in Canada of 59 per cent. This is consistent with the province's lower level of hourly labour compensation. The labour share was relatively unchanged for both Canada and New Brunswick between 1997 and 2016 (Table 5). This reflected the identical growth rates in each jurisdiction for total labour compensation and nominal output: 1.71 per cent versus 1.72 per cent per year respectively in Canada and 2.16 per cent versus 2.14 per cent in New Brunswick. A rising labour share can lead to a fall in cost competitiveness.

But in New Brunswick the rise in relative ULC was linked to the province's poor productivity performance, not labour costs becoming out of line with output growth.

IV. A Provincial Perspective on New Brunswick Manufacturing Productivity Performance

The main benchmark to assess New Brunswick's manufacturing productivity performance used in this report is that of Canada. This section briefly provides a provincial perspective on this performance. As has been seen, the level of manufacturing productivity in New Brunswick in 2019 was only three quarters of the national average and productivity growth since 1997 has been well below the national average. Relative to the other provinces, New Brunswick also performed poorly in terms of both manufacturing productivity levels and growth rates.

A. Labour Productivity Levels and Growth Rates in terms of real value added

In 2019, at $48.10 per hour (2012 dollars), output per hour in New Brunswick manufacturing was the second lowest among the ten provinces, with only Nova Scotia lower at $45.20 (Table 6). This represented a marked deterioration from the situation in 1997 when New Brunswick ranked fourth, with only Ontario, Saskatchewan, and Alberta higher.

This development of course reflected weak manufacturing productivity growth over the 1997-2019 period. Indeed, among the ten provinces, New Brunswick had by far the lowest manufacturing productivity growth at 0.36 per cent per year (Chart 11 and Table 6). Second lowest was Manitoba at 0.89 per cent.

Table 6: Levels of Labour Productivity (Chained (2012) dollars per hour) for Manufacturing for Canada and the Provinces in 1997 and 2019, (Compound Annual Growth Rate)

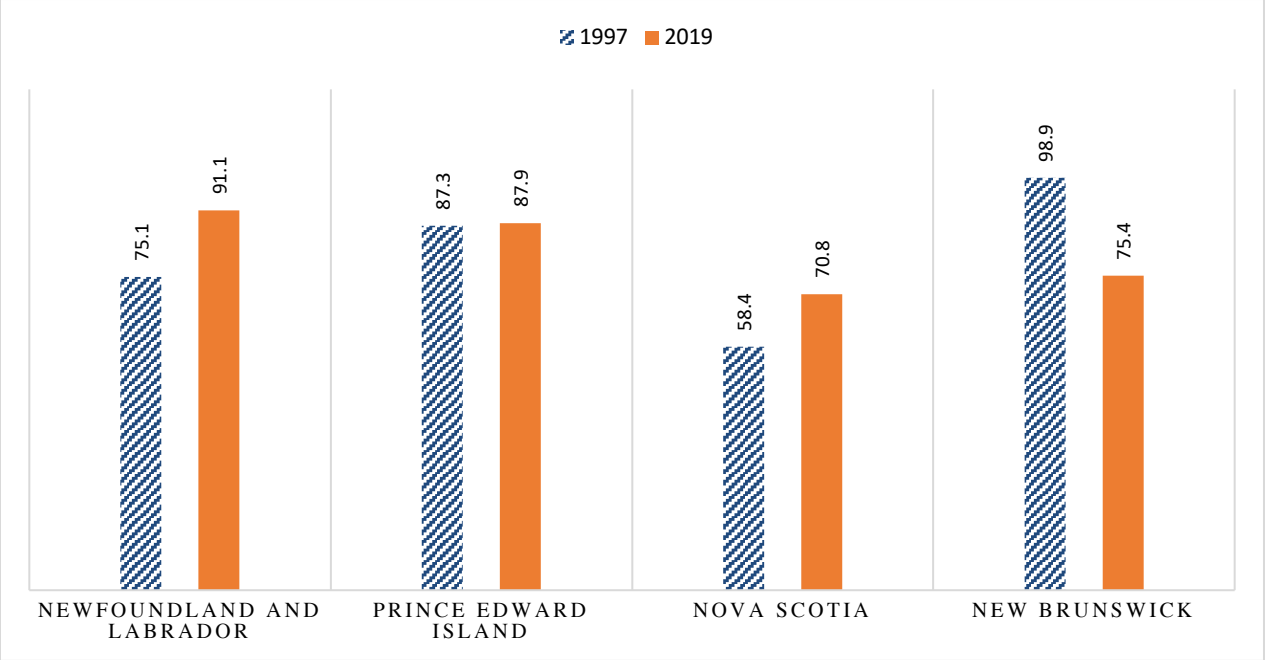
Canada and the Provinces	Labour Productivity (Chained (2012) dollars per hour)	Per cent of Canada	Labour Productivity (Chained (2012) dollars per hour)	Per cent of Canada	Compound annual growth rate (1997-2019)
	1997		**2019**		
Canada	44.9	100.0	63.8	100.0	1.61
Newfoundland and Labrador	33.7	75.1	58.1	91.1	2.51
Prince Edward Island	39.2	87.3	56.1	87.9	1.64
Nova Scotia	26.2	58.4	45.2	70.8	2.51
New Brunswick	44.4	98.9	48.1	75.4	0.36
Quebec	43.3	96.4	58.1	91.1	1.35
Ontario	45.0	100.2	63.1	98.9	1.55
Manitoba	42.5	94.7	51.6	80.9	0.89
Saskatchewan	55.7	124.1	91.9	144.0	2.30
Alberta	73.4	163.5	100.9	158.2	1.46
British Columbia	32.4	72.2	58.6	91.8	2.73

Source: Statistics Canada, Table: 36-10-0480-01

New Brunswick's poor manufacturing productivity performance over the 1997-2019 period lies in sharp contrast to that of the other Atlantic provinces, as seen in Panel A of Chart 10. Both Nova Scotia and Newfoundland and Labrador enjoyed productivity growth above the national rate, as evidenced by the increase in their productivity level relative to the national average. Prince Edward Island experienced productivity growth at the national rate.

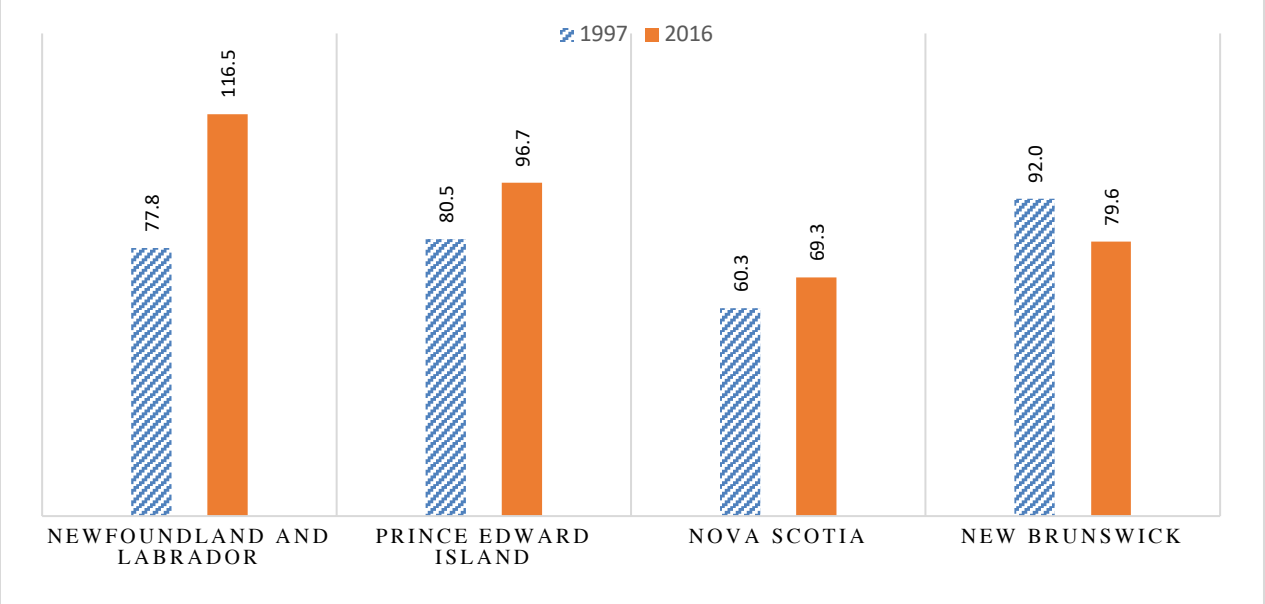
Chart 10: Labour Productivity (2012 dollars) and Nominal Value Added per Hour (1997-2016) for Manufacturing for Atlantic Provinces as a Percent of Canada, in 1997 and 2019, (Canada = 100)

Panel A: Labour Productivity (2012 dollars)



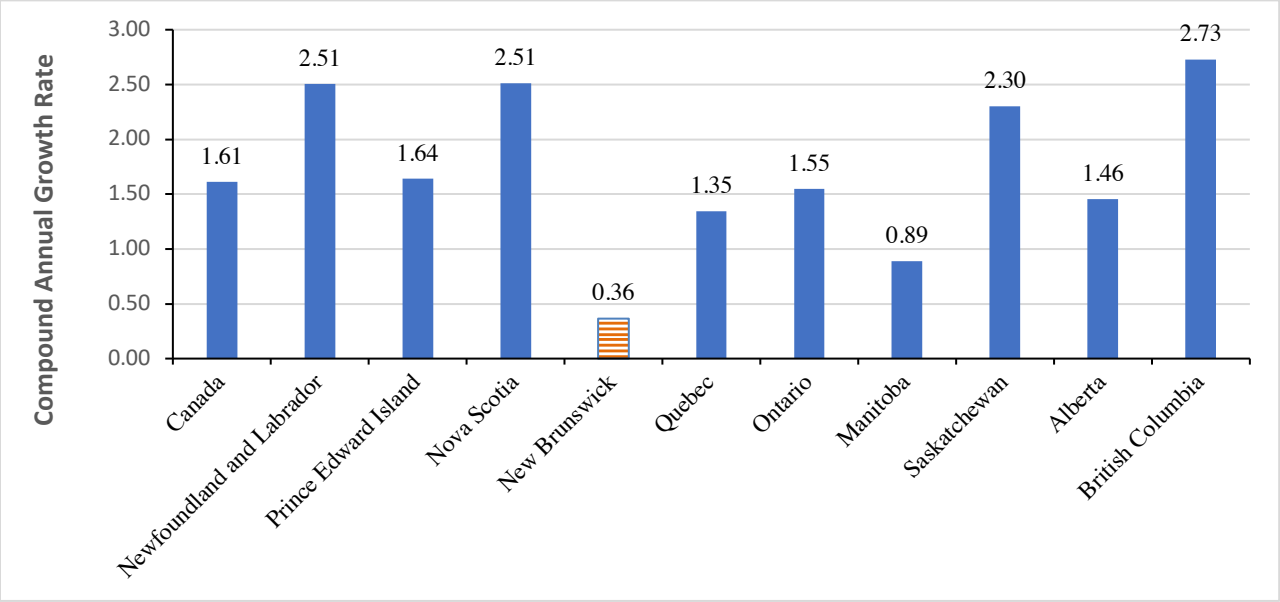
Source: Statistics Canada, Table: 36-10-0480-01

Panel B: Nominal Value Added per Hour, in 1997 and 2016, (Canada = 100)



Source: Statistics Canada, Table: 36-10-0480-01

Chart 11: Labour Productivity (2012 dollars) for Manufacturing for Canada and the Provinces, 1997-2019, (Compound Annual Growth Rate)



Source: Statistics Canada, Table: 36-10-0480-01

B. Nominal value added per hour

Table 7: Nominal Value Added per hour for Manufacturing for Canada and the Provinces in 1997 and 2016, (Compound Annual Growth Rate)

Canada and the Provinces	Labour Productivity	Per cent of Canada	Labour Productivity	Per cent of Canada	Compound annual growth rate
	1997		**2016**		
Canada	38.3	100.0	66.6	100.0	2.95
Newfoundland and Labrador	29.8	77.8	77.6	116.5	5.17
Prince Edward Island	30.8	80.5	64.4	96.7	3.95
Nova Scotia	23.1	60.3	46.2	69.3	3.71
New Brunswick	35.2	92.0	53.0	79.6	2.18
Quebec	37.4	97.6	60.0	90.0	2.52
Ontario	40.0	104.4	67.8	101.8	2.82
Manitoba	31.7	82.9	55.5	83.3	2.98
Saskatchewan	36.8	96.0	78.3	117.6	4.06
Alberta	48.0	125.3	101.0	151.7	4.00
British Columbia	33.0	86.2	60.6	91.0	3.25

Source: Statistics Canada, Table: 36-10-0480-01

As in the case of labour productivity based on real value added, New Brunswick's manufacturing labour productivity based on nominal value added, at $53.00 in 2016 and 79.6 per cent of the national average, was near the bottom of the rankings, with only Nova Scotia lower (Table 7). Again, this represented a relative fall in ranking from 1997 when the province ranked fifth.

Similar to the growth rate of real value added per hour, New Brunswick's growth rate of nominal value added per hour worked, which, as noted earlier, is not a true productivity measure since it includes an inflation component, was the lowest among the provinces (2.18 per cent per year).

Panel B of Chart 10 shows manufacturing labour productivity in terms of nominal value added in the Atlantic provinces compared with Canada in 1997 and 2016. Similar to the panel on labour productivity in terms of real value added, New Brunswick had a lower level of labour productivity in 2016 than in 1997 relative to Canada. In contrast, all other Atlantic provinces had a higher relative productivity level in 2016 than in 1997. Only Newfoundland and Labrador’s labour productivity level in manufacturing exceeded the national average.

Table 8: Labour Productivity in Manufacturing Industries for Canada and New Brunswick, 1977 and 2019 (chained 2012 dollars per hour)

	1997		2019		Compound Annual Growth Rate 1997-2019 (CAGR)		Difference in CAGR between Canada and New Brunswick
	Canada	New Brunswick	Canada	New Brunswick			
Industry	**Labour productivity (Chained (2012) dollars per hour)**				Canada	New Brunswick	
Manufacturing	44.9	44.4	63.8	48.1	1.61	0.36	1.25
Food manufacturing	44.3	38.6	57.0	32.7	1.15	-0.75	1.90
Beverage and tobacco product manufacturing	142.1	103.9	84.7	81.8	-2.32	-1.08	-1.24
Textile and textile product mills	27.7	27.9	39.8	27.1	1.66	-0.13	1.79
Clothing and leather and allied product manufacturing	18.8	21.5	34.2	18.6	2.76	-0.66	3.41
Wood product manufacturing	21.0	20.8	48.6	36.2	3.89	2.55	1.34
Paper manufacturing	47.4	62.7	63.6	96.3	1.35	1.97	-0.62
Printing and related support activities	35.9	26.8	52.4	22.0	1.73	-0.89	2.63
Petroleum and coal product manufacturing	650.5	1,334.3	320.7	245.1	-3.16	-7.41	4.25
Chemical manufacturing	96.1	162.7	127.3	41.9	1.29	-5.98	7.27
Plastics and rubber products manufacturing	36.1	31.9	52.4	57.0	1.71	2.67	-0.97
Non-metallic mineral product manufacturing	49.9	47.5	71.5	35.6	1.65	-1.30	2.95
Primary metal manufacturing	60.3	47.9	90.1	103.0	1.84	3.54	-1.70
Fabricated metal product manufacturing	39.5	29.1	50.4	37.8	1.11	1.20	-0.08
Machinery manufacturing	40.1	25.2	62.3	38.9	2.02	1.99	0.03
Computer and electronic product manufacturing	37.1	44.6	65.2	44.2	2.60	-0.04	2.64
Electrical equipment, appliance and component manufacturing	40.7	16.9	59.2	42.3	1.72	4.26	-2.54
Transportation equipment manufacturing	44.4	30.4	64.6	32.9	1.72	0.36	1.36
Furniture and related product manufacturing	27.3	25.0	40.2	25.0	1.77	0.00	1.77
Miscellaneous manufacturing	37.8	34.1	46.0	20.0	0.90	-2.40	3.29

Source: Statistics Canada, Table: 36-10-0480-01

V. An Industry Perspective on New Brunswick's Manufacturing Productivity Performance

This section will provide an industry perspective on labour productivity in New Brunswick manufacturing over the 1997-2019 period by examining both productivity levels and growth rates for 19 three-digit NAICS industries in the province relative to the national average. A key finding of this section is a great variation of productivity performance across manufacturing industries, both in terms of levels and growth rates.

Manufacturing industries in New Brunswick differ greatly in their importance, measured in terms of their share in overall manufacturing for total hours worked (Appendix Tables 26 and 27), and output (Appendix Tables 22 and 23). Their relative weighs affect the industry contributions to overall productivity growth in manufacturing. This section looks at only industry-specific productivity growth rates. Part two of the report, on the post-2004 fall-off, uses the data on the relative size of the industries in the calculation of the contribution of particular industries to the falloff.

There are very large differences in the level of labour productivity in New Brunswick manufacturing industries. In 2019, petroleum and coal product manufacturing, which consists basically of the one oil refinery in the province, had by far the highest level of labour productivity (Table 8). Real value added per hour was $245.10 (2012 dollars), reflecting the capital-intensive nature of this sector. In contrast, the clothing and leather products industry had a level of labour productivity of only $18.60 per hour (2012 dollars), less than one tenth that of petroleum manufacturing. Other industries with high labour productivity levels were primary metals ($103.00 per hour) and paper ($96.30 per hour).

As noted earlier, the level of labour productivity in manufacturing in New Brunswick in 2019 was $48.10 per hour, 75.4 per cent of the national average. A number of industries in the province exceeded this relative, with three even exceeding the national average for the industry, namely paper at 151.4 per cent of the national average, primary metals at 114.3 per cent, and plastics and rubber at 108.8 per cent (Chart 12). On the other hand, 14 of the 19 manufacturing industries did even worse that the overall manufacturing relative productivity level, with particularly poor performance in chemicals (32.9 per cent of the national level), printing (42.0 per cent), miscellaneous manufacturing (43.5), and non-metallic mineral products (49.8 per cent).

