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CENTRE FOR THE STUDY OF LIVING STANDARDS

An Analysis of New Brunswick's Productivity Performance, 1997-2007: Labour Productivity Driven by Capital Intensity Growth

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An Analysis of New Brunswick's Productivity Performance, 1997-2007: Labour Productivity Driven by Capital Intensity Growth

Executive Summary

The report, based on the CSLS Provincial Productivity Database, provides an overview of New Brunswick's productivity performance over the 1997-2007 period. The key findings are the following:

- New Brunswick experienced slightly higher labour productivity growth than Canada as a whole in the market sector from 1997 to 2007, with an average growth rate of 1.8 per cent per year, compared to the Canadian rate of 1.7 per cent per year. In terms of labour productivity growth, New Brunswick's performance ranks 5th among the provinces.
- Despite good labour productivity growth overall, 4 industries witnessed declining productivity: arts, entertainment and recreation (-5.5 per cent per year), mining, and oil and gas extraction (-4.8 per cent), utilities (-1.1 per cent) and Administrative and support and waste management and remediation services (-1.1 per cent each).
- New Brunswick's labour productivity level in 2007 was $28.20 (1997 dollars) per hour, which represents 78.1 per cent of the Canadian level (which implies a labour productivity gap of 21.9 percentage points), up from 77.5 per cent in 1997. The province had the 3rd lowest labour productivity level among the ten provinces in 2007.
- Labour productivity growth in the province was driven mainly by capital intensity growth, which accounted for 63.4 per cent of the increase experienced over the 1997-2007 period. Multifactor productivity growth accounted for 20.9 per cent of the growth. Finally, increased in labour quality was responsible for 14.8 per cent of the labour productivity growth experienced in 2007.
- New Brunswick in 2007 had a labour productivity gap relative to Canada in 13 of the 15 two-digit NAICS industries. The largest gap was in mining and oil and gas extraction, where labour productivity was below the national rate by 64.3 per cent in 2007. In contrast, labour productivity in agriculture, forestry, fishing and hunting was 36.1 per cent above the national level and information and cultural industries were 7.5 per cent above.
- Capital productivity, defined as real GDP per unit of capital services, shrunk at a rate of 1.0 per cent per year in New Brunswick's market sector during the 1997-2007 period. New Brunswick ranked 8th in growth of capital productivity and was one of six provinces that experienced a decline rather than an increase in the measure.
- New Brunswick's multifactor productivity in the market sector grew at an average rate of 0.37 per cent per year during the 1997-2007 period, about the same as the national average of 0.44 per cent per year. The province ranked 6th in Canada, ahead of Saskatchewan, Prince Edward Island and Alberta.

An Analysis of New Brunswick's Productivity Performance, 1997-2007: Labour Productivity Driven by Capital Intensity Growth

Productivity is the key factor that determines living standards in the long run. If the amount of output each worker produces does not increase, real wages and incomes cannot rise (Sharpe, 2010a). Since 2000, Canada's labour productivity growth has been abysmal, both from an historical and an international perspective (Sharpe and Thomson, 2010b).[1] Improving this poor performance must be a key objective of Canada's economic agenda. To develop policies with this goal in mind, it is important to understand the nature of labour productivity at both the national and provincial levels, including the sources of growth at the market sector and industry levels.

This report analyzes New Brunswick's productivity performance over the 1997-2007 period. It is based on the CSLS Provincial Productivity Database. Level and growth rate estimates of labour, capital and multifactor productivity are discussed, with an emphasis on New Brunswick's market sector. Two-digit NAICS industry level estimates are also presented.[2]

This report is divided into ten sections. The first section provides a brief overview of basic concepts related to productivity, along with the methodology and the data sources used. Section two discusses New Brunswick's industry composition by nominal GDP and total hours worked. Sections three through nine detail New Brunswick's productivity performance, focusing on the following topics: labour productivity, capital productivity, multifactor productivity, capital intensity, labour quality, sources of labour productivity growth in the market sector, and sources of labour productivity gap by industry. Section ten concludes. An appendix provides details on the growth accounting framework used in the report.