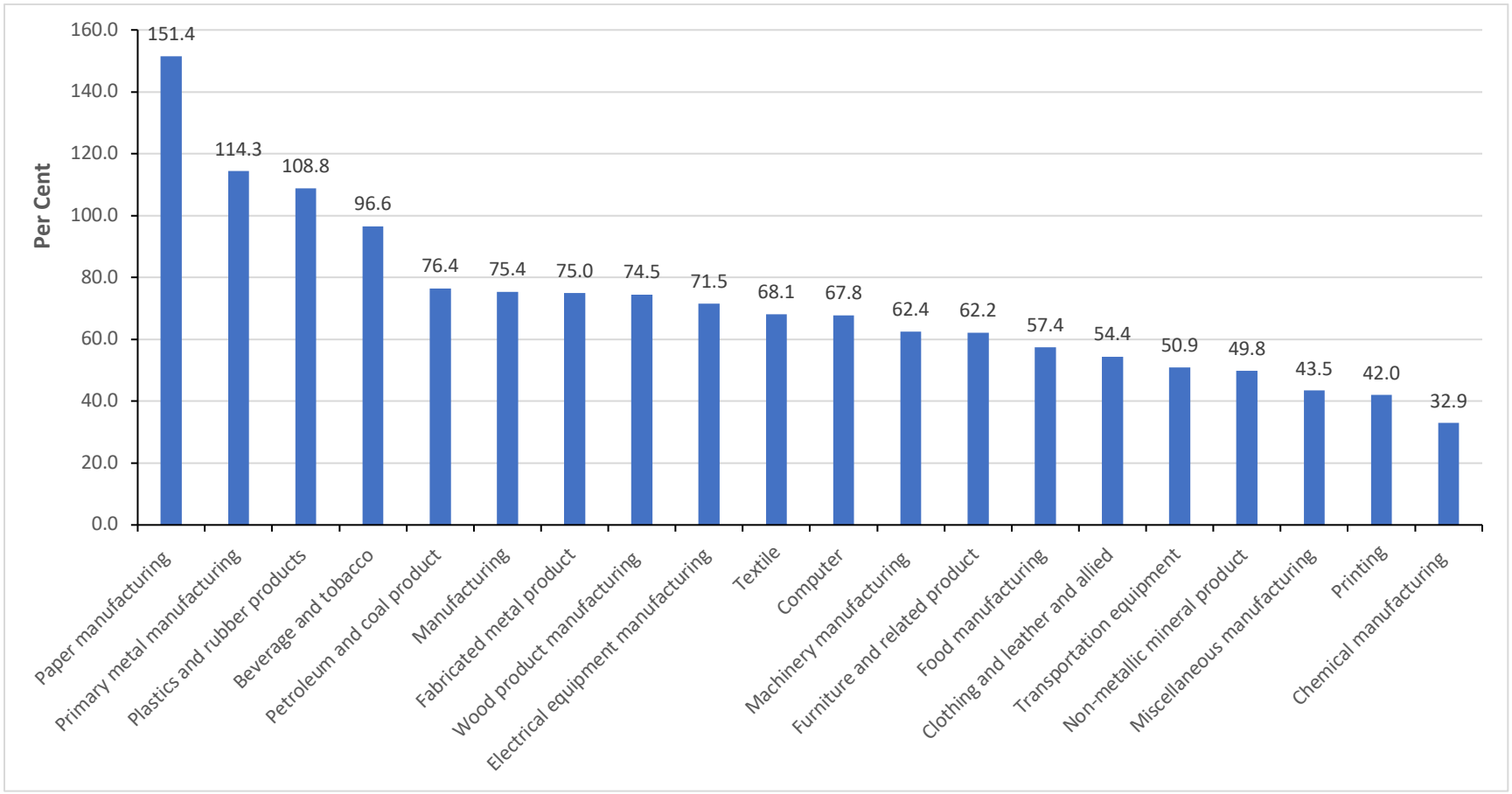
Just as productivity levels in 2019 in manufacturing in New Brunswick varied greatly by industry, labour productivity growth rates over the 1997-2019 period also exhibited massive differences, from 4.26 per cent per year in electrical equipment to -7.41 per cent in petroleum products (Table 8 and Chart 13). Seven of the 19 industries exceeded the average manufacturing labour productivity growth rate of 0.36 per cent per year and 12 industries did worse. Six industries

enjoyed strong productivity growth of 2 per cent or more per year: electrical equipment, primary metals, plastic and rubber, machinery and paper. On the other hand, nine industries experience negative productivity growth, with three industries worse than -2 per cent per year (petroleum, chemicals, and miscellaneous manufacturing). Surprisingly, only four manufacturing industries in New Brunswick had productivity growth between 0 and 2 per cent over the 1997-2019 period. In other words, since 1997 the productivity performance of the province's 19 three-digit manufacturing industries has been either superlative (2 per cent or more per year) or dismal (negative), with very few industries turning in an average performance.

For the overall manufacturing sector, New Brunswick experienced labour productivity growth of 1.25 percentage points per year less than the national average over the 1997-2019 period: 0.36 per cent versus 1.61 per cent. But a significant number (six) of New Brunswick manufacturing industries actually outperformed their counterparts at the national level (Chart 14). Not surprisingly, there were largely the industries that enjoyed productivity growth rates of 2 per cent or more noted above. Electrical products experienced the strongest relative performance, with labour productivity growth 2.54 percentage points faster than the national average, followed by primary metals (1.70 points), beverage and tobacco (1.24 points), plastics and rubber (0.97 points), and paper (0.62 points). In other words, certain manufacturing industries in the province have done very well in terms of productivity growth, both in absolute terms and relative to the national average. There are success stories in New Brunswick manufacturing.

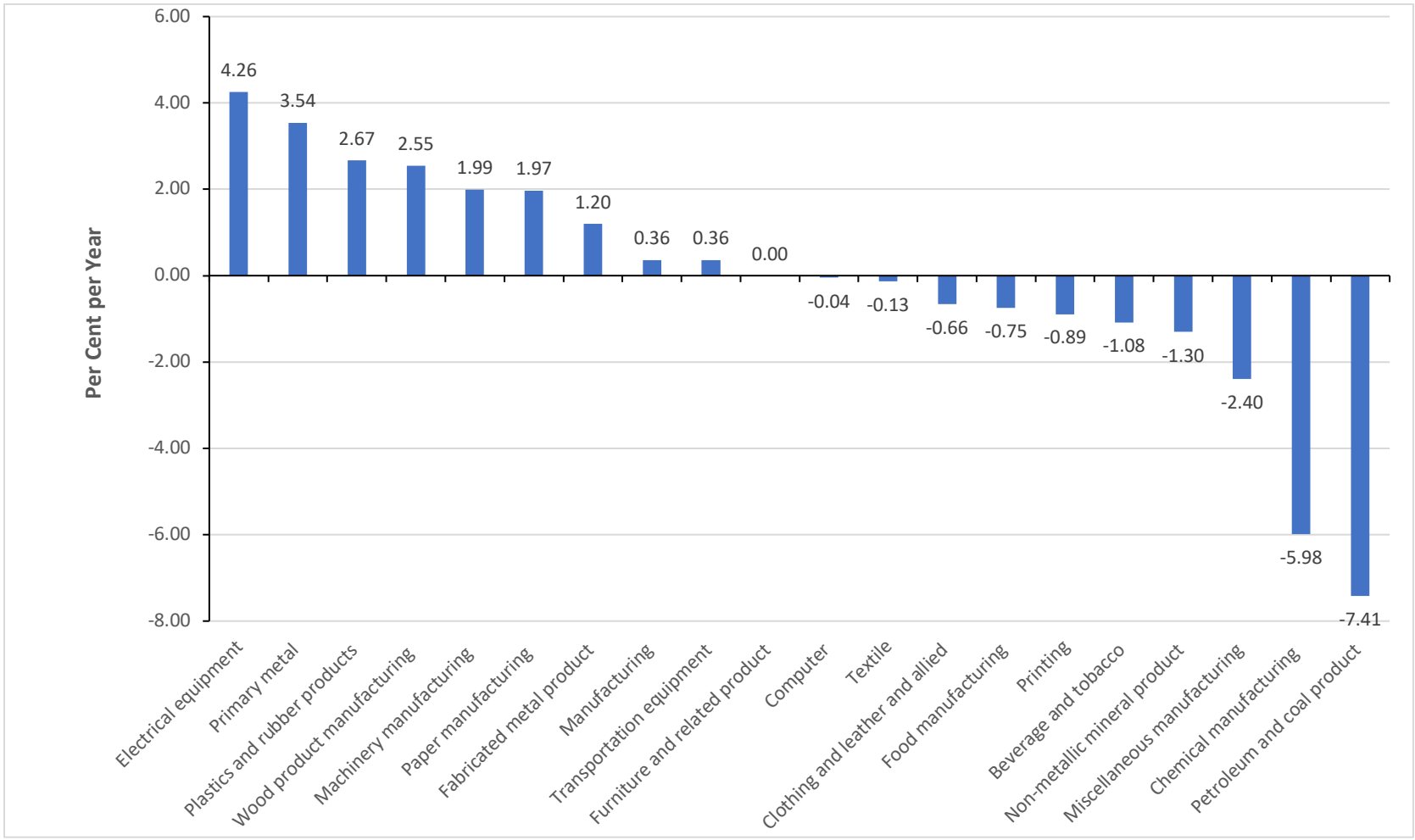
On the other hand, 13 manufacturing industries in New Brunswick had labour productivity growth less than the overall manufacturing productivity growth rate gap of 1.25 points, with 10 of the industries with a gap of 1.8 percentage points or more with the national rate. The industries where labour productivity growth in New Brunswick was at least 2 percentage points below the industry-specific national average the 1997-2019 period were: chemicals (-7.27 percentage points), petroleum (-4.25 points), clothing and leather (-3.41 per cent), miscellaneous manufacturing (-3.29 points), non-metallic mineral products (-2.95 points), computer and electronics products (-2.64 points) and printing (-2.63 points).

Chart 12: Labour Productivity (Chained (2012) dollars per hour) for Manufacturing and its Three-Digit Industries, 2019, (Ratio of New Brunswick compared to Canada)



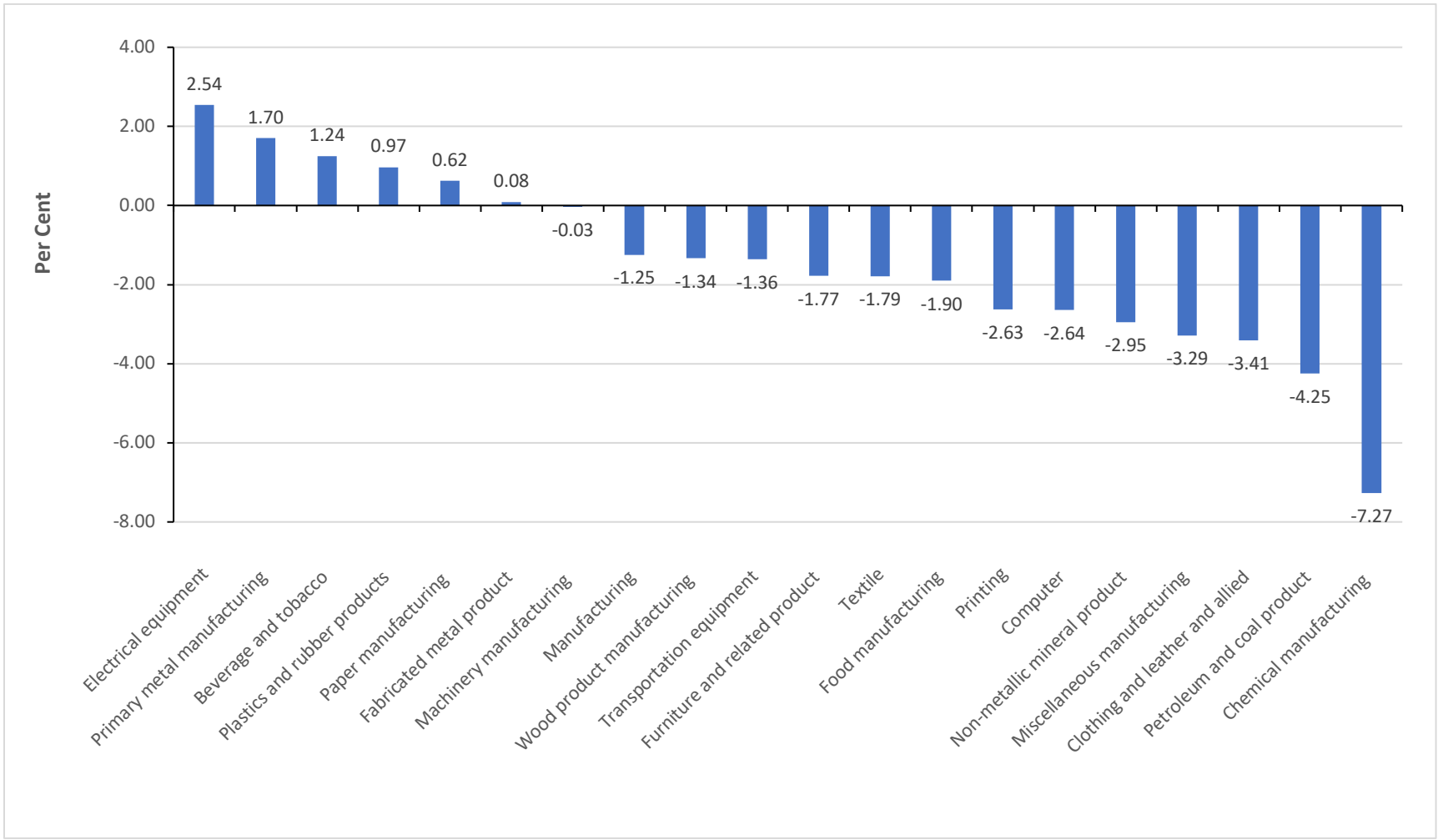
Source: Statistics Canada, Table: 36-10-0480-01

Chart 13: Labour Productivity (2012 dollars) for Manufacturing and its Three-Digit Industries for New Brunswick, 1997-2019, (Compound Annual Growth Rate)



Source: Statistics Canada, Table: 36-10-0480-01

Chart 14: Difference between New Brunswick and Canada in Labour Productivity (chained (2012) dollars per hour), Growth Rate for Manufacturing Industries, 1997-2019



Source: Statistics Canada, Table: 36-10-0480-01

VI. A Growth Accounting Perspective on New Brunswick's Manufacturing Productivity Performance

Growth accounting is the standard approach used by economists to identify and estimate the sources of both economic growth and labour productivity growth. Based on the assumption that capital and labour are paid their marginal product, which is approximated by their income share, growth accounting apportions labour productivity growth into three sources: improvements in labour quality or composition, capital deepening or growth in capital intensity, defined as the capital-labour ratio, and total factor productivity (TFP) growth. The latter term is defined as output growth not accounted for by increases in labour and capital and is considered by some a proxy for technological change and by others as a measure of our ignorance. The contribution of changes in labour composition and capital intensity to labour productivity growth is the product of the growth rate of the variable and its income share.

Statistics Canada provides official growth accounting estimates for two-digit industries by province so fortunately estimates are available for manufacturing in New Brunswick and Canada for the 1997-2018, as shown in Table 9 and found in Appendix Table 42 for New Brunswick and Appendix Table 43 for Canada. Also, Appendix Table 58 shows data for other years.

Labour productivity growth in manufacturing in New Brunswick grew at an 0.46 per cent average annual rate between 1997 and 2018.[14] Labour composition or quality grew at 0.67 per cent per year. The labour share is defined as total labour compensation divided by nominal value added and averaged 53 per cent. This means that improvement on labour quality contributed 0.36 percentage points to labour productivity growth. Given the weak productivity growth this contribution represented or accounted for slightly over three quarters of productivity growth.

Capital input in New Brunswick manufacturing advanced at a 1.46 per cent average annual rate from 1997 to 2018. As there was no change in total hours worked between 1997 and 2019, capital per hour worked also rose 1.46 per cent. The capital share is defined at total capital compensation divided by nominal value added (1 minus the labour compensation share) and averaged 47 per cent. This means that capital deepening contributed 0.69 percentage points to labour productivity growth.

The third source of labour productivity growth is total factor productivity growth. It can be calculated as the residual after the percentage points contributions of labour quality (0.36 points) and capital deepening (0.69 points) are subtracted from labour productivity growth (0.46 per cent), resulting in TFP of -0.58 points or per cent, as this source of labour productivity growth is not weighted by an income share. Unfortunately, this finding that falling TFP explains all the weakness of New Brunswick's labour productivity growth in manufacturing since 1997 does not shed much light on the

[14] Note that this growth rate is slightly faster than the labour productivity growth rate recorded in 1997-2019 (0.36 per cent). This reflects the 2.70 per cent fall in output per hour in 2019.

reasons for this situation, other than to rule our falls in labour quality or an absence of capital intensity growth.

While growth accounting is not particularly insightful in explaining New Brunswick's weak labour productivity growth in manufacturing, it does offer an interesting perspective on the differences in the sources of this productivity growth between New Brunswick and Canada. Labour productivity growth was more than three times faster over the 1997-2018 period in Canada than in New Brunswick (1.72 per cent versus 0.46 per cent per year). But despite this faster productivity growth in Canada two of the three sources of growth made larger contributions in New Brunswick. Improvements in labour quality contributed 0.36 percentage points to labour productivity growth in manufacturing in New Brunswick, compared to only 0.24 points in Canada. Equally, capital deepening contributed 0.69 points in New Brunswick, compared to 0.46 points in Canada. These smaller contributions from labour and capital at the national level were more than offset by TFP growth which contributed 1.01 percentage points to labour productivity growth in Canada, versus -0.58 points in New Brunswick, a difference of 1.59 percentage points. All of New Brunswick's lower productivity growth in manufacturing in 1997-2018 can thus be attributed to the province's dismal TFP performance. The province appears to have kept pace, if not exceeded the national average in terms of labour quality improvements and capital intensity growth.

Table 9: **Multifactor Productivity and Related Variables in the Manufacturing Sector for Canada and New Brunswick, 1997-2018, (Compound Annual Growth Rate)**

	1997-2018			
	New Brunswick	Canada	**Per Cent Contribution to Labour Productivity Growth**	
			New Brunswick	Canada
Real Gross Domestic Product	0.46	0.78	-	-
Labour Productivity	0.46	1.72	100.0	100.0
Labour Composition	0.67	0.39	145.0	22.8
Contribution of Labour Composition to Labour Productivity Growth	0.36	0.24	77.4	13.9
Capital Input	1.46	0.29	314.7	16.9
Hours	0.00	-0.93	0.8	-54.3
Capital Deepening	1.46	1.22	313.9	71.2
Contribution of Capital Intensity to Labour Productivity Growth	0.69	0.46	148.1	27.0
Total Factor Productivity	-0.58	1.01	-125.5	59.1

Source: Statistics Canada, Tables: 36-10-0211-01, 36-10-0208-01

In summary, comparing manufacturing labour productivity growth and its sources between New Brunswick and Canada over the 1997-2018 period, a number of observations emerge (Table 9).

- The much slower labour productivity growth in New Brunswick relative to Canada (0.46 per cent versus 1.72 per cent) is completely explained by much slower TFP growth: -0.58 per cent per year versus 1.01 per cent. Since TFP is a "measure of our ignorance", it provides little insight on why New Brunswick's manufacturing sector performed so poorly on this productivity measure. However, it does suggest a number of hypotheses, including weak innovation, lack of economies of scale, and low-capacity utilization.

- The contribution of labour composition to labour productivity in New Brunswick was one- and one-half times greater than at the national level (0.36 versus 0.24 percentage points) because of the greater pace of improvement in labour quality. This suggest that the province is doing relatively well in educating and training its workforce.

- The contribution of capital intensity to labour productivity growth in New Brunswick was also one- and one-half times greater than at the national level (0.69 versus 0.46 percentage points) because of the greater pace of capital deepening, reflecting stronger capital stock and investment growth. This suggest that the business climate for investment in the province has been healthy since 1997.

Part Two: Explaining the Post-2004 Fall-off in New Brunswick Manufacturing Productivity

This part of the report closely examines the most salient development identified in the previous part of the report on labour productivity developments in New Brunswick manufacturing over the 1997-2019 period, namely the massive fall off in productivity growth after 2004. As highlighted earlier, output per hour in manufacturing in the province rose rapidly from 1997 to 2004, at 4.1 per cent per year, and then plummeted 1.3 per cent per year until 2018. This resulted in New Brunswick's manufacturing labour productivity level falling from 108.8 per cent of the national level in 2004, the third highest in Canada to 75.4 per cent in 2019, the second lowest (Chart 6).[15]

This part of the report contains four sections. The first takes a growth accounting approach to the fall-off, looking at the contributions from labour composition, capital intensity and total factor productivity before and after 2004. The second and longest section, presents estimates of the industry contributions to the fall-off in manufacturing productivity using different approaches and examines the role of with-in industry and reallocations effects in accounting for the fall-off. The third section discusses the possible role of labour shortages in the fall-off. The fourth section looks at a number of additional explanations for the post-2004 fall-off in manufacturing productivity growth in New Brunswick, including the link between changes in capital intensity and labour productivity growth at the industry level, the relationship between productivity growth and the exchange rate, and the economies of scale associated with the size of manufacturing enterprises as a source of the fall-off.

[15] The year 2004 appears to have been peak year for the New Brunswick economy. As noted by a reviewer of this report, the province lost three pulp mills after 2004 and industrial power rates for large establishments increased abruptly. The Irving Shipyard closed in 2003 and relocated to Halifax: "On 27 June 2003, Irving Shipbuilding announced that it had signed an agreement with the federal government for $55 million in economic readjustment funding provided that Saint John Shipbuilding be closed permanently. The Irving Group of Companies announced the intention of permanently decommissioning Canada's largest shipyard and building a new wallboard manufacturing plant and other businesses on the site." The wallboard plant closed in 2020.

Table 10: Multifactor Productivity and Related Variables in the Manufacturing Sector for Canada and New Brunswick, 1997-2004 and 2004-2019, and Difference Between Periods (1997-2004 and 2004-2018), (Compound Annual Growth Rate)

	1997-2004		2004-2018		Difference Between Periods (1997-2004 and 2004-2018)	
	New Brunswick	Canada	New Brunswick	Canada	New Brunswick	Canada
Real Gross Domestic Product	4.77	2.99	-1.62	-0.31	-6.39	-3.30
Labour Productivity	4.07	2.62	-1.30	1.28	-5.37	-1.34
Labour Composition	1.02	0.50	0.50	0.34	-0.52	-0.16
Contribution of Labour Composition to Labour Productivity Growth	0.50	0.29	0.29	0.21	-0.21	-0.08
Capital Input	3.15	1.55	0.62	-0.34	-2.53	-1.89
Hours	0.68	0.36	-0.33	-1.57	-1.01	-1.93
Capital Deepening	2.47	1.19	0.95	1.23	-1.52	0.04
Contribution of Capital Intensity to Labour Productivity Growth	1.21	0.49	0.42	0.45	-0.79	-0.04
Total Factor Productivity	2.30	1.83	-1.99	0.61	-4.29	-1.22
Per Cent Contribution to Labour Productivity Growth						
Labour Productivity	100.0	100.0	100.0	100.0	100.0	100.0
Labour Composition	25.1	19.1	-38.5	26.6	9.7	11.9
Contribution of Labour Composition to Labour Productivity Growth	12.3	11.1	-22.3	16.4	3.9	6.0
Capital Input	77.4	59.2	-47.7	-26.6	47.1	141.0
Capital Deepening	60.7	45.4	-73.1	96.1	28.3	-3.0
Contribution of Capital Intensity to Labour Productivity Growth	29.7	18.7	-32.3	35.2	14.7	3.0
Total Factor Productivity	56.5	69.8	153.1	47.7	79.9	91.0

Source: Statistics Canada, Tables: 36-10-0211-01, 36-10-0208-01

I. A Growth Accounting Perspective on New Brunswick's Post-2004 Manufacturing Labour Productivity Fall-off

As noted in part one of this report, insight on the productivity performance of the manufacturing sector in New Brunswick, relative to the performance at the national level, can be obtained from the detailed growth accounting estimates provided by Statistics Canada. These growth accounts provide estimates of what are called the "proximate sources of growth."

The sources of labour productivity growth in New Brunswick manufacturing for the 1997-2019 period were presented earlier in the report. This section looks at differences in sources of growth between 1997-2004 and 2004-2019 to account for the post-2004 deterioration in productivity. Appendix Table 58 provides data related to the growth accounting for other periods.

As has been noted, in the 1997-2004 period New Brunswick's labour productivity performance was very strong, outperforming that of Canada (4.07 per cent per year versus 2.62 per cent) (Table 10). In addition, all sources of growth contributed significantly to labour productivity growth with 0.50 percentage points from improved labour quality, 1.21 points from capital deepening, and 2.30 points from total factor productivity. All these contributions exceed the equivalent contributions for Canada.

New Brunswick experienced a major deterioration in manufacturing productivity performance in the 2004-2019 period, relative both to the 1997-2004 period and to Canada in the post-2004 period. Labour productivity growth from 2004 to 2018 fell at a 1.30 per cent average annual rate, down 5.29 percentage points from 4.07 per cent in 1997-2004 and 2.58 percentage points less than the national rate of growth of 1.28 per cent.

The contributions of all three sources of labour productivity growth fell off significantly after 2004 in New Brunswick. The contribution of labour quality growth fell to 0.29 points, that of capital deepening to 0.42 and most importantly, that of total factor productivity to -1.99 points. Of the fall in labour productivity growth of 5.3 percentage points between periods, and total factor productivity accounted for 80.1 per cent of the drop, followed by 14.9 per cent from capital deepening, and 4.0 per cent labour quality. Clearly, labour quality and capital intensity played only a minor role in the drastic decline in productivity so attention needs to be focused on factors that caused total factor productivity to drop so sharply. This is challenging since TFP is a residual or a measure of our ignorance and influenced by many factors. The identification of TFP as the dominant proximate source of the deterioration in labour productivity growth in New Brunswick manufacturing after 2004 tells us little about what caused the fall-off.

II. Industry Contributions to New Brunswick's Post-2004 Manufacturing Productivity Fall-off

This section first looks at which manufacturing industries experienced a fall-off in labour productivity growth after 2004 in New Brunswick and Canada. It then develops estimates of the industry contributions to the fall-off by weighting the relative important of the industries in terms of labour input or output.

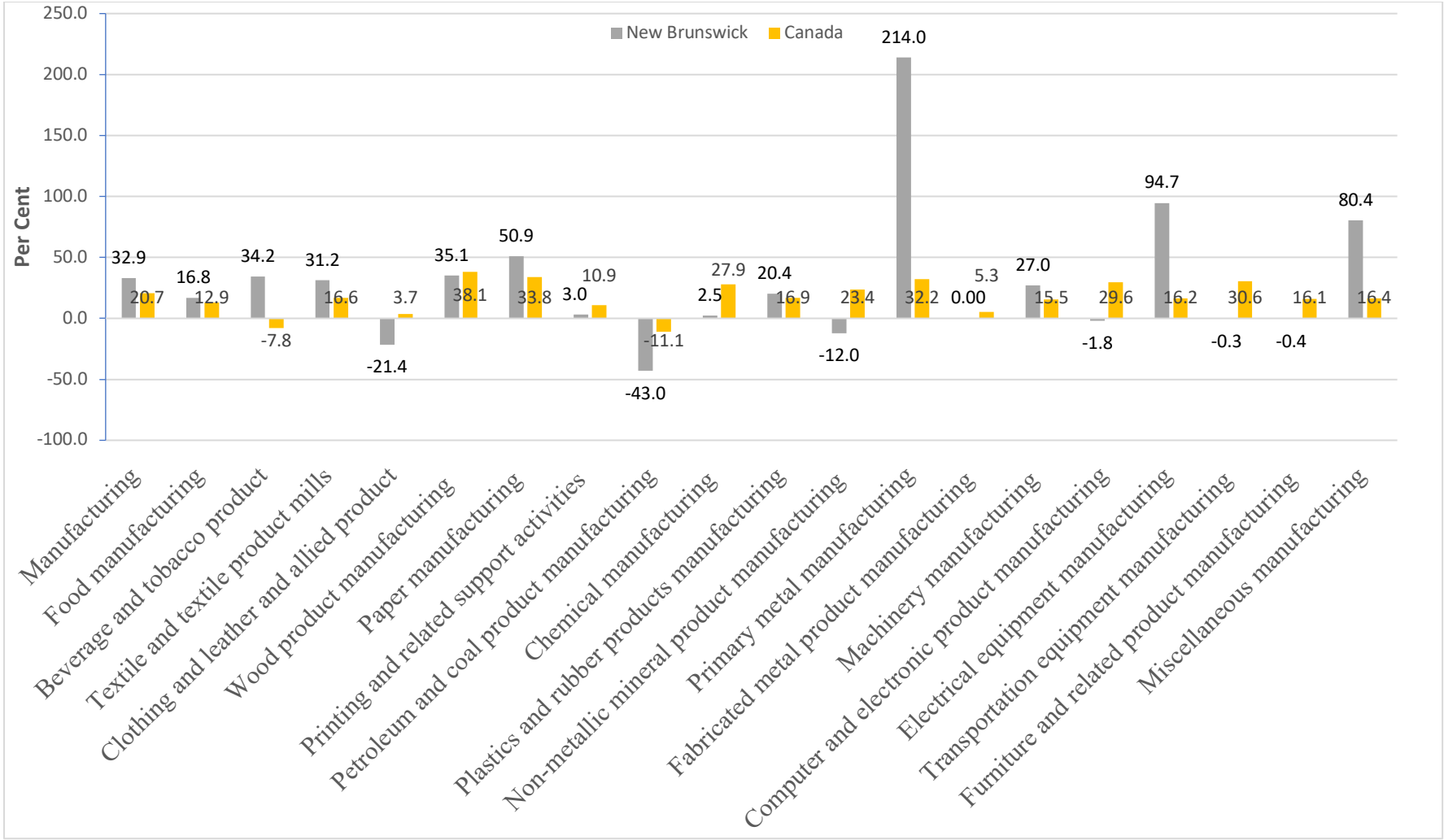
A. Industry Productivity Developments between 1997-2004 and 2004-2019

In 1997-2004, the rate of growth of labour productivity in New Brunswick manufacturing exceeded the national average. Not surprisingly at the industry level, the majority of manufacturing industries (10 of 19) in the province had labour productivity growth rate that exceeded the national average for their industry (Chart 15).

In 2004-2019, the rate of growth of labour productivity in New Brunswick manufacturing was well below the national average. Again, not unexpectedly, the vast majority of manufacturing industries (16 of 19) had labour productivity growth less than the national average (Chart 16).

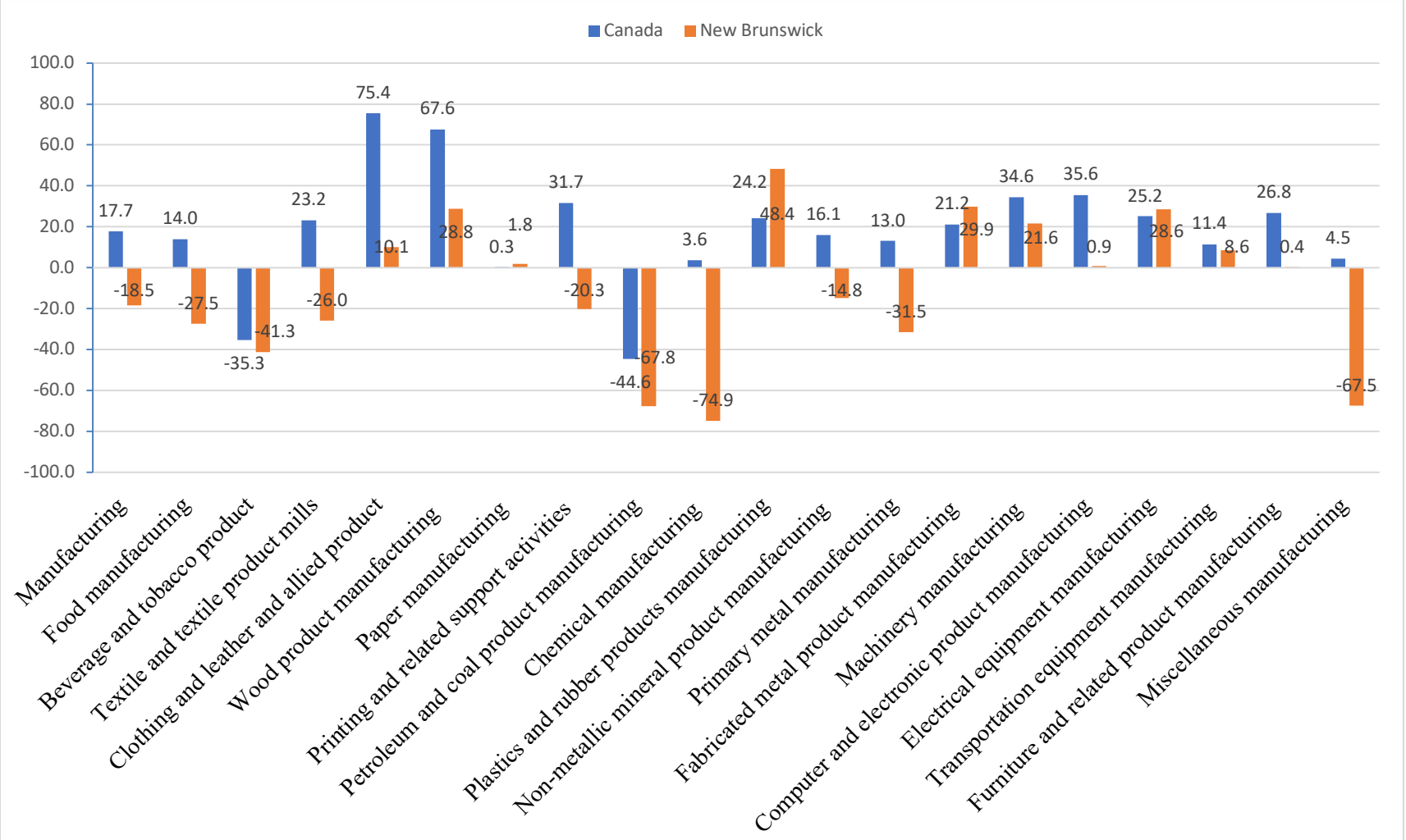
The post-2004 fall-off in labour productivity in manufacturing in New Brunswick was widespread. As Chart 17 and Appendix Tables 30 and 31 show, 14 of the 19 manufacturing industries in the province experienced slower output per hour growth in 2004-2019 compared to 1997-2004. The four industries that went against the overall trend were furniture, transportation equipment, machinery and fabricated metal. The productivity growth improvements in these sectors were small. On the other hand, many industries experienced massive falloffs in labour productivity growth after 2004. The largest falloffs were in primary metals (214.0 per cent to -32.5 per cent), miscellaneous manufacturing (80.4 per cent to -67.5 per cent), electrical equipment (94.7 per cent to 28.6 per cent) and chemicals (2.5 per cent to -74.6 per cent (Appendix Tables 30 and 31).