I. Basic Concepts, Methodology and Data Sources

In this section, we first define the main concepts used in this report, as well as explain important topics related to productivity analysis – such as the difference between partial and total productivity measures, and the distinction between productivity growth rates and levels. This is followed by a brief discussion on methodology and data sources. Although the basics of the growth accounting framework used in the report are presented in this section, its details are only discussed in the Appendix.

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[1] From 1981 to 2000, labour productivity in Canada's business sector grew at an average annual rate of 1.6 per cent. In the 2000-2009 period, labour productivity growth dropped sharply to a mere 0.7 per cent per year in Canada. This slowdown in labour productivity growth in Canada was not experienced in the United States, which grew at an average annual rate of 2.5 per cent during the same period (up from 2.0 per cent during the 1981-2000 period).

[2] This report builds on and extends earlier CSLS work on provincial productivity. The CSLS Provincial Productivity Database is available at http://www.csls.ca/data/mfp_new.asp. Previous CSLS articles on this topic include Sharpe and Arsenault (2009), Sharpe (2010) and Sharpe and Thomson (2010a, 2010b).

Basic Concepts

Productivity is, broadly speaking, a measure of how much output is produced per unit of input used. The output and input measures used will affect, however, the productivity estimates. In this sub-section, we define the input, output and productivity measures used throughout this paper:

- The **labour services input** is defined as total *quality adjusted* hours worked in a particular sector or in the market sector as a whole. It is the weighted sum of hours worked across different categories of workers, with the weights being equal to relative labour compensation shares.

- **Labour quality** (also known as **labour composition**) is defined residually as the difference between growth in labour services and growth in hours worked (*unadjusted* by quality). In Canada, the variables used to differentiate labour quality are education (four education levels), experience (proxied by seven age groups) and class of workers (paid employees versus self-employed workers). Overall, there are 56 different categories of workers.[3]

- The **capital services input** represents the flow of services provided by the capital stock. The difference between capital stock and capital services stems from the fact that not all forms of capital assets provide services at the same rate. Short-lived assets, such as a car or a computer, must provide all of their services in just a few years before they completely depreciate. Office buildings provide their services over decades. As a consequence, over a single year, a dollar's worth of a car provides relatively more capital services than a dollar's worth of a building. Thus, capital services growth is driven by: 1) increases in the level of **capital stock**; and 2) shifts in the **capital composition** caused by more investment in assets that provide relatively more services per dollar of capital stock (i.e. short lived assets).

- **Capital intensity** is defined as capital services per hour worked.

- **Gross domestic product (GDP)** measures the value of all *final* goods and services produced in a defined geographic region during a certain time period, typically a year or a quarter.

- **Labour productivity** is defined as real GDP per hour worked.

- **Capital productivity** is real GDP per unit of capital services.

- **Multifactor Productivity (MFP)**[4] growth is measured as the difference between real output growth and combined input growth. In other words, MFP reflects output growth that is not accounted for by input growth. The inputs that are taken into account to construct a combined

[3] For more information on how Statistics Canada calculates labour quality, see Gu *et al* (2002).
[4] Also known as total factor productivity (TFP).

input aggregate vary whether we are calculating MFP using a gross output basis or a value added basis. The gross output basis takes into consideration labour, capital, and intermediate inputs, while the value added basis takes into account only capital and labour (because intermediate consumption is already subtracted from value added). Thus, MFP captures the residual effects of several elements of the production process, such as improvements in technology and organizations, capacity utilization, increasing returns to scale, mismeasurement, etc. In this report, MFP growth is calculated on a value added basis.

When discussing productivity, there are two important dimensions to consider. The first is whether productivity is measured using a partial productivity approach or a multifactor productivity approach. The second is whether the focus is on growth rates, levels, or both.