Chart 15: Labour Productivity, Chained (2012 Dollars), for Manufacturing and its Three-Digit Industries, for New Brunswick and Canada, 1997-2004, (Per Cent Change)



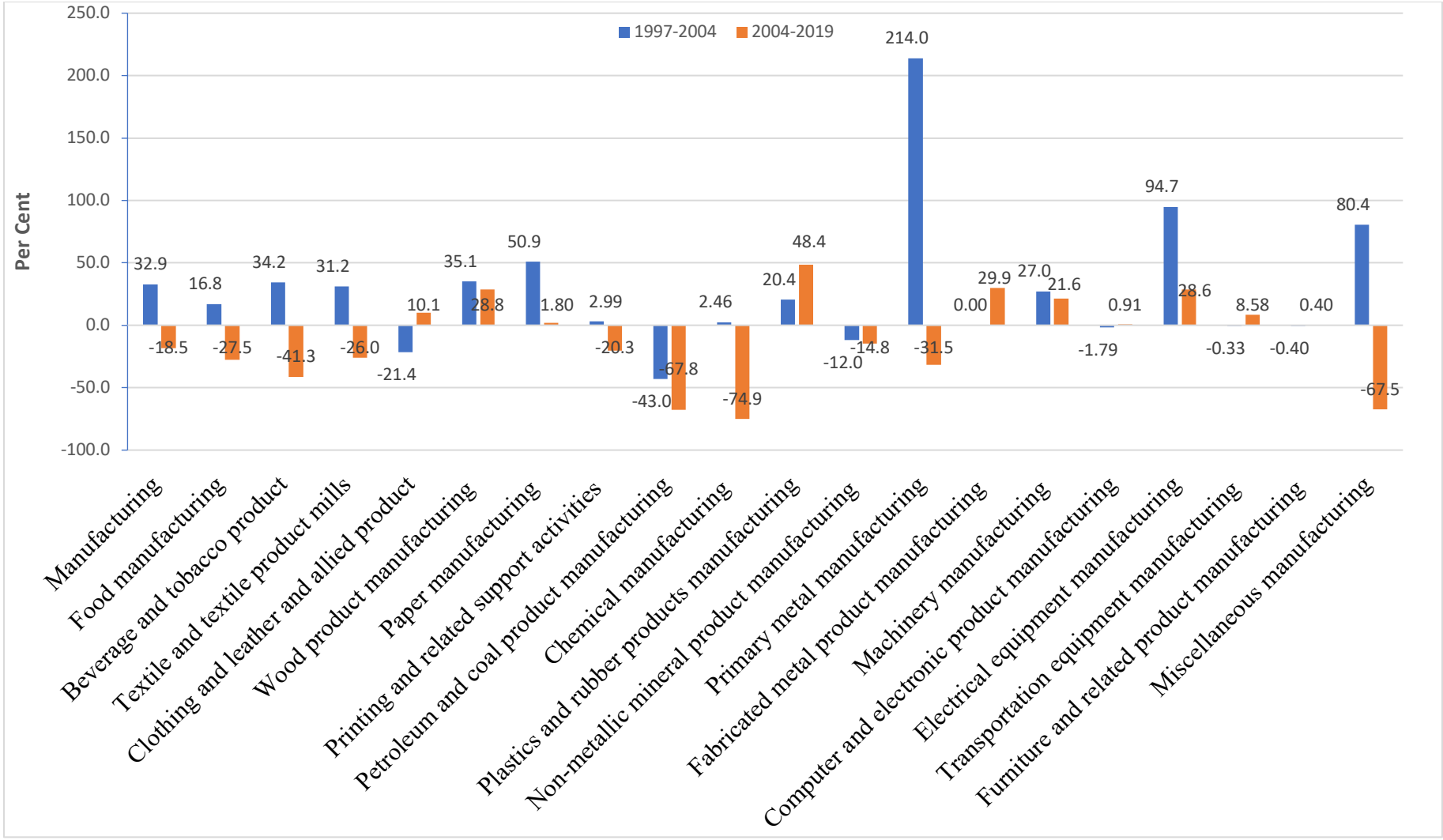
Source: Statistics Canada, Table: 36-10-0480-01

Chart 16: Labour Productivity, Chained (2012 Dollars), for Manufacturing and its Three-Digit Industries, for New Brunswick and Canada, 2004-2019, (Per Cent Change)



Source: Statistics Canada, Table: 36-10-0480-01

Chart 17: Labour Productivity, Chained (2012 Dollars), for Manufacturing and its Three-Digit Industries, for New Brunswick, 1997-2004 and 2004-2019, (Per Cent Change)



Source: Statistics Canada, Table: 36-10-0480-01

B. Industry Contributions to the Post-2004 Productivity Fall-off

This section calculates industry contributions of the 19 three-digit manufacturing industries to total manufacturing labour productivity growth to shed light on industry sources of productivity growth. The intuition for the estimation of industry contributions to aggregate productivity growth might seem straightforward, namely weight the productivity change of each industry by its relative importance. But in reality, there are a number of technical or methodological issues that require choices which that affect the results. These issues are highlighted below briefly.

1. Methodological Issues

The most important issue or choice is whether industry changes in productivity are weighted by the industry's share of labour input, generally hours, or output, generally value added in real terms. Industries with above average productivity levels have by definition larger output shares than hours shares while industries with below average productivity levels have larger hours shares than output shares. This means that output-weighted calculations assign greater contributions to aggregate productivity growth to industries with above average productivity levels than would be assigned to these industries with an hours-weighted contribution where the weight is less. Conversely, output-weighted calculations assign smaller contributions to below average productivity level industries. The opposite result is obtained for hours-weighted calculations.

A second issue is whether the change in productivity growth used for the contribution formula is a per cent change in the productivity level between years or an absolute change in productivity level. Since the absolute change is not affected by the base, while the per cent change is, results can differ. As well, per cent changes can be expressed as total per cent change over the period or as a compound annual growth rate. Results differ slightly.

Choices must be made in how hours or output shares are calculated. Options include the base year of the period, the end year of the period, the average of the base and end years, or an average of all years in the period. The most widely used practice is to use the average of the base and end years.

The use of real or chain dollar estimates of output poses challenges as chain dollar estimates are not additive across industries, although the differences between the sum of the industry output and the published totals can be small, particularly for short periods and when changes in relative process ae small. The effect of the use of chain dollar output estimates is that the sum of the industry productivity contributions may be less than 100 per cent. This problem can be avoided by the use of nominal or current dollar output, which is always additive, ensuring industry contributions will add to 100 per cent. However, the rate of change in nominal value added per hour is not a true productivity

growth rates since it includes an inflation component. Labour productivity growth is defined as changes in physical output per hour worked with real output assumed to be a proxy for physical output.

As the key driver of productivity growth is the underlying pace of technological change, one expects to see a slow upward trend in labour productivity growth over time, with cyclical fluctuations due to recessions. This is not what happened in manufacturing in New Brunswick over the 1997-2019 period.

2. Industry Contributions

From 1997 to 2004, output per hour in manufacturing in New Brunswick increased 32.9 per cent, well above the 17.7 per cent for Canada. This resulted in New Brunswick's relative manufacturing labour productivity level jumping from 98.9 per cent of the national level in 1997 to 108.9 per cent in 2004, an impressive achievement.

After 2004, New Brunswick's manufacturing productivity performance fell in both absolute and relative terms. Between 2004 and 2019, output per hour fell 18.5 per cent, compared to a 17.7 per cent rise in Canada. This resulted in the province's manufacturing productivity level falling from above the national average (108.9 per cent) to three quarters of the national level (to 75.4 per cent). This section examines the productivity developments at the three-digit manufacturing industries than can explain this situation. Both industry-specific or within industry productivity development as well as compositional shifts in output and hours play roles.

Industry contributions to productivity growth within a period can be calculated by weighting the per cent change and absolute change in productivity by the average hours and output shares for the period.[16]

1997-2004

Appendix Table 28 provides estimates for Canada of total hours worked for total manufacturing and for 18 three-digit manufacturing industries for 1997 and 2004, with data on the per cent distribution of hours and the per cent change in hours by industry as well as the industry contribution to the total change in hours. Appendix Table 26 provides the same data for New Brunswick for 1997 and 2004. Appendix Table 29 provides the same data for Canada for 2004 and 2019 while Appendix Table 27

[16] Appendix Tables 15 and 16, provide for New Brunswick the labour input (jobs and hours) and the output (real and nominal value added) for the 19 manufacturing industries for the most recent year for which data area available. Four industries stand out in terms of their importance to the manufacturing sector in 2019: food manufacturing, wood manufacturing, paper manufacturing, and petroleum and coal product manufacturing. The first three industries have the highest weight for manufacturing in terms of jobs and hours worked. However, when it comes to real value added, in addition to the first three industries, petroleum and coal product manufacturing represents a considerable weight for manufacturing (19.3 per cent) compared to food manufacturing (23.2 per cent), wood manufacturing (13.5 per cent) and paper manufacturing (19.5 per cent).

does the same for New Brunswick. Appendix 22-25 provide four comparable tables for real output and Appendix Tables 30-33 do the same for labour productivity levels. The discussion focuses on the productivity tables.

Appendix Table 34 shows that the industry that made by far the largest contribution to the absolute change of $14.60 per hour (2012 dollars) in labour productivity in manufacturing in New Brunswick in the 1997-2004 period was paper. This industry accounted for 34.7 per cent of labour productivity growth on an hours-weighted basis and 52.5 per cent on an output-weighted basis. This large contribution reflected three factors: the industry's rapid output growth (89.6 per cent from Appendix Table 22), high relative productivity level (160 per cent of the provincial average for manufacturing in 2004 from Appendix Table 30) and fast productivity growth (50.9 per cent from Appendix Table 30).

Four other industries made significant contributions (8-12 per cent) to labour productivity growth in New Brunswick manufacturing in 1997-2004 on a hour-weighted basis, namely food products, wood products, primary metals, and miscellaneous manufacturing.[17] The contributions of the first two of these industries were based on their large employment shares while the contributions of the latter two industries were based on their large productivity increases (214 per cent and 80 per cent respectively).

The contribution of the petroleum and coal product manufacturing to productivity growth in New Brunswick manufacturing in 1997-2004 was negative. This industry is dominated by one establishment, the Irving oil refinery in Saint John, Canada's largest refinery. Because of the unique nature of the industry, estimates should be treated with caution. Because of its capital-intensive nature, labour productivity in petroleum refining industry is extremely high. In 1997, real value per hour (2012 dollars), was 30 times that of the manufacturing average for New Brunswick (Appendix Table 30). With only 1.0 per cent of manufacturing hour worked this small industry contributed to 30 per cent of to the average productivity level of $44.4.[18] Labour productivity in the industry fell 43 per cent between 1997 and 2004 as output fell 10.9 per cent and hours worked increased 50.4 per cent. This development is calculated to have significantly reduced total productivity growth in manufacturing, offsetting some of the productivity growth contributed by paper and the other industries identified above.

As noted, manufacturing productivity growth at the national level was weaker than in New Brunswick between 1997 and 2004. Chart 14 shows that 13 out of 19 industries had slower productivity

[17] It is interesting to note that when contributions are calculated on an output-weighted basis beverage and tobacco products can be added to this list, accounting for 9.2 per cent of labour productivity growth. This can be explained by the high productivity level in the industry, more than double the manufacturing average (Appendix Table 28.)

[18] The 30 per cent figure is calculated from $1224 (0.010)/$44.4. The importance of the industry to the province's average manufacturing labour productivity level has fallen over time to 19 per cent in both 2004 and 2019 with the decline in the relative labour productivity of the sector (13 times the average in 2004 and only 5 times in 2019), which has more than offset the industry's rising hours share (1.5 per cent in 2004 and 3.8 per cent in 2019).

growth at the national level than in New Brunswick. Appendix Table 32 provides the industry contributions to labour productivity growth in Canada over the 1997-2004 period. Compared to New Brunswick (Appendix Table 30), three developments stand out. First, the increase in manufacturing labour productivity was much less: 20.7 per cent versus 32.9 per cent. Second, the industry contributions were much less concentrated, with no industry making a contribution of 20 per cent or more. Third, transport equipment drove labour productivity growth in manufacturing at the national level with a 19 per cent contribution, compared to no contribution in New Brunswick.

2004-2019

Appendix Table 23 provides for New Brunswick estimates of real value added for total manufacturing and for 18 three-digit manufacturing industries for 2004 and 2019, with data on the per cent distribution of output. Appendix Table 27 provides hours data for New Brunswick. For Canada for 2004 and 2019, Appendix Table 25 provides the output data and Appendix Table 29 hours data.

Output per hour in manufacturing in New Brunswick fell 18.5 per cent between 2004 and 2019, reducing the province's productivity level from above the national average to three quarters of the national average. The absolute fall in output per hour in manufacturing was $10.90. The fall-off in labour productivity growth in manufacturing after 2004 was widespread, with 16 of 19 industries experiencing slower productivity growth (Chart 16).

Appendix Table 35 shows that the industry that made by far the largest contribution to the absolute decline of $10.90 per hour (2012 dollars) in labour productivity in manufacturing in New Brunswick in the 2004-2019 period was petroleum. This industry accounted for 125.1 per cent of the fall in labour productivity on an hours-weighted basis and 99.7 per cent on an output-weighted basis. This development reflected the fall in output per hour in petroleum of $516 per hour from $791 per hour in 2004 to $245 per hour in 2019 (Appendix Table 31).

Appendix Table 37 shows the industry contributions to the 18.5 per cent fall in labour productivity growth in manufacturing in New Brunswick for the 2004-2019 period. On a hours-weighted basis food made by fall the largest contribution at 38.7 per cent, with a 27.8 per cent fall in labour productivity between 2004 and 2019. The other industries that contributed significantly to the fall in manufacturing productivity resulting from negative productivity growth were miscellaneous manufacturing (16.6 per cent) and petroleum (9.7 per cent) The only major industry in the province that had positive productivity growth and hence offset the negative overall manufacturing productivity trend was wood.[19]

[19] A reviewer of this report commented that there were many mills closing after 2004 as the pulp and paper mills shut down. Paper and wood are integrated through the sawmill residues and with the loss of demand for residues, sawmills had challenges.

Industry contributions to labour productivity growth that are output-weighted are larger than hours-weighted contributions in industries with above average labour productivity levels and below hours-weighted contributions in industries with below average labour productivity levels. Appendix Table 37 provides these output and hours-weighted levels. The largest deviation between the two sets of contributions is for petroleum given its very high relative productivity level. Moving from hours to output shares to weight productivity growth raises the contribution of the petroleum to the fall in labour productivity between 2004 to 2019 from 9.7 per cent to 70.9 per cent. The contributions of other industries did not change greatly.

As noted, manufacturing productivity growth at the national level was much stronger than in New Brunswick between 2004 and 2019. Chart 16 shows that 15 out of 19 industries had faster productivity growth in Canada than in New Brunswick. Appendix Table 33 provides the industry contributions weighted by hours to labour productivity growth in Canada over the 2004-2019 period. Compared to New Brunswick, two developments stand out. First, the nearly 40 percentage point difference in growth rates (17.7 versus -18.5). Second, the absence of any industry dominating industry contributions to productivity growth. The largest positive contribution for Canada was by machinery at 14.3 per cent and the largest negative contribution was petroleum at 23.0 per cent.

3. Falloff between 1997-2004 and 2004-2019

Labour productivity growth in manufacturing in New Brunswick fell off 51.4 percentage points from an increase of 32.5 per cent between 1997 and 2004 to -18.5 per cent between 2004 and 2019. In terms of average annual rates of growth this is equivalent to an annual falloff of 5.50 percentage points from 4.02 per cent to -1.28 per cent. In absolute terms, after increasing by $14.60 per hour (2012 dollars) between 1997 and 2004, output per hour in New Brunswick manufacturing fell $10.90 between 2004 and 2019, a turnaround of $25.50.

The industry sources of this massive deterioration in productivity performance can be calculated in four ways, based on per cent changes and absolute changes, and each weighted by output or hours.[20]

Appendix Table 39 provides absolute and percentage contributions to the change in total manufacturing productivity growth between the 1997-2004 and 2004-2019 periods based on per cent changes in industry productivity growth both weighted by hours and output. Looking first at hours-weighted results one sees the largest contributions to the fall-off were by food products (24.4 per cent), paper (11.5 per cent), miscellaneous manufacturing (9.9 per cent), and primary metal products (7.0 per cent). The contributions of the first two industries were in line with their share of total hours worked while the contributions of other two industries reflected the much greater falloffs in productivity growth.

[20] See Appendix Tables 38 and 39.

Turning to output-weighted results, the largest contributions to the fall-off were by food products (18.4 per cent), paper (19.0 per cent), miscellaneous manufacturing (5.9 per cent), and primary metal products (10.2 per cent). The contribution of food products was less than on an hours-weighted basis as the industry has a below-average productivity level. The opposite situation was obtained in the paper industry. On an output-weighted basis the petroleum industry made a 12.2 per cent contribution to the fall-off in productivity growth, ten times the hours-based contribution because of the extremely high relative labour productivity of the sector. This is reflected in the much greater output share compared to the hours share.

Appendix Table 38 provides absolute and percentage contributions to the absolute change in total manufacturing productivity between the 1997-2004 and 2004-2019 periods based on the absolute changes in output per hour per cent by industry weighted by both hours and output. Looking first at hours-weighted results one sees the largest contributions to the fall-off were by food products (20.9 per cent), paper (14.3 per cent), miscellaneous manufacturing (9.3 per cent), and primary metal products (8.6 per cent). Again, the contributions of the first two industries were in line with their share of total hours worked while the contributions of the other two industries reflected the much greater falloffs in productivity growth.

Regarding output-weighted results, the largest contributions to the fall-off were by food products (15.8 per cent), paper (23.6 per cent), miscellaneous manufacturing (5.5 per cent), and primary metal products (12.6 per cent). Again, the contributions of food products were less than on an hours-weighted basis as the industry has a below average productivity level. The opposite situation was obtained in the paper industry. On an output-weighted basis the petroleum industry made a -56.7 per cent contribution to the fall-off in productivity growth reflecting the increase in output per hour in the industry between 2004 and 2019. This contribution was ten times the hours-based contribution because of the extremely high relative labour productivity of the sector. This is reflected in the much greater output share compared to the hours share. The impact of the petroleum industry on contributions to change in productivity is much greater when measured by absolute changes in output per hour instead of per cent changes, given the extremely high level of labour productivity in the industry.

4. Within-Industry Reallocation Effects and the New Brunswick Manufacturing Productivity Fall-off

The discussion above of the contributions of an industry to the total change in manufacturing productivity ignores the impact of the reallocation of resources on the industry's contribution. This latter factor influences the aggregate productivity through a composition effect. For example, an increase in the hours share of an industry with an above-average productivity will boost the aggregate productivity level. An increase in the hours share of an industry with a below average productivity will had the opposite effect. The Centre for the Study of Living Standards has developed a methodology to

estimate a within-industry effects and reallocation effects linked to both productivity level and growth rates (Sharpe and Thomson, 2010; Avillez, 2012, and Reinsdorf, 2014)

At both the total manufacturing level and for three-digit manufacturing industries, productivity growth can be broken down into within-sector effects and re-allocation effects, which include both level and growth effects (Sharpe and Thomson, 2012).

Appendix Table 45 for New Brunswick and Appendix Table 46 for Canada provide estimates of the contributions in 2012 dollars of the within-sector effect, the reallocation level effect, and the reallocation growth effect to the absolute change in labour productivity measured as output per hour of work in 2012 dollars for the 19 manufacturing industries. The summation of the industry estimates gives the net effect for the manufacturing sector (Table 10).[21] The data for both tables are for the 1997-2004 and 2004-2019 periods and the change between periods.

The bottom line is that the net reallocation effect, defined as the sum of the level and growth effects, boosted productivity growth in manufacturing in New Brunswick considerably in the 1997-2004 period ($4.20 per hour) and had a negative effect in the 2004-2019 ($1.30 per hour). The fall-off in productivity growth between periods was thus in part linked to the reduction of the reallocation effect. Of the total change in output per hour of $20.40 between periods, $2.80 or 13.8 per cent can be attributed to reallocation effects.

Looking first at the within sector effect in 1997-2004, one sees that by far the largest contribution to the absolute change in output per hour was in the paper industry at $4.60 per hour (2012 dollars). This reflected both the size of the industry and its very rapid productivity growth. Other industries making important within-sector contributions were food products ($1.40). wood products ($1.90), primary metals ($1.90) and miscellaneous manufacturing ($0.96). On the other hand, the petroleum industry reduced productivity by $6.00 due to the very large fall in productivity (-43.0 per cent) and its very high productivity level. This offset much of the positive contributions from other industries, resulting in a total within-sector effect for manufacturing of $5.90 per hour, around 60 per cent of the total increase of $10.10 per hour.

The difference between the total increase in productivity in manufacturing and the contribution of the within-sector effect, that is own productivity growth in the industry proper, is due to reallocation effects. This implies that 40 per cent of the strong productivity growth enjoyed by manufacturing in New Brunswick was due to reallocation effects.

[21] For New Brunswick, the summation of the total for the 2004-2019 period of -10.3 is almost identical to the actual estimate of -10.9 per cent. For some reason, this is not the case in 1997-2004 where the total of 10.1 is less than the actual estimate of 14.6.

Turning first to the reallocation level effect, we find that the petroleum industry made a $5.90 contribution to productivity growth. This was due to the industry's extremely high labour productivity level (30 times the manufacturing average in 1997) and the 50 per cent increase in hours worked. No other industry had a significant reallocation level effect. The petroleum industry made a -$2.70 contribution to reallocation growth effect because its falling productivity. The total reallocation effect for petroleum was $3.20, the lion's share of the total reallocation effect for manufacturing ($4.10). It should be noted that the positive reallocation effect of the petroleum industry was more than offset by the large and negative with-in sector effect (-$6.00) resulting in a negative contribution of -$2.70 from the petroleum industry to the overall increase in labour productivity.

Table 11: Within-Sector and Reallocations Effects for Labour Productivity Growth in Manufacturing in New Brunswick and Canada, in 1997-2004 and 2004-2019, (in 2012 dollars)

	1997-2004		2004-2019		Difference Between Periods	
	New Brunswick	Canada	New Brunswick	Canada	New Brunswick	Canada
Within-Sector Effect	5.9	8.5	-11.7	7.6	-17.6	-0.9
Reallocation Level Effect	6.4	1.5	15.6	6.1	9.2	4.6
Reallocation Growth Effect	-2.3	-0.47	-14.3	-2.6	-12.0	-2.2
Total Reallocation	4.1	1.0	1.3	3.4	-2.8	2.4
Total	10.1	9.5	-10.3	11.0	-20.4	1.5
Per Cent Contribution to Total						
Within-Sector Effect	58.7	89.2	113.2	68.8	86.2	-59.0
Reallocation Level Effect	63.5	15.7	-151.6	55.0	-44.9	301.1
Reallocation Growth Effect	-22.2	-4.9	138.4	-23.8	58.8	-142.1
Total Reallocation	41.3	10.8	-13.2	31.2	13.8	159.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: based on Appendix Tables 45 and 46; Statistics Canada, Table: 36-10-0480-01

In addition to the identification of reallocation effects, Appendix Table 45 sheds light on the total industry contributions to the change in manufacturing productivity. The most important industry source of rapid manufacturing productivity growth in New Brunswick in 1997-2004 was the paper industry ($5.60) which contributed over half the total increase of $10.10. Wood products also made a significant contribution at $3.40 as did food ($2.10), As noted, the petroleum industry made a negative contribution because of its negative productivity growth despite its extremely high productivity level and its growing employment, which reallocation lead to a large level effect The three industries (paper, wood, food) identified as making the largest contributions to the rapid manufacturing productivity growth were also identified as such in the decomposition methodology that produced the hours-weighted contributions found above.

Looking at the 2004-2019 period, output per hour in manufacturing in New Brunswick fell $10.30 (Table 11 and Appendix Table 45), with the within-sector effect contributing -$11.70, the reallocation level effect $15.60 and the reallocation growth effect -$14.30. This makes the net reallocation effect $1.30, down from $4.10 in 1997-2004. This means that reallocation effects were less important in 2004-2019 than in 1997-2004.

As was the case in 1997-2004, it was the petroleum industry that accounted for the reallocation effects, with a $16.00 level effect combined with a -$11.51 growth effect. The level effect was due to a large increase in hours in the very high productivity petroleum industry. The growth effect reflects the large fall in productivity in the petroleum industry over the period.

Table 11 summarizes the dollar contributions to the change in output per hour in New Brunswick manufacturing from decomposition into within-sector effect, reallocation level effect, reallocation rate effect and net allocation effect. There was a positive net reallocation effect in both periods, but it fell from $4.10 in 1997-2004 to $1.30 in 2004-2019. After rising $10.10 in 1997-2004 output per hour fell $10.30 in 2004-2019, a turnaround of $20.40. the weakening of the reallocation effects accounted for 13.8 per cent of this change. In other words, the large fall-off in manufacturing productivity growth in New Brunswick after 2004 was primarily a within-sector phenomenon, responsible for 86.2 per cent of the deterioration.

The role of reallocation effects in accounting for productivity growth increased in Canada in 2004-2019 compared to 1997-2004, so unlike in New Brunswick, reallocation of resources boosted productivity (Table 11 and Appendix Table 46). Indeed, all the slight pick-up in manufacturing productivity ($1.50) in Canada after 2004 was due to reallocation effects as the change in within-sector productivity fell from $8.50 to $7.60. The net reallocation effect rose $2.40 between periods from $1,00 in 1997-2004 to $3.50 in 2004-2019.

The takeaway from this analysis of the industry sources of the post-2004 manufacturing productivity fall-off in New Brunswick is that the story lies with food and paper, both of which are important manufacturing industries in the province. Together these two industries accounted for around 77 per cent of the fall-off.

III. Labour Shortages and Manufacturing Productivity in New Brunswick

Manufacturers in New Brunswick in recent years have complained of labour shortages. This situation has been put forward as a factor contributing to the manufacturing sector's slow output, employment, and productivity growth. This section of the report examines this issue by looking at three indicators of labour shortages in New Brunswick manufacturing: the unemployment rates, job vacancies, and wage increases. These indicators are then compared to developments at the national level and to all industries in New Brunswick.

The relationship between labour shortages and productivity is ambiguous. It can be argued that labour shortages can both hinder and foster productivity growth. Regarding the first case, labour shortages can result in difficulties for a firm to fill key positions, leading to production bottlenecks and falls in output and potentially productivity. In addition, an inability of a firm to find workers to increase or even maintain production can limit economies of scale and scope, normally an important source of productivity growth.

On the other hand, labour shortages and the consequent upward pressure of wages can have positive labour productivity effects through two channels. First, firms that cannot afford to pay higher wages will not be able to stay in business. As these firms are likely to have below average productivity levels, their exit can have a positive composition effect on aggregate productivity. Second, rising wages give firms an incentive to substitute capital for labour, boosting capital intensity and labour productivity.

The empirical evidence suggests that the positive linkage between labour shortages and productivity is stronger and more important than the negative linkage between the two phenomena.[22] In any case, the purpose of this section is not to assess the relative importance of the two linkages in the New Brunswick manufacturing context. Rather it is to assess whether the labour market for New Brunswick manufacturers can be characterized as one of labour shortage.

A. Unemployment rate

The unemployment rate for workers in manufacturing, which covers unemployed persons whose last job was in manufacturing, was 9.7 per cent in New Brunswick in 2019 (Chart 18, Panel A).

[22] A reviewer of this report points out that some NB-based manufacturers allege that labour shortages influence where they choose to invest. Some NB manufacturers indicate they are expanding operations outside New Brunswick "closer to the market" because they cannot find labour in New Brunswick, even with the higher unemployment rate and lower job vacancy rate. Some argue the seasonal nature of much of unemployment in the province means the unemployed are not available to work in non-seasonal industries despite their apparent availability. For example, the Dr Oetker's frozen pizza plant near Florenceville closed due to its aging equipment and the new plant was built in London, Ontario.

Since 1997 only three years have seen lower rates, 2007, 2017 and 2018. But the decline in the rate has not been particularly dramatic. The average unemployment rate from 1997 to 2018 was 11.3 per cent.

However, the manufacturing unemployment rate in New Brunswick is nearly three times as high as the national rate for manufacturing, which was only 3.6 per cent in 2019. This indicates that the labour market for manufacturing workers exhibits much slacker in New Brunswick than at the national level.

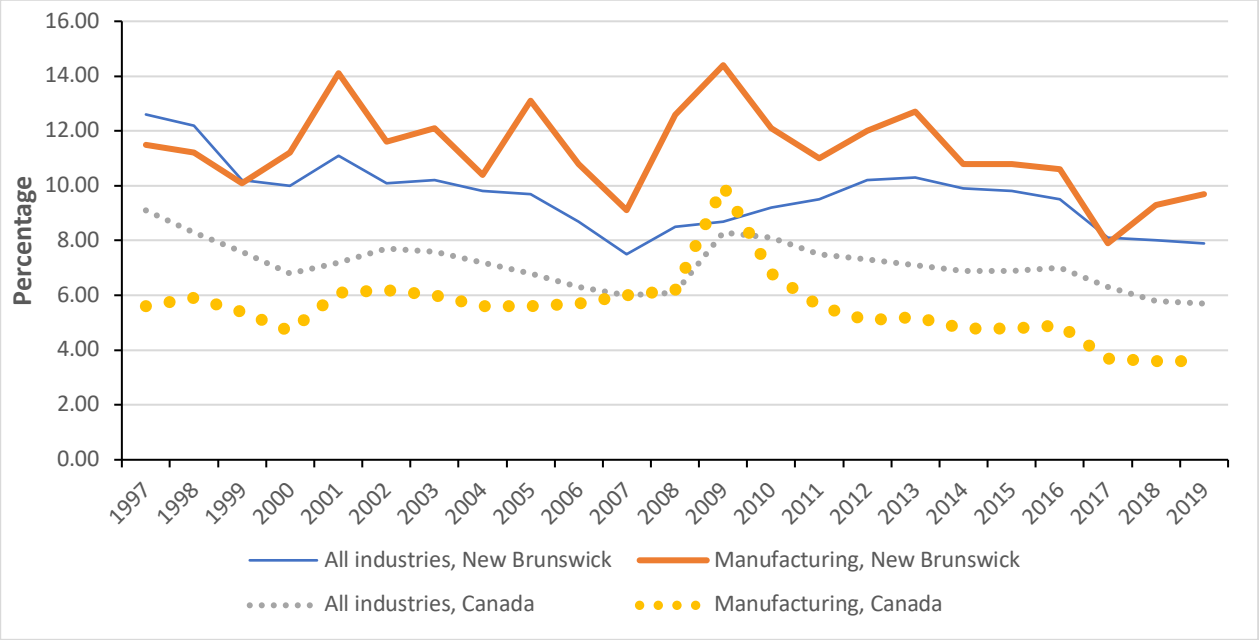
The relationship between the all-industries or overall unemployment rate and the manufacturing unemployment rate differs significantly between New Brunswick and Canada. In the former, the manufacturing unemployment rate has exceeded the overall rate since 2000 in all years but one. In 2019, the manufacturing unemployment rate was 1.23 times that of the all-industries rate (9.7 per cent versus 7.9 per cent). This may be surprising as manufacturing jobs are generally full-time, permanent, with above average wages. This makes them more attractive than jobs in other industries, especially the service sector, and might be expected to put downward pressure on the unemployment rate.

At the national level, the unemployment rate in manufacturing is generally below that for all industries. In 2019, it was only 63 per cent of the overall rates: 3.6 per cent versus 5.7 per cent. This situation can reverse itself in recession years like 2009 when the cyclical manufacturing experienced layoffs. In New Brunswick, as noted, it is the reverse and the all-industries unemployment rate in 2019 was below the one for manufacturing.

At 9.7 per cent, the much higher manufacturing unemployment rate in New Brunswick in 2019, compared to that for manufacturing in Canada (3.6 per cent) and to the total economy unemployment rate in New Brunswick (7.9 per cent) suggest that there is much slacker in the manufacturing labour market in New Brunswick than in the Canadian manufacturing labour market and the overall labour market in New Brunswick.

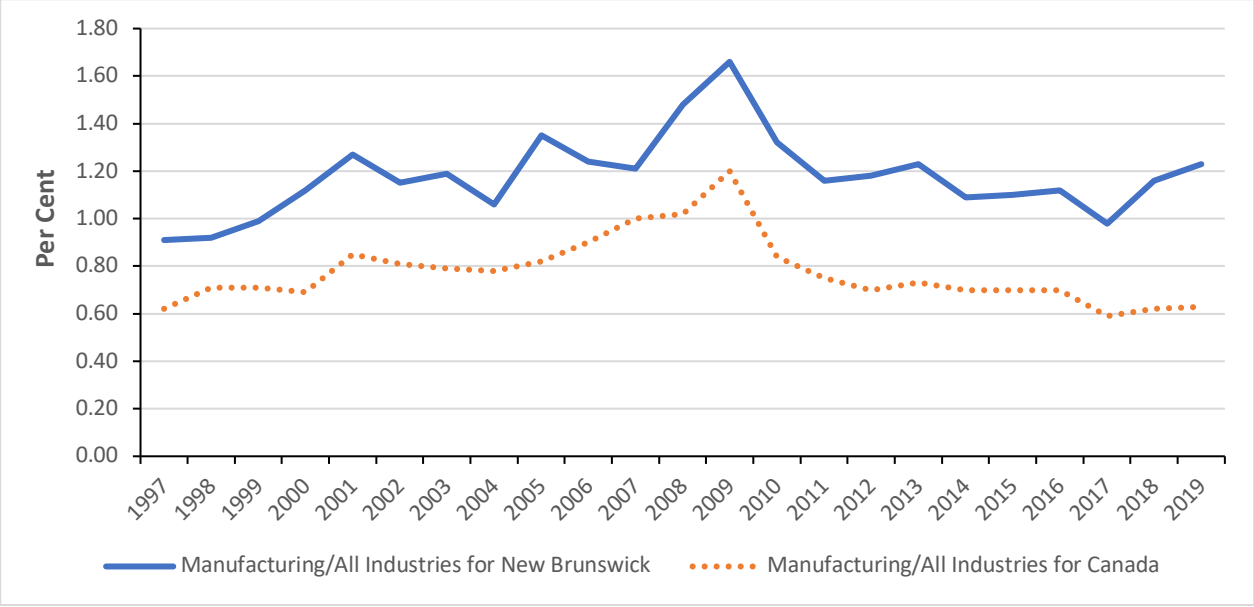
Chart 18: Unemployment Rate for All Industries and for Manufacturing in Canada and in New Brunswick and the Ratio between the Unemployment Rate for Manufacturing and the Unemployment Rate for All Industries, 1997-2019

Panel A: Unemployment Rate



Source: Statistics Canada, Labour Force Survey, Table: 14-10-0023-01

Panel B: Ratio



Source: Statistics Canada, Labour Force Survey, Table: 14-10-0023-01

B. Job Vacancies and the Unemployment-vacancy ratio

A key indicator of labour shortages and trends in labour market tightness in the ratio of unemployed to job vacancies, or U-V ratio. Table 12 and 13 show the number of unemployed and job vacancies in all industries and in manufacturing for New Brunswick and Canada for the 2015-2019 period, the most recent years for which consistent job vacancy data are available from Statistics Canada (Table 14-10-0023-01) the years for which data are available.[23]

Looking first at manufacturing, there were 1,300 job vacancies reported in the sector in 2019 in New Brunswick. While this number is up from 1,020 job vacancies in 2016, it is down from 1,400 in 2015 and the 1,350 reported in 2018. There is consequently no evidence of a major surge of unfilled manufacturing jobs in New Brunswick from official Statistics Canada job vacancy estimates.

With 3,330 persons unemployed in manufacturing in New Brunswick in 2019, the U-V ratio was 2.54. This means that there are two- and one-half unemployed manufacturing workers for every job vacancy. Of course, differences between the geographic location within the province and the skill requirements of the jobs and the location and skills of the unemployed mean it is unrealistic to expect that all vacancies can be easily filled by the unemployed. The U-V ratio in 2019 was the same as 2015, indicating no increased tightening of labour market in the manufacturing sector over this period. Unfortunately, job vacancy estimates are not available before 2015, so the U-V ratio may have been higher before then. The higher unemployment rate in New Brunswick manufacturing would support this view, as unemployment and job vacancies tend to move in the opposite direction.