There is a fundamental distinction between partial and multifactor productivity (MFP). Partial productivity measures refer to the relationship between output and a single input, such as labour or capital. Multifactor productivity, on the other hand, attempts to measure how efficiently all factors of production are used in the production process. This report provides estimates for two partial productivity measures – labour productivity (the most commonly used measure of productivity) and capital productivity –, as well as multifactor productivity.

Productivity can be expressed either in growth rates or in levels. The economics literature largely focuses on productivity growth rates, which reflect increases in *real* output per hour or per unit of capital. In this report we are also interested in making level comparisons between provinces. Ideally, productivity level comparisons are done in current dollars (i.e. using *nominal* GDP), as these estimates capture changes in relative prices. However, at the time the CSLS Provincial Productivity Database was constructed, nominal GDP figures at the industry level were available only up to 2005. As a consequence, the productivity levels were calculated using real GDP. One advantage of using real GDP instead of nominal GDP for the level comparisons is that the growth rates and changes in levels are consistent with each other. Regardless of whether nominal or real GDP figures are used for productivity level comparisons, it is important to note that these comparisons should be used with caution, due not only to differences in industry composition between provinces, but also due to the lack of industry purchasing power parities (PPPs) estimates at the provincial level.

As mentioned above, this report makes provincial comparisons of both productivity levels and growth rates. These comparisons are done both at the **market sector level** and at the **two-digit NAICS industry level**.[5] The North American Industry Classification System (NAICS) breaks down the economy into 20 sectors:

[5] The words *industry* and *sector* are used interchangeably in this report.

Exhibit A: The North American Industry Classification System (NAICS) at the Two-Digit Level

Sector Number	Description
11	Agriculture, Forestry, Fishing and Hunting
21	Mining, and Oil and Gas Extraction
22	Utilities
23	Construction
31-33	Manufacturing
42	Wholesale Trade
44-45	Retail Trade
48-49	Transportation and Warehousing
51	Information and Cultural Industries
52	Finance and Insurance
53	Real Estate, Rental and Leasing
54	Professional, Scientific, and Technical Services
55	Management of Companies and Enterprises
56	Administrative and Support, Waste Management and Remediation Services
61	Education Services
62	Health Care and Social Assistance
71	Arts, Entertainment, and Recreation
72	Accommodation and Food Services
81	Other Services (except Public Administration)
92	Public Administration

The market sector is comprised by 17 of the 20 sectors, all of which have been highlighted in Exhibit A. The only three sectors that are not included in the market sector are: education services, health care and social assistance, and public administration. For practical purposes, we have grouped the finance and insurance, real estate, rental and leasing, and management of companies and enterprises sectors into only one sector, which will be referred to as the finance, insurance, real estate, rental and leasing (FIRE) sector. Since this change is only a slight departure from the standard NAICS breakdown, we will still refer to these 15 sectors as NAICS sectors.

The provincial comparisons are done by ranking the productivity growth rates and levels of different provinces from 1 (highest) to 10 (lowest). Each province has two market sector ranks: an **equally-weighted rank** and an **industry composition weighted rank**. The industry composition weighted market sector rank, which will be referred throughout this report simply as the market sector rank, takes into account the province's market sector output, labour input and capital input, which are basically a sum of the outputs and inputs of the 15 two-digit NAICS industries in the province. Thus, it gives more weight to the sectors that comprise a more significant part of the province's economy. The equally-weighted market sector rank, as the name implies, attributes equal weights to all industries. Comparing the two ranks allows for important characteristics of the province's productivity performance to be identified. For instance, a province with a high market sector rank and a low equally-weighted market sector rank in labour productivity growth will most likely have strong labour productivity growth in its largest industries, but low productivity growth in most of the fifteen two-digit NAICS industries.