In contrast to manufacturing in New Brunswick, there has been a significant tightening of the labour market in manufacturing in Canada since 2015 as shown by the U-V ratio. The number of unemployed fell from 86 thousand to 65 thousand between 2015 and 2019 with the number of job vacancies jumping from 33 thousand to 48 thousand. Consequently, the U-V ratio has fallen from 2.61 to 1.35. The ratio in 2019 was around one half that in New Brunswick. This evidence suggests that the labour market for manufacturing workers is twice as tight at the national level as in New Brunswick and that the last five years have seen a very large fall in labour market slack in manufacturing at the national level compared to no change in New Brunswick. This is consistent with the much lower manufacturing unemployment rate at the national level than in New Brunswick as well as the slightly greater fall in this unemployment rate since 2015.

In recent years, the trend toward labour market tightening in the New Brunswick labour market appears to more pronounced at the all-industries level than for manufacturing. The number of job vacancies in the province rose from 7,330 in 2015 to 9,370 in 2019 while the number of unemployed fell from 38,400 to 30,800. This resulted in the U-V ratio falling from 5.26 to 3.28. As noted, there was

[23] Statistics Canada has an earlier job vacancy series (Table 14-10-0227-01) that begins in 2011 but ends in 2018. It shows the same trends as the more up-to-date series. See Appendix Tables 53 and 54 for the older series.

no fall in the U-V ratio in manufacturing in New Brunswick between 2015 and 2019. In other words, there has been a significant tightening of the aggregate labour market in New Brunswick since 2015, with no tightening of the manufacturing labour market. But the degree of labour market slack in 2019 is still less in manufacturing than in all industries, as evidenced by the lower U-V ratio (2.54 versus 3.28).

New Brunswick labour market has outperformed the national labour market in terms of the pace of tightening since 2015. The U-V ratio has fallen 1.98 points from 5.26 in 2015 to 3.28 in 2019 compared to a 1.17 points fall in Canada from 3.29 to 2.12. This is consistent with the trend in the unemployment rate which fell 1.9 percentage points from 9.8 per cent in 2015 to 7.9 per cent in 2019 in New Brunswick, compared to a 1.2 point fall for Canada from 6.9 per cent to 5.7 per cent. Of course, the absolute degree of slack in the labour market was greater in New Brunswick than Canada in 2019, as evidenced by the higher U-V ratio and unemployment rate.

Table 12:Number of Unemployed, Number of Jobs Vacancies and the Ratio of these two Variables for All Industries in Canada and in New Brunswick, 2015-2019

	New Brunswick			**Canada**		
	All Industries			All Industries		
	Number of Unemployed (x1000)	Number of Jobs Vacancies (x1000)	Unemployed/Jobs Vacancies	Number of Unemployed (x1000)	Number of Jobs Vacancies (x1000)	Unemployed /Jobs Vacancies
2015	38.4	7.33	5.26	1,337	407	3.29
2016	37.1	6.20	5.98	1,366	377	3.62
2017	31.0	7.31	4.25	1,251	446	2.81
2018	30.7	9.20	3.34	1,160	527	2.20
2019	30.8	9.37	3.28	1,144	540	2.12

Source: Statistics Canada, Tables: 14-10-0227-01 (for unemployed, until 2018), 14-10-0023-01 (for unemployed, 2019); 14-10-0326-01 (the time series for the number of jobs vacancies where quarterly, we did the average to find the annual value).

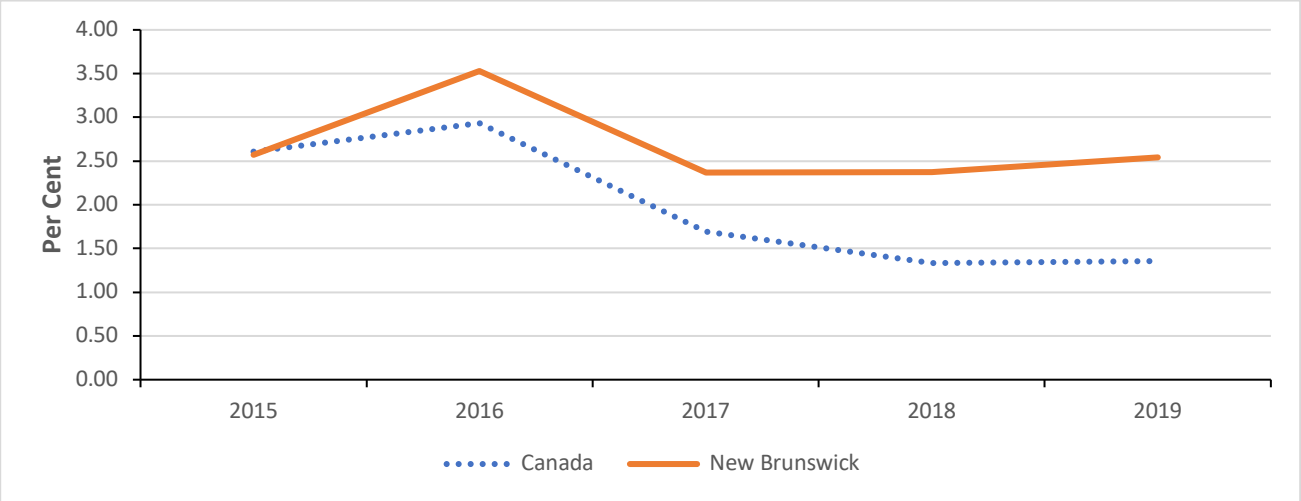
Table 13:Number of Unemployed, Number of Jobs Vacancies and the Ratio of these two Variables for Manufacturing in Canada and in New Brunswick, 2015-2019

	New Brunswick			Canada		
	Manufacturing			Manufacturing		
	Number of Unemployed	Number of Jobs Vacancies	Unemployed/Jobs Vacancies	Number of Unemployed (x1000)	Number of Jobs Vacancies (x1000)	Unemployed/Jobs Vacancies
2015	3,600	1,400	2.57	86	33	2.61
2016	3,600	1,020	3.53	88	30	2.93
2017	2,700	1,140	2.37	66	39	1.69
2018	3,200	1,350	2.37	64	48	1.33
2019	3,300	1,300	2.54	65	48	1.35

Source: Statistics Canada, Tables: 14-10-0227-01 (for unemployed, until 2018), 14-10-0023-01 (for unemployed, 2019); 14-10-0326-01 (the time series for the number of jobs vacancies where quarterly, we did the average to find the annual value).

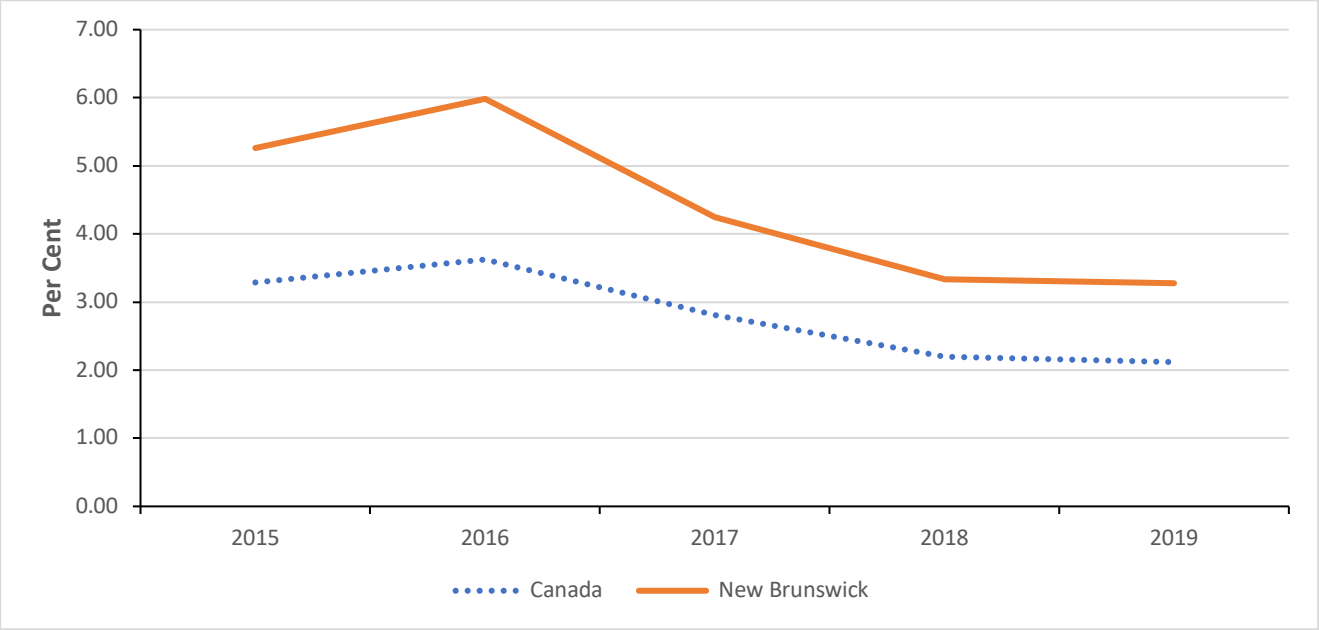
Chart 19:Number of Unemployed/ Number of Jobs Vacancies in Manufacturing and in All Industries, for Canada and New Brunswick, 2015-2019

Panel A: Manufacturing



Source: Statistics Canada, Tables: 14-10-0227-01 (for unemployed, until 2018), 14-10-0023-01 (for unemployed, 2019); 14-10-0326-01 (the time series for the number of jobs vacancies where quarterly, we did the average to find the annual value).

Panel B: All Industries



Source: Statistics Canada, Tables: 14-10-0227-01 (for unemployed, until 2018), 14-10-0023-01 (for unemployed, 2019); 14-10-0326-01 (the time series for the number of jobs vacancies where quarterly, we did the average to find the annual value).

C. Wage trends

Stronger labour market demand by employers leads to additional hiring and a reduction in market slack as well as greater increases in wages to attract workers. According to this indicator, the New Brunswick labour market in manufacturing has tightened in recent years. Hourly labour compensation in manufacturing in New Brunswick advanced at a 2.84 per cent rate from 2014 to 2019 considerably faster than the 0.95 per cent rate in 2008-2014, but comparable to the 2.9 per cent rate of the 1997-2008 period. In contrast, compensation growth in manufacturing at the national level was only 1.93 per cent per year in 2014-2019, down from the over 3 per cent rate from 1997 to 2008. This metric suggests that the manufacturing labour market in New Brunswick has been tightening faster than at the national level since 2014.

However, some of the stronger labour compensation growth since 2014 may be partial catch-up for weaker growth before 2014. Since 2011, labour compensation growth in New Brunswick manufacturing has been weaker than at the national level (Appendix Table 10). This has also been the case since 1997. Hourly labour compensation in New Brunswick manufacturing fell from 83.1 per cent of the national average in 1997, to 73.9 per cent in 2019.

Wage growth in manufacturing can also be compared to wage growth for all industries to gain perspective on where labour market tightening is taking place faster. At the national level, wage growth

in manufacturing and for all industries was identical in the 2014-2019 period, at 1.93/1.94 per cent per year. In contrast, in New Brunswick, wage growth after 2014 was faster in manufacturing than for all industries: 2.84 per cent versus 2.46 per cent per year. Given that wage trends reflect the relative balance between the demand and supply of labour in a sector, the province's manufacturing sector appears to be experiencing greater labour market tightening than the aggregate economy.

Again, part of this superior post-2014 labour compensation may be partial catch-up. Before 2014, manufacturing labour compensation growth in New Brunswick was significantly slower than for that of the total economy. In addition, even in 2019, manufacturing compensation in New Brunswick was a much higher percent of the national average than was the proportion for the total economy: 73.9 per cent versus 85.8 per cent. These low relative wages in New Brunswick manufacturing do not support a story of serious labour shortages in the sector.

D. Summary

There is little evidence of serious labour shortages in manufacturing in New Brunswick. The number of job vacancies has not increased in the short period for which estimates of job vacancies are available from 2015 to 2019. The unemployment rate in manufacturing increased in 2019 and is nearly three times the national average for manufacturing and higher than the total economy average for New Brunswick. While there has been some pick-up in wage growth in manufacturing in New Brunswick since 2014, this may reflect catch-up from weaker growth in the pre-2014 period. The level of hourly labour compensation in New Brunswick manufacturing is less than three quarters the national average and has been on a downward trend.

This suggests that labour shortages have not placed a significant role in explaining the province's poor manufacturing productivity performance. Indeed, just the opposite case might be made. Namely, the considerable slack in the manufacturing labour market in New Brunswick, as manifested by the high unemployment rate, the relatively high U-V ratio, and below-average long-term wage growth, may be providing employers an incentive to add labour and to not mechanize, resulting in slower labour productivity advance. Evidence for this story includes the much better performance of the New Brunswick manufacturing sector in terms of employment compared to the national average.[24]

[24] A reviewer of this report has offered another perspective on labour shortages. He argues that in a small open economy with elastic capital supply, it is possible that the lack of labour for additional capacity without raising wages discourages entry and investment and this could explain poor productivity performance.
New Brunswick manufacturing may be living off old equipment and buildings while regions with abundant labour obtain the new investment. Much of the thinking about labour shortages seems rooted in market adjustment in a closed economy setting.

IV. Additional Explanations of the Post-2004 Fall-off in Manufacturing Productivity Growth in New Brunswick

This section of the report examines three additional factors that have been put forth as explanation of the fall-off in labour productivity growth in New Brunswick manufacturing after 2004, namely lagging capital intensity growth, unfavorable exchange rate developments and low establishment size.

A. Weak Investment and Capital Intensity Growth

Emery and Gu (2019:2) have identified weak investment and capital intensity growth as a factor contributing to the poor productivity growth of manufacturing in New Brunswick. In addition, they address the issue of "what is holding back the capital investment that would drive transformational changes in New Brunswick manufacturing" and make the case that the answer is "an eroding business climate that dampens technology investment, including rising tax burdens, onerous regulations and public policy decisions that drive up business costs."

There are different measures of capital intensity depending on a number of factors, including whether capital stock or capital services are used. Official Statistics Canada estimates of capital intensity reported earlier in the report (Table 10) show that after increasing at a 2.47 per cent average annual rate in the 1997-2004 period, capital input per hour worked advanced only 0.95 per cent per year in 2004-2019, a fall-off of 1.52 percentage points. Based on the growth accounting methodology, slower capital intensity growth accounted for 14.7 per cent of the post-2004 fall-off in manufacturing productivity growth in New Brunswick.

A second measure of capital intensity for New Brunswick manufacturing, based on capital stock data as opposed to capital services, shows a much greater fall-off in capital intensity. According to this measure, the net capital stock based on geometric depreciation per hour fell from an average annual growth rate of 1.99 per year in 1997-2004 to -0.74 per cent, a fall-off of 2.73 points (Appendix Table 51). Based on a capital income share of around 50 per cent, the fall in capital intensity contributed 1.37 percentage points to the 5.37 percentage point fall in labour productivity growth between 1997-2004 and 2004-2019, 25.5 per cent of the total fall-off. This finding provides stronger support for the lagging capital intensity explanation put forward by Emery and Gu than the official Statistics Canada estimates.

Since much, if not most, of technological advance is embodied in new machinery and equipment through investment and hence in the capital stock, some economists argue that the standard growth accounting methodology underestimates the role of the capital accumulation in productivity growth. If such a view is valid, then the capital intensity story is even more important in accounting for weak productivity growth in New Brunswick manufacturing. One way to assess this if to see if

there is a relationship on an industry basis between capital intensity growth and labour productivity growth.

When analyzing the relationship between capital intensity and labour productivity, it can be expected that the higher the capital per worker or per hour worked, the higher the labour productivity should be. Hence, new technology embodied in capital used by companies should make it possible to achieve a higher level of labour productivity. Similarly, a faster growth rate in capital intensity should have a positive impact on the growth rate of labour productivity.

Chart 20 based on data in Table 14, shows the relationship between the per cent change in labour productivity (the "dependent variable") and the per cent change in capital intensity (the explanatory variable) for the 19 manufacturing industries in New Brunswick between 1997-2019. Each point on the chart indicates a manufacturing industry in New Brunswick. Two industries have a very strong relationship between changes in capital intensity and changes in labour productivity. The electrical equipment industry had the highest growth in both capital intensity (an increase of 362.4 per cent) and productivity (an increase of 150.3 per cent). At the opposite side, chemical manufacturing had the largest decline in capital intensity (-79.9 per cent) and the second largest fall in productivity (-74.2 per cent). The relationship was weaker in the other industries, producing an R-squared value that was relatively low (0.2264).

Moreover, when looking at the same variables over the sub-periods 1997-2004 and 2004-2019 (Chart 2 and Chart 3), the relationship between changes in capital intensity and labour productivity is even weaker than in the longer period, although still positive (0.0216 and 0.0675 respectively). It appears that the longer the period, the stronger or more robust the relationship between capital intensity and productivity at the industry level.