Lastly, we also perform **growth accounting** exercises in order to measure how different factors contributed to labour productivity growth. Contributions to labour productivity growth were broken

down into three factors: 1) capital intensity[6]; 2) labour quality; and 3) multifactor productivity.[7] Formally, this decomposition is a consequence of the growth accounting framework adopted in this report. However, it is also quite intuitive:

- Workers that have access to more capital (i.e. higher capital intensity) tend to have, *ceteris paribus*, higher labour productivity. Imagine, for example, two teams with two workers each. In the first team, one worker has a shovel and the other has a snow blower. In the second team, both workers have snow blowers. The second team uses capital more intensively than the first, and thus is able to clear much more snow in the same period of time.

- Improvements in labour quality tend to increase the amount of output a worker can produce in a given time period. Thus, an experienced coal miner will normally be able to extract more coal than a novice miner during a given timeframe.

- Technological progress can substantially increase output per worker. A logger with a chainsaw, for instance, is much more productive than one with an axe. This is an example of productivity growth driven by MFP. It should be noted, however, that technological progress is only one of the several possible factors to drive MFP growth.

Methodology and Data Sources

Statistics Canada has detailed the methodologies and data sources used in the preparation of its estimates of multifactor productivity (MFP) at the national level in Baldwin *et al*. (2007). The provincial estimates used in this report have been prepared by Statistics Canada for the Centre for the Study of Living Standards (CSLS) and largely follow the methodologies used for the national estimates. There are, however, certain differences between the national and provincial estimates which are discussed in detail in Sharpe and Arsenault (2009). CSLS supplemented Statistics Canada data by calculating multifactor productivity level estimates for the provinces relative to the Canadian average.[8]

The growth accounting framework used in this report is the same as the one used in Sharpe and Thomson (2010a). It assumes a Cobb-Douglas production function such that:

$$Y = AK^{\alpha}L^{1-\alpha}$$

where *Y* is real output, *K* stands for capital services, *L* for labour input (quality adjusted hours), *A* for multifactor productivity and α is the share of output that takes the form of capital compensation. For more information, refer to the Appendix.

[6] Note, once again, that capital intensity has been defined here as capital services per hour worked, *not* capital stock per hour worked.
[7] To understand the reasons behind this decomposition, refer to the Appendix.
[8] For more details, see Appendix.

II. Industry Composition by Nominal GDP and Total Hours Worked

In order to understand New Brunswick's overall productivity performance, it is essential to understand how each of the 15 two-digit NAICS industries contributed to the province's market sector in terms of nominal GDP and actual hours worked. Table 1 details these contribution shares for 1997 and 2007. In New Brunswick, the industries that had the highest GDP shares in 2007 were manufacturing (18.6 per cent of GDP), finance, insurance, real estate, rental and leasing (11.6 per cent), and construction (10.4 per cent). In terms of actual hours worked, the three industries that had the highest shares in 2007 were manufacturing (15.0 per cent), retail (14.8 per cent), and construction (11.0 per cent).

Table 1: Industry Share of Nominal GDP and Total Hours Worked in New Brunswick

	1997				2007			
	GDP		Hours Worked		GDP		Hours Worked	
	Canada	New Brunswick	Canada	New Brunswick	Canada	New Brunswick	Canada	New Brunswick
Market Sector	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Agriculture, Forestry, Fishing and Hunting	3.2	5.7	5.4	7.5	2.1	3.5	3.4	4.6
Mining, and Oil and Gas Extraction	5.5	3.1	1.7	1.6	11.1	5.3	2.0	1.5
Utilities	4.2	5.8	0.9	1.4	3.0	5.2	0.8	1.4
Construction	7.0	7.8	7.9	9.4	9.0	10.4	10.1	11.0
Manufacturing	23.2	21.2	18.3	15.0	16.8	18.6	14.8	15.0
Wholesale Trade	7.1	6.3	7.4	6.6	7.1	7.1	6.9	4.9
Retail Trade	6.9	8.5	13.1	16.0	7.4	9.7	12.9	14.8
Transportation and Warehousing	6.2	8.2	6.3	8.5	5.6	6.4	6.6	8.7
Information and Cultural Industries	4.3	4.4	2.5	2.2	4.3	4.1	2.7	2.2
FIRE*	15.0	12.8	7.5	5.5	14.6	11.6	7.8	5.1
Professional, Scientific and Technical Services	4.9	3.6	6.3	4.2	6.2	4.2	7.9	5.0
ASWMR**	2.5	1.6	4.0	2.7	3.3	3.6	5.7	6.8
Arts, Entertainment and Recreation	0.9	0.8	1.5	1.0	0.9	0.7	1.9	1.5
Accommodation and Food Services	3.2	3.7	7.8	8.4	2.8	3.2	7.0	7.5
Other Services (Except Public Administration)	5.7	6.3	9.4	10.0	5.8	6.7	9.5	10.1

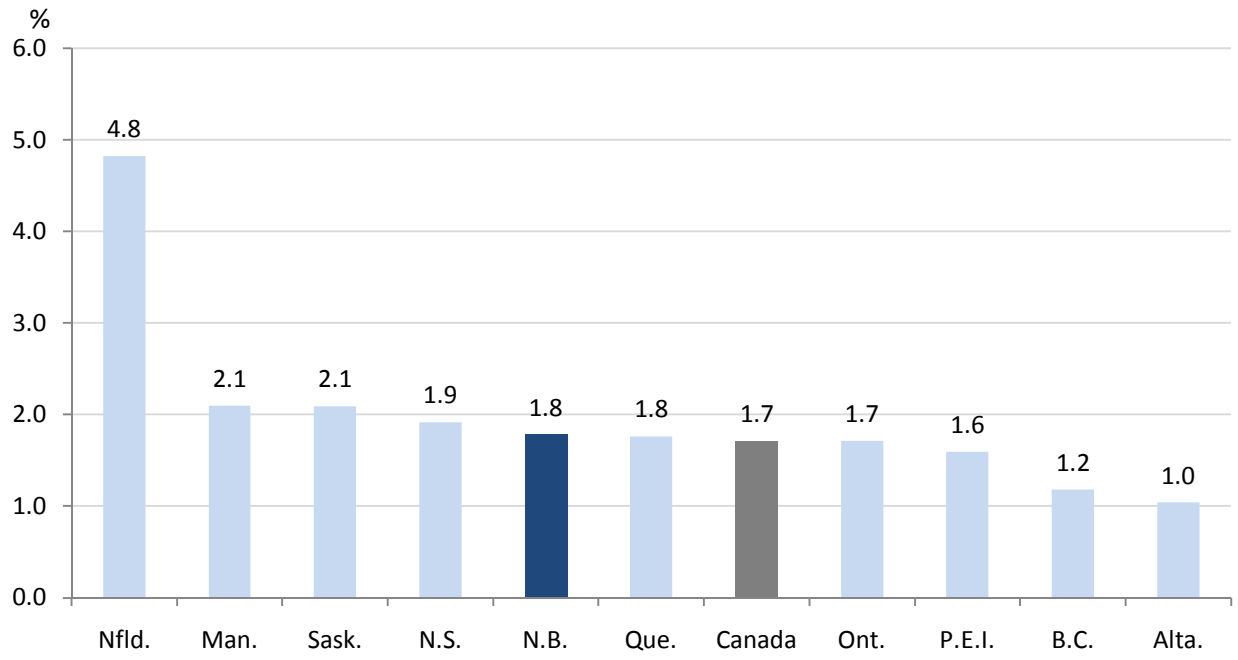
Source: Shares calculated by the CSLS, based on Statistics Canada data (Cansim Table 383-0011).

*Finance, insurance, real estate, rental and leasing **Administrative and support, waste management and remediation services

III. Labour Productivity

Labour productivity, defined as real GDP per hour worked,[9] grew at an average rate of 1.8 per cent per year in New Brunswick's market sector during the 1997-2007 period. This is somewhat better than the national average of 1.7 per cent per year, the 5th highest growth rate experienced by a province. While Manitoba, Saskatchewan and Nova Scotia witnessed greater labour productivity growth than New Brunswick, only Newfoundland experienced much higher growth rates (Chart 1).