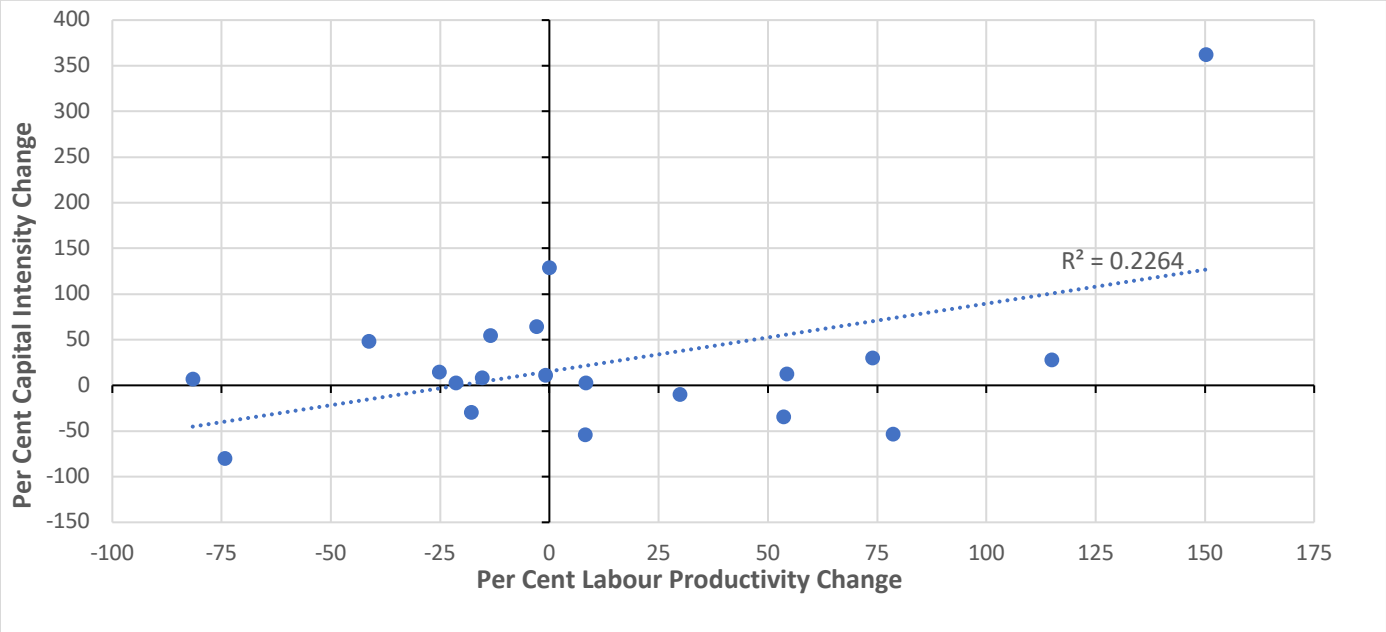
If one believes that that the capital intensity story is the key to explaining the post-2004 fall-off in manufacturing productivity growth in New Brunswick, then one might expect that the industries with the largest falloffs in capital intensity would have the largest declines in labour productivity. Chart 4 shows the percentage point changes in growth rates for capital intensity and labour productivity between 1997-2004 and 2004-2019. Most industries are in the quadrant of the chart where the change in both capital intensity and labour productivity are negative. The clothing and leather industry was the only one that had an increase in capital intensity growth and labour productivity growth, while primary metal manufacturing had the largest declines in growth rates for the two variables. The R-squared between the change in growth rates for capital intensity and labour productivity is extremely small (0.0111). This suggests, perhaps surprisingly, that there is virtually no relationship between the two variables. There are industries that, although they experienced a decrease in capital intensity growth, enjoyed an increase in productivity growth and vice versa. This lack of a relationship on an industry basis between developments in capital intensity and productivity appears not to support the story of capital intensity developments as the key to the New Brunswick manufacturing productivity puzzle.

Table 14: Labour Productivity (2012 dollars) and Capital Intensity for New Brunswick, for the selected periods, (Per Cent Change)

	Labour Productivity	Capital Intensity	Labour Productivity	Capital Intensity	Labour Productivity	Capital Intensity
	Per Cent Change					
	1997-2019		1997-2004		2004-2019	
Manufacturing	8.3	2.6	32.9	14.8	-18.5	-10.6
Food manufacturing	-15.3	8.2	16.8	37.2	-27.5	-21.2
Beverage and tobacco products manufacturing	-21.3	2.4	34.2	-12.0	-41.3	16.4
Textile and textile product mills	-2.9	64.6	31.2	21.0	-26.0	36.0
Clothing and leather and allied product manufacturing	-13.5	54.3	-21.4	7.5	10.1	43.5
Wood product manufacturing	74.0	30.0	35.1	25.4	28.8	3.7
Paper manufacturing	53.6	-34.5	50.9	-44.6	1.8	18.3
Printing and related support activities	-17.9	-29.7	3.0	-11.4	-20.3	-20.7
Petroleum and coal products manufacturing	-81.6	7.0	-43.0	154.5	-67.8	-58.0
Chemical manufacturing	-74.2	-79.9	2.5	-22.7	-74.9	-74.0
Plastics and rubber products manufacturing	78.7	-53.6	20.4	-17.1	48.4	-44.0
Non-metallic mineral product manufacturing	-25.1	14.9	-12.0	5.6	-14.8	8.9
Primary metal manufacturing	115.0	27.9	214.0	93.3	-31.5	-33.8
Fabricated metal product manufacturing	29.9	-9.9	0.00	5.7	29.9	-14.7
Machinery manufacturing	54.4	12.8	27.0	21.2	21.6	-6.9
Computer and electronic product manufacturing	-0.9	11.2	-1.8	249.4	0.9	-68.2
Electrical equipment, appliance and component manufacturing	150.3	362.4	94.7	233.6	28.6	38.6
Transportation equipment manufacturing	8.2	-53.9	-0.3	35.5	8.6	-66.0
Furniture and related product manufacturing	0.0	128.7	-0.4	110.6	0.4	8.6
Miscellaneous manufacturing	-41.3	48.2	80.4	60.3	-67.5	-7.6

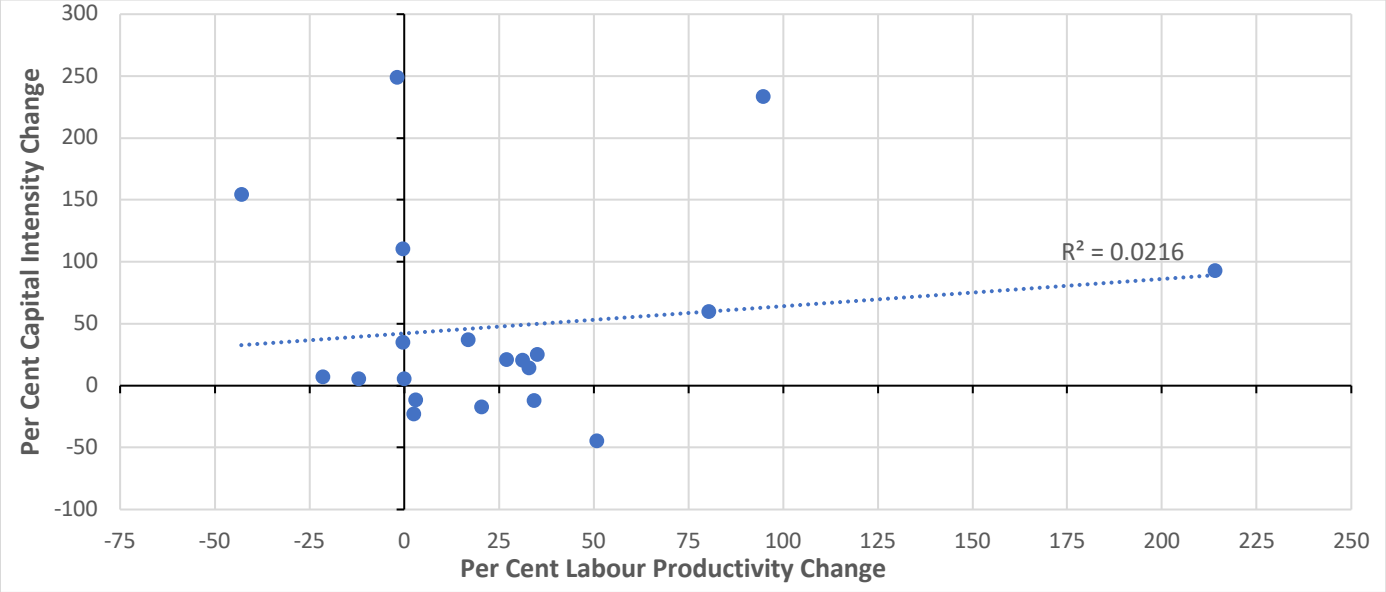
Source: Statistics Canada, Tables: 36-10-0480-01, 36-10-0096-01

Chart 20: Labour Productivity (2012 dollars) and Capital Intensity for Manufacturing Industries in New Brunswick, 1997-2019, (Per Cent Change)



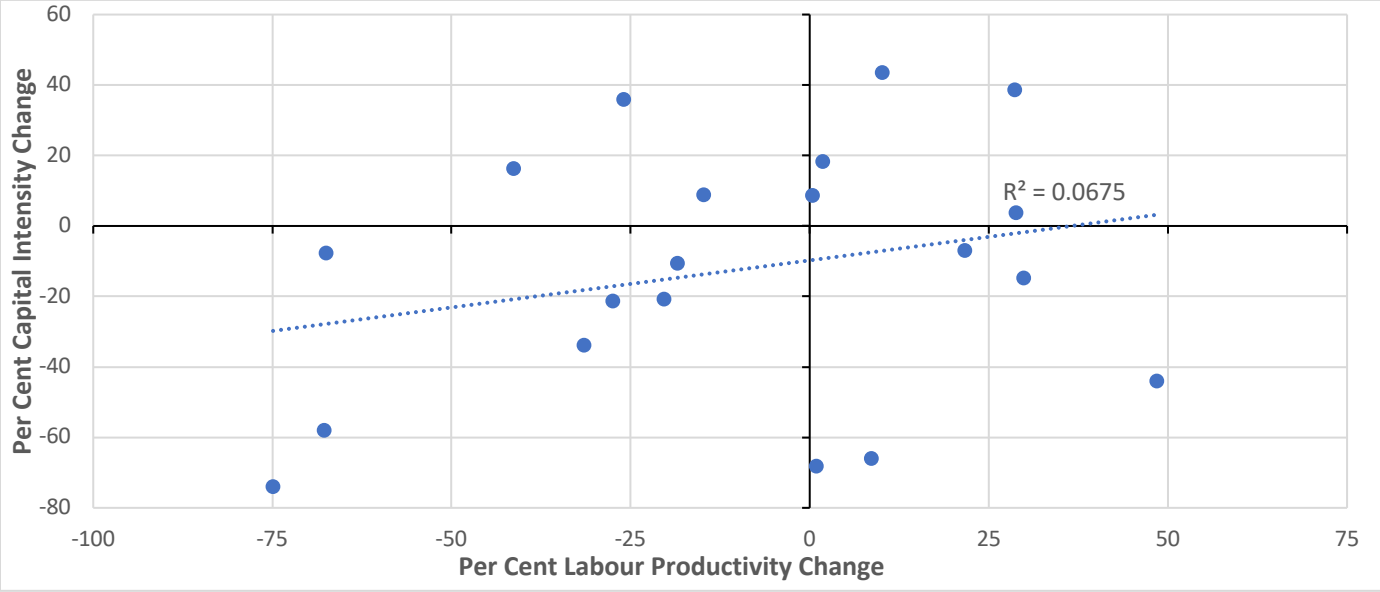
Source: Statistics Canada, Tables: 36-10-0480-01, 36-10-0096-01

Chart 21: Labour Productivity (2012 dollars) and Capital Intensity for Manufacturing Industries in New Brunswick, 1997-2004, (Per Cent Change)



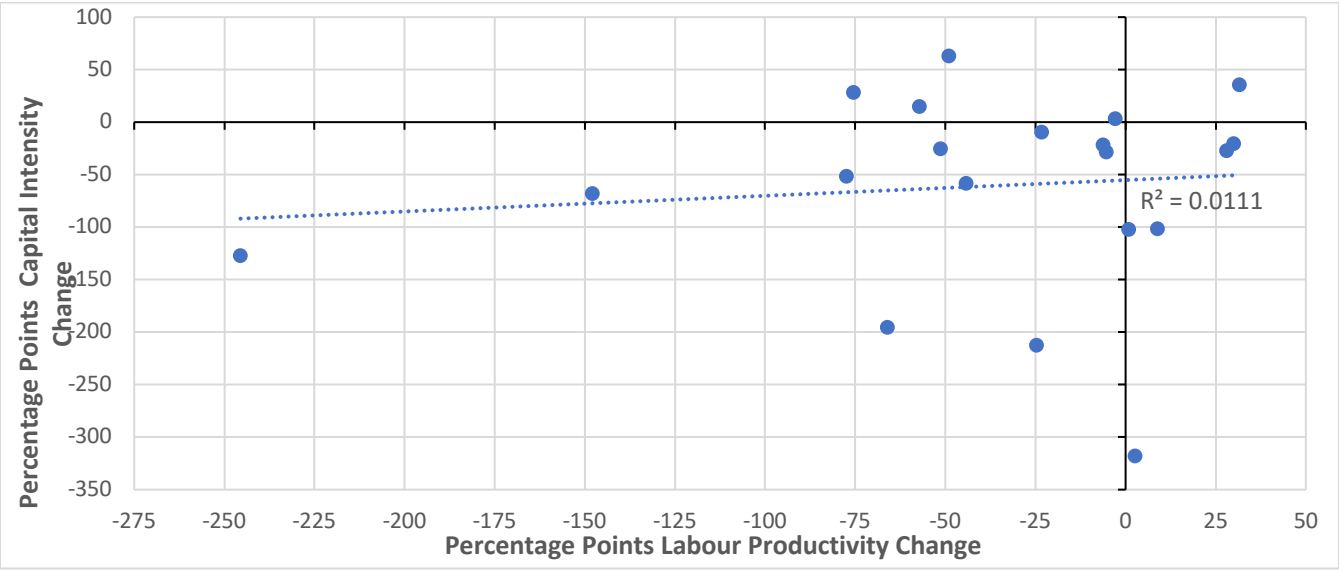
Source: Statistics Canada, Tables: 36-10-0480-01, 36-10-0096-01

Chart 22: Labour Productivity (2012 dollars) and Capital Intensity for Manufacturing Industries in New Brunswick, 2004-2019, (Per Cent Change)



Source: Statistics Canada, Tables: 36-10-0480-01, 36-10-0096-01

Chart 23: Labour Productivity (2012 dollars) and Capital Intensity for Manufacturing Industries in New Brunswick, (Difference between the Per Cent Change for the periods 1997-2004 and 2004-2019)



Source: Statistics Canada, Tables: 36-10-0480-01, 36-10-0096-01

B. Exchange Rate Developments

Emery and Gu (2019) have pointed out that a high proportion of New Brunswick's manufacturing output is exported, and that the province is highly dependent on the US market. The value of the Canadian dollar in terms of the US dollar has fluctuated significantly over the 1997-2019 period. These developments may be linked to the evolution of manufacturing productivity in the province.

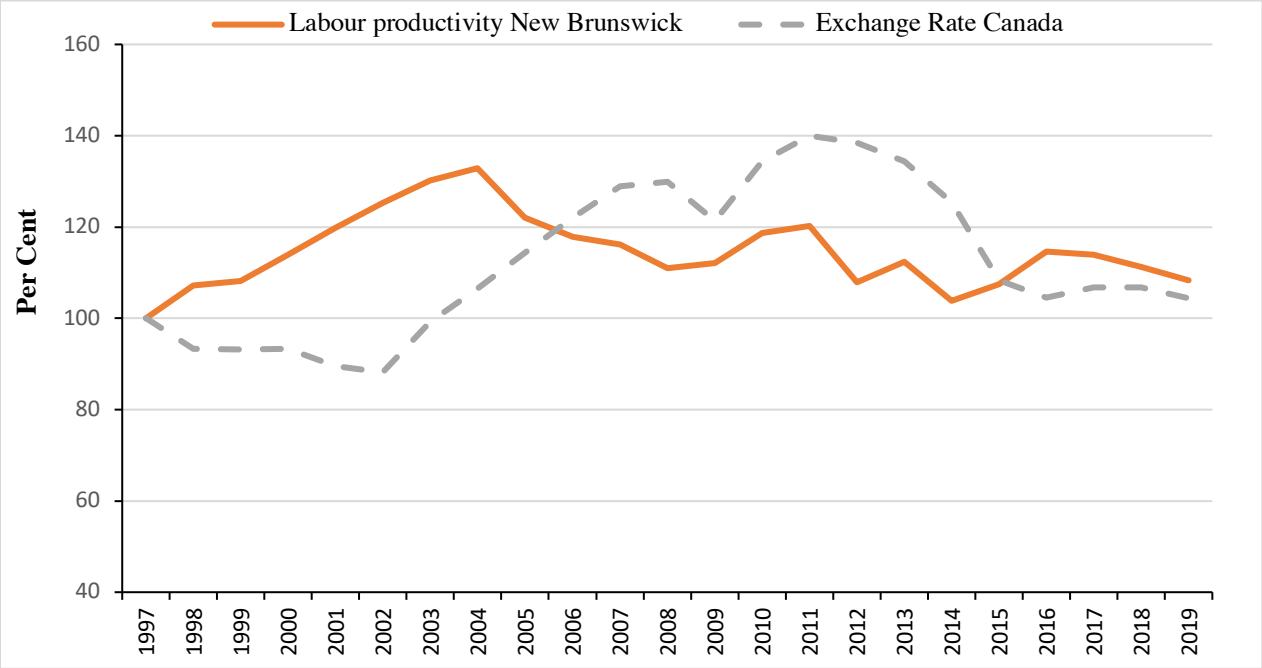
Chart 24 plots the paths of the labour productivity in New Brunswick manufacturing and the exchange rate over the 1997-2019 period, with both series indexed to 100 in 1997. The exchange rate is expressed as Canadian dollars per US dollar, so a fall is equivalent to a depreciation and a rise an appreciation. Four distinct periods can be identified for the exchange rate: a depreciation from 1997 to 2002 when the Canadian dollar hit $0.66 US, a strong and long period of appreciation, with the dollar peaking above parity in 2011, a depreciation to 2015, followed by a final period of stability. There are only two distinct periods of productivity growth: a strong upward trend from 1997 to 2004 followed by a long period of a more or less steady downward trend.

The relationship between the exchange rate and productivity growth is ambiguous. An appreciation of the exchange rate can decrease cost competitiveness, reducing exports and hence the scale of productivity, reducing economies of scale and scope. On the other hand, an appreciation can have two potential productivity-enhancing effects. The first is the "lazy manufacturers hypothesis" whereby falling margins and sales due to an appreciation force the manufacturer to cut costs and operate more efficiently. The second is that imported machinery and equipment becomes less expensive with an appreciated currency, giving the firm a greater incentive to adopt best practice technologies and thereby raise productivity. The academic literature has not reached a consensus on this issue, but the evidence appears to point to the negative effect of an appreciation on productivity through the capacity utilization channel as the most dominant. However, the long-run negative effect of exchange rates on trend productivity may be small once adjustments in factor inputs have been made.