Chart 1: Labour Productivity Growth in Canada and the Provinces, Market Sector, 1997-2007
(Average Annual Growth Rates)



Source: CSLS Provincial Productivity Database, Appendix Tables, http://www.csls.ca/data/mfp_new.asp.

During the 1997-2007 period, the industry that experienced the highest labour productivity growth rate in New Brunswick was agriculture, forestry, fishing and hunting (7.6 per cent per year), followed by wholesale trade (4.5 per cent), and the information and cultural industries (4.4 per cent) (Table 2). The industry that had the lowest labour productivity growth rate was arts, entertainment and recreation (-5.5 per cent), followed by the mining, and oil and gas extraction (-4.8 per cent) and utilities (-1.1 per cent).

New Brunswick experienced growth in labour productivity in the market sector outpacing five provinces, but underperforming in many industries. The province ranked 3rd or higher in four of the 15 two-digit NAICS industries, but also came 7th or below in six industries. New Brunswick had the best labour productivity growth rate of any province in wholesale (4.5 per cent per annum) as well as construction (3.5 per cent). New Brunswick tended to have below average growth in its larger industries, which is

[9] Note that the total hours worked figures used to calculate labour productivity are unadjusted for labour quality.

why it ranked 5th in market sector labour productivity growth but had an equally weighted market sector rank of 4th.

New Brunswick's labour productivity level in 2007 was $28.20 (1997 dollars) per hour, which represents 78.1 per cent of the Canadian level, down from 77.5 per cent in 1997. The province had the 3rd lowest labour productivity level in Canada in 2007, ahead of only Prince Edward Island and Nova Scotia.

At the industry level, New Brunswick ranked low in terms of labour productivity levels. Only agriculture, forestry, fishing and hunting (136.1 per cent of the national level) and the information and culture industry (107.5 per cent) have levels above the Canadian level in 2007. While all other industries were less productive in New Brunswick than in Canada as a whole, one industry was particularly behind: mining, oil and gas extraction (35.7 per cent) was just over a third as productive as the national counterpart. There were three other industries where New Brunswick lagged the national labour productivity by at least 30 per cent: arts entertainment and recreation (61.9 per cent), utilities (64.0 per cent), and administrative and support, waste management and remediation services (64.3 per cent). There were only two industries for which New Brunswick ranked among the top four provinces with regards to level, and there were eight industries in which New Brunswick was ranked in the bottom three.

Table 2: Labour Productivity Levels and Growth Rates in New Brunswick, 1997-2007

	Compound Annual Growth Rate, 1997-2007	Rank out of 10 Provinces	Province's Labour Productivity Level Relative to Canada's		Labour Productivity Level, 2007	Rank out of 10 Provinces, 2007
	(per cent)		1997 (Canada=100)	2007 (Canada=100)	(1997 Dollars)	
Market Sector	**1.8**	**5**	**77.5**	**78.1**	**28.2**	**8**
Agriculture, Forestry, Fishing and Hunting	7.6	2	98.3	136.1	36.9	3
Mining, and Oil and Gas Extraction	-4.8	9	46.7	35.7	28.1	9
Utilities	-1.1	6	65.4	64.0	86.2	9
Construction	3.5	1	72.5	86.4	27.6	6
Manufacturing	0.9	6	86.8	76.1	36.4	6
Wholesale Trade	4.5	1	77.4	83.4	34.9	8
Retail Trade	3.8	5	79.3	82.5	18.2	8
Transportation and Warehousing	0.2	8	76.9	73.2	23.2	7
Information and Cultural Industries	4.4	4	94.0	107.5	73.7	4
FIRE*	2.2	2	90.6	96.7	68.0	6
Professional, Scientific and Technical Services	0.9	6	84.8	81.3	21.9	6
ASWMR**	-1.1	7	74.0	64.3	12.7	9
Arts, Entertainment and Recreation	-5.5	9	96.9	61.9	10.0	8
Accommodation and Food Services	0.7	7	83.5	80.0	11.0	10
Other Services (Except Public Administration)	1.8	7	78.8	76.2	12.4	9
Absolute Equally Weighted Average Rank		5.3				7.2
Equally Weighted Market Sector Rank		**4**				**8**

Source: CSLS Provincial Productivity Database, Appendix Tables, http://www.csls.ca/data/mfp_new.asp.

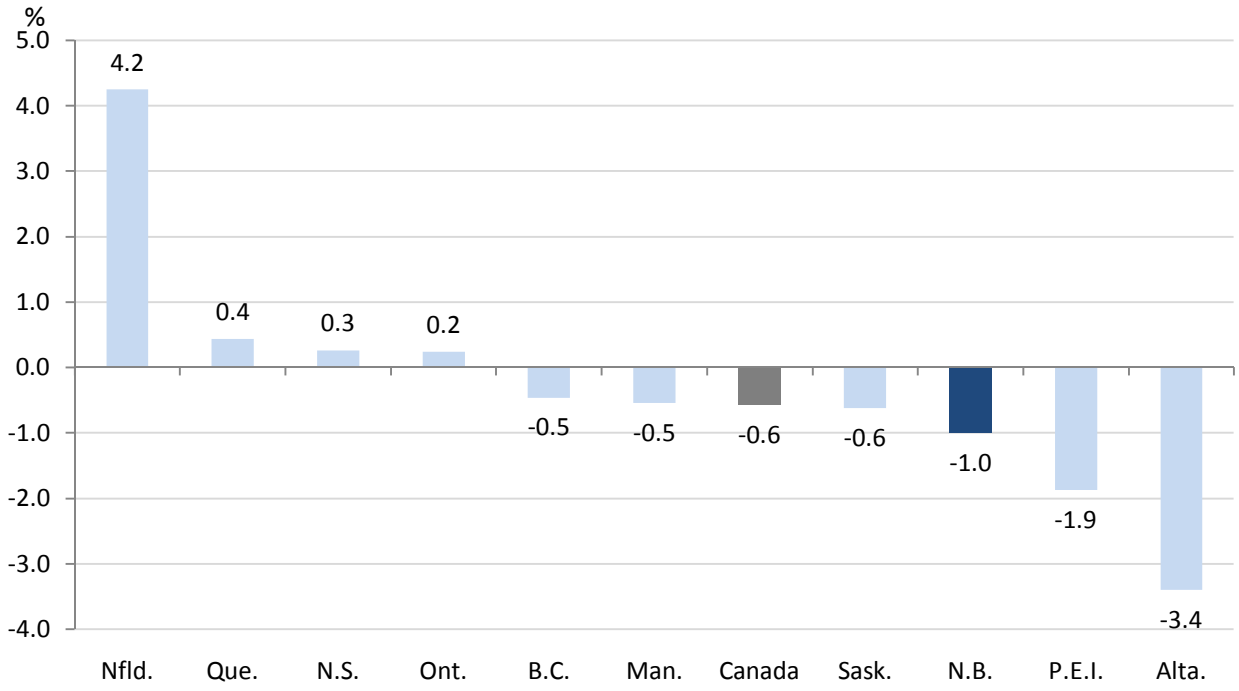
*Finance, insurance, real estate, rental and leasing **Administrative and support, waste management and remediation services

IV. Capital Productivity

Capital productivity, defined as real GDP per unit of capital services, declined at a rate of 1.0 per cent per year in New Brunswick's market sector during the 1997-2007 period. Falling capital productivity was by no means unique to New Brunswick, having taken place in six of the ten provinces. Canada's capital productivity declined 0.6 per cent per year over the period. The province's capital productivity growth in the market sector ranked 3rd last in Canada (Chart 2).

In New Brunswick, 11 of the 15 two-digit NAICS industries had negative capital productivity growth rates during the period. The industries that had the worst performances were professional, scientific and technical services (-7.8 per cent per year), followed by mining, oil and gas extraction (-5.1 per cent), and transportation and warehousing (-3.9 per cent) (Table