The depreciation of the Canadian dollar in the 1997-2002 period corresponded with very strong labour productivity growth in New Brunswick manufacturing. Indeed, there may be a causal relationship in this case as increased demand for New Brunswick exports such as paper and wood products lead to greater production and capacity utilization in these industries, boosting productivity. Equally, the appreciation of the Canadian dollar from 2002 corresponds, with a two-year lag, to the fall in labour productivity in New Brunswick manufacturing that started in 2004 and bottomed out in 2008. The continued appreciation after 2008 however did not correspond with any further declines in productivity. The fall in the exchange rate after 2011 until 2015 did not boost productivity growth, as might have been expected. The impact on the exchange rate on New Brunswick manufacturing productivity appears inconclusive, although more sophisticated analysis is needed before a definitive conclusion can be drawn. However, productivity is a long run phenomenon, and what one is interested

in explaining is the post-2004 fall in productivity growth slowdown. Exchange rate effects on productivity are of a shorter to medium term in nature and can be offsetting over long periods. From this perspective it appears that the exchange rate was not a key factor in explaining the fall in labour productivity in New Brunswick manufacturing after 2004.

Chart 24: Labour Productivity for Manufacturing (2012 dollars) in New Brunswick and the Exchange Rate (from Canadian Dollar to US Dollar; 1997 =100) in Canada



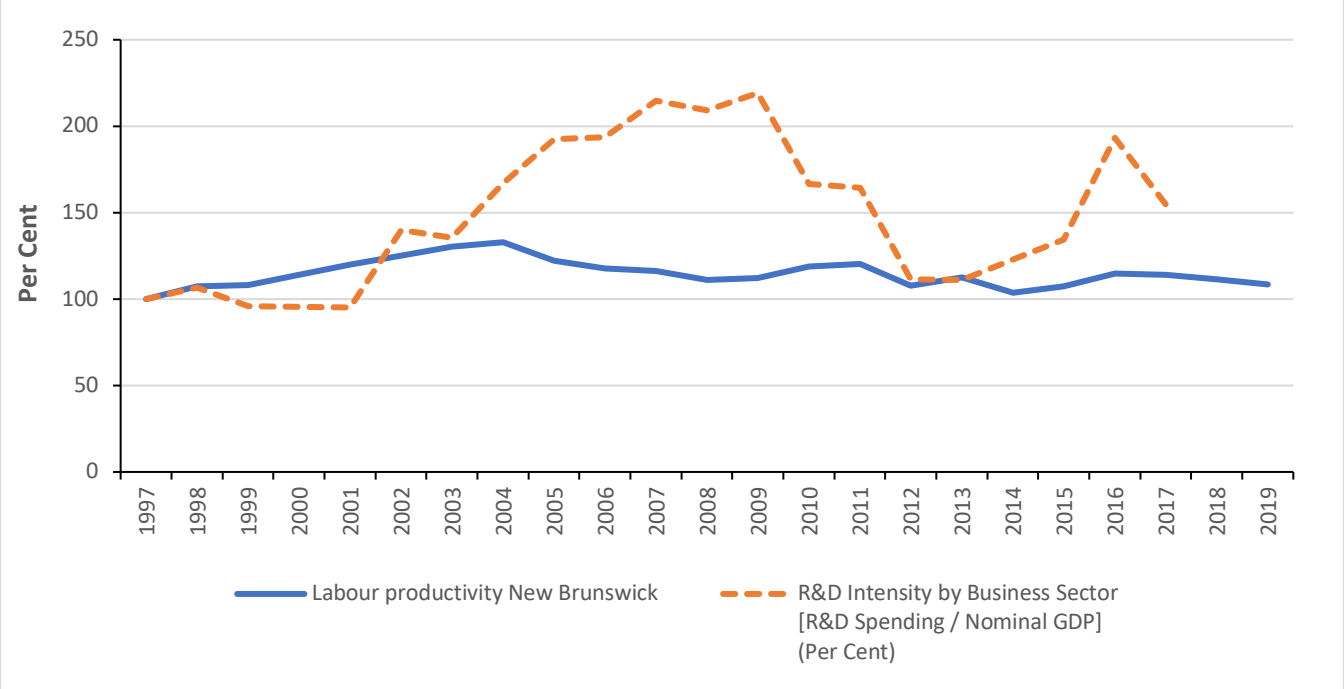
Source: For the exchange rate : OFX, https://www.ofx.com/en-ca/forex-news/historical-exchange-rates/yearly-average-rates/; For the labour productivity: Statistics Canada, Table: 36-10-0480-01

C. Research and Development

In the long run, technical progress or innovation has been recognized as the primary source of productivity advance. As documented in a recent AIPR report on innovation indicators in New Brunswick (Wong, 2020), the province's innovation performance is weak. The most widely reported innovation indicator is research and development (R&D), which is to the creation of new production processes and products. A possible explanation of the post-2004 fall in labour productivity in New Brunswick manufacturing may be a fall in R&D. Unfortunately, because of the limited number of manufacturing firms undertaking R&D in the province, estimates are not available for R&D expenditure in the sector. Estimates are, however, available for the total business sector. As manufacturing accounts for the lion's share of business R&D, it is used as a proxy for trends in manufacturing R&D.

Chart 25 shows trends in business sector R&D intensity (R&D/value added) and manufacturing labour productivity in New Brunswick over the 1997-2017 period, with both variables indexed to 100 in 1997. One sees that business sector R&D intensity in the province rose massively from 2001 to a peak in 2009, then fell sharply to a trough in 2012 before picking up in subsequent years. There appears to be little relationship with the trend in manufacturing productivity. Despite the large increase in R&D intensity from 2004 to 2009, productivity plummeted during this period. Equally, the fall in R&D intensity from 2009 to 2012 did not appear to have led to any further deterioration in productivity growth, just as the pick-up in R&D intensity between 2012 and 2016 did not produce any improvement in productivity performance. While greater R&D would undoubtedly contribute to a stronger productivity performance in New Brunswick manufacturing, it does not appear that the post-2004 fall in productivity is linked to a fall in business R&D.

Chart 25: R&D Intensity by Business Sector and Labour Productivity for Manufacturing in New Brunswick (1997 =100)



Source: Statistics Canada, Table 36-10-0222-01 (Nominal GDP), Table 27-10-0273-01 (R&D spending), Table 36-10-0480-01 (Labour productivity)

D. Size of Manufacturing Establishments

A hypothesis that has been advanced to explain the lower level labour productivity in manufacturing in New Brunswick relative to the national average is fewer economies of scale and scope due to smaller average establishment size. The explanation can also be used to explain slower productivity growth, with average size in the provinces progressing at less than the national rate.

Statistics Canada's business register provides data on the number of business establishments for all industries. Establishments with no payroll employees are classified as "non-employer". Establishments in this category do not maintain payroll accounts but may have a workforce.

As of December 31, 2019, there were 1,321 manufacturing establishments in New Brunswick, with 423 (32.0 per cent) classified as non-employers and 898 (68.0 per cent) as employers. This compares to 43.3 per cent and 56.7 per cent respectively for Canada, indicating New Brunswick has a smaller proportion of manufacturing establishments without payrolls.

Looking at the manufacturing establishments with payrolls by size in 2019 (Table 15), 82.1 per cent of the establishments in New Brunswick fell in the small category (1-49 employees) below the national average of 86.0 per cent.), 17.4 per cent of establishments in New Brunswick were medium-sized (50-499 employees), above the national average of 13.3 per cent, and 0.6 per cent of establishments in New Brunswick were large (500 plus employees), the same as the national average. These statistics indicate that New Brunswick does not appear disadvantaged in terms of the average size of establishment and hence the ability to benefit from economies of scale and scope.

A second perspective on the economies of scale and scope issue in New Brunswick can be obtained by calculating the average establishment size from establishment and employment data. The Canadian Business Counts estimates that there 1,321 manufacturing establishment in New Brunswick in 2019. The Labour Force Survey estimates manufacturing employment of 30,600 in 2019, giving an average establishment size of 23.2. The national figure is 19.0. It appears that average size of a manufacturing establishment in New Brunswick is significantly above the national average, suggesting that more limited economies of scale cannot account for new Brunswick's lower level of labour productivity.[25]

[25] A reviewer of the report points out that this situation may also be related to a policy focus on jobs that leads to labour hoarding. Economic historian Ian Keay from Queen's University has showed this for Canada versus the United States over the last century. Canada has had more labour-intensive production than higher productivity countries.

Table 15: Number of Manufacturing Establishments (with employees) by Establishment Size in New Brunswick and in Canada, 2014 and 2019

	Total, with employees	1 to 4 employees	5 to 9 employees	10 to 19 employees	20 to 49 employees	50 to 99 employees	100 to 199 employees	200 to 499 employees	500 plus employees
2014									
New Brunswick	879	314	165	140	120	61	42	30	7
Canada	51,485	18,097	10,270	8,315	7,896	3,487	2,009	1,135	276
Per Cent Distribution									
New Brunswick	100.0	35.7	18.8	15.9	13.7	6.9	4.8	3.4	0.8
Canada	100.0	35.2	19.9	16.2	15.3	6.8	3.9	2.2	0.5
2019									
New Brunswick	898	309	165	143	120	65	51	40	5
Canada	51,653	17,823	10,400	8,335	7,889	3,574	2,115	1,207	310
Per Cent Distribution									
New Brunswick	100.0	34.4	18.4	15.9	13.4	7.2	5.7	4.5	0.6
Canada	100.0	34.5	20.1	16.1	15.3	6.9	4.1	2.3	0.6

Source: Statistics Canada, Canadian Business Counts (December data), Tables: 33-10-0023-01 (for 2014) and 33-10-0222-01 (for 2019)

Table 16: Number of Establishments with Employees, Employees and Employee per Establishment in Manufacturing in New Brunswick and in Canada, 2014-2019

	New Brunswick			Canada		
	Manufacturing Establishments	Employees (x1,000)	Employees/establishment	Manufacturing Establishments	Employees (x1,000)	Employees/establishment
2014	879	28.0	31.9	51,485	1,711.0	33.2
2015	844	29.8	35.3	50,902	1,712.4	33.6
2016	839	30.4	36.2	50,817	1,694.8	33.4
2017	847	31.7	37.4	50,442	1,724.8	34.2
2018	864	31.3	36.2	51,338	1,728.4	33.7
2019	898	30.6	34.1	51,653	1,733.1	33.6

Source: Statistics Canada: Canadian Business Counts (December data) and 14-10-0023-01 (Labour Force Characteristics by Industry)

Table 17: Number of Establishments, Employees and Employee per Establishment in Manufacturing in Canada and in the Provinces, 2019

2019			
	Manufacturing Establishments	Employees (x1,000)	Employees/establishment
Canada	51,653	1,733.1	33.6
Newfoundland and Labrador	393	8.9	22.6
Prince Edward Island	246	6.5	26.4
Nova Scotia	1,077	31.9	29.6
New Brunswick	898	30.6	34.1
Quebec	13,700	497.7	36.3
Ontario	20,385	761.1	37.3
Manitoba	1,380	64.2	46.5
Saskatchewan	1,070	30.7	28.7
Alberta	4,992	136	27.2
British Columbia	7,456	165.7	22.2

Source: Statistics Canada: Canadian Business Counts (December data), Table: 33-10-0222-01 and 14-10-0023-01 (Labour Force Characteristics by Industry)

Conclusion

This report has provided a comprehensive and detailed analysis of the labour productivity performance of the manufacturing sector in New Brunswick from 1997 to 2019. Output per hour advanced at a robust pace from 1997 to 2004, exceeding the national average and boosting the level of real output per hour to 108 per cent of the national average. After 2004, manufacturing labour productivity fell and by 2019 the 2004 level had still not been regained. With positive productivity growth at the national level, New Brunswick's relative level of manufacturing productivity fell to 75 per cent of the national average, the second lowest among the ten provinces. This 33-percentage point fall in the province's relative manufacturing productivity level represents an unprecedented deterioration in long-term manufacturing productivity performance among the ten provinces.

The report focuses on the factors that can explain this fall-off in productivity growth. Key findings are highlighted below.

- Growth accounting estimates produced by Statistics Canada show the fall-off in total factor productivity growth (TFP) accounts for around three quarters of the fall in labour productivity growth in New Brunswick manufacturing, with much smaller but positive roles played by weaker growth in capital intensity and labour quality. Unfortunately, TFP is a measure of our ignorance and sheds little light on the underlying reasons for productivity decline.

- Official figures may be underestimating the role of capital intensity in the fall-off because of definitional issues and methodological weaknesses associated with growth accounting. Use of capital stock instead of capital services as capital input boosts the contribution of capital intensity to one third of the fall-off. Use of the capital's income share to weight capital intensity growth share may underestimate the contribution of this factor since technological change is largely embodied in capital equipment. But perhaps surprisingly, the industries with the largest fall-off in capital intensity growth were not necessarily the ones with the largest productivity growth fall-off.

- The report uses a number of methodologies to estimate the contribution of a manufacturing industry to overall manufacturing productivity growth. The results point to six of the 19 manufacturing industries accounting for the lion's share of the fall-off: petroleum, food, paper, wood, primary metals, and miscellaneous manufacturing. The contribution of petroleum industry to productivity is much larger when output weights are used rather than employment weight because of the extremely high level of labour productivity in the sector.

- Shifts in the relative importance of industries with different productivity levels and growth rates can impact aggregate productivity growth. Resource reallocation boosted productivity growth more in 1997-2004 than in 2004-2019. It is estimated that decline in productivity gains from resources reallocation accounted for 13 per cent of the post-2004 fall-off in manufacturing labour productivity growth in New Brunswick.

- No evidence is found that labour shortages contributed to the fall-off in labour productivity growth in New Brunswick after 2004. Indeed, the continued high unemployment rate and a relatively low unemployment-vacancy ratio in the sector suggest that labour slack may be a more important factor. Labour compensation levels in New Brunswick manufacturing are well below the national average and on a long-term basis have failed to keep up with the national rate of increase. This gives manufacturers less incentive to substitute capital for labour, slowing labour productivity growth.

- While exchange rates can affect productivity growth in the short to medium term, there appears to be no link between developments in the value of the Canadian dollar expressed in US dollars and the evolution of manufacturing labour productivity in New Brunswick. One possible exception was the late 1990s and early 2000s when the Canadian dollar was depreciating and manufacturing productivity soaring.

- Innovation is key to productivity growth and R&D is an important component of innovation. However, New Brunswick manufacturers undertake little R&D. The adoption of best practices technologies developed in other jurisdictions plays a much more important role in the province's innovation picture than domestic. This suggest that R&D it is unlikely to have been an important factor in explaining the post-2004 manufacturing productivity fall-off in the province. In addition, business sector R&D intensity increased after 2004 at the same time that productivity was falling, not the relationship one would expect.

This report represents a first attempt at developing an explanation for the drastic fall-off in labour productivity growth in New Brunswick manufacturing after 2004. Undoubtedly, many possible hypotheses have not been explored and can be examined in future work.

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Appendix: Analytical Framework for Decomposition of Labour Productivity Growth into Within-Sector and Reallocation Effects[26]

To begin we note that at any given point in time.

$$P \equiv \frac{Q}{H} = \frac{\sum Q_i}{H} = \frac{\sum H_i P_i}{H} = \sum P_i h_i \quad (1)$$

where
P = Aggregate labour productivity level
P_i = Labour productivity level in sector i
H = Aggregate hours worked
H_i = Hours worked in sector i
h_i = Share of hours worked in sector i
Q = Aggregate real output
Q_i = Real output of sector i

Equation (1) states that aggregate labour productivity P is equal to the weighted average of labour productivity in each of the sectors that make up the economy. The weight for each sector is its share of the total number of hours worked in the economy.

Since we are interested in how shifts in hours worked across sectors affect aggregate labour productivity growth, we must move beyond a single point in time. Equation (2) expresses the absolute change in aggregate labour productivity from period 0 to period 1, $\Delta P = P^1 - P^0$ where superscripts denote the period.

$$\Delta P = \Sigma h_i^0 \Delta P_i + \Sigma P_i^0 \Delta h_i + \Sigma \Delta h_i \Delta P_i \quad (2)$$

In equation (2) h_i^0 and P_i^0 are respectively the share of total hours worked in sector i and the level of labour productivity in sector i in period 0, expressed in dollars.

In order to obtain economically meaningful sectoral contributions to aggregate productivity growth, we adjust the second term of equation (2) by subtracting the average level of labour productivity $\bar{P}^0$ from the level of labour productivity in each sector in period 0, P_i^0. In the third term, we subtract the average change in labour productivity $\Delta\bar{P}$ from the change in labour productivity in each sector, ΔP_i. The first adjustment ensures that an increase in the share of hours in a sector with a below-average labour productivity level makes a negative contribution to aggregate labour productivity growth.[27]The second adjustment also ensures that an increase in the share of hours in a sector with below-average absolute growth in labour productivity makes a negative contribution to aggregate labour productivity growth. The result of these adjustments is equation (3):

$$\Delta P = \Sigma h_i^0 \Delta P_i + \Sigma (P_i^0 - \bar{P}^0)\Delta h_i + \Sigma \Delta h_i (\Delta P_i - \Delta \bar{P}) \quad (3)$$

[26] This section is based on Sharpe (2010a).

[27] It is this adjustment for the average productivity level that differentiates our decomposition formula from that of Tang and Wang (2004).

We are able to subtract $\bar{P}^0$ and $\Delta\bar{P}$ from equation (2) because the terms $\Delta\bar{P}\Delta h_i$ and $\bar{P}^0\Delta h_i$ each sum to zero across all sectors, since $\bar{P}^0$ and $\Delta\bar{P}$ are constant and all changes in the share of hours, Δh_i, sum to zero across sectors.

The three terms in equation (3) represent the within-sector, reallocation level and reallocation growth effects, respectively. The within-sector effect captures the change in labour productivity within a sector. The reallocation level effect indicates whether changes in the share of hours have favoured sectors with above- or below-average labour productivity levels. The reallocation growth effect is the sum of the product of the absolute change in the share of hours worked and the absolute change in the labour productivity level for each of the *i* sectors. It measures whether an economy is subject to a phenomenon akin to Baumol's cost disease, *i.e*. the tendency of labour to move towards sectors with relatively small absolute increases in labour productivity. A negative reallocation growth effect at the aggregate level means that labour is moving to sectors with relatively smaller absolute labour productivity increases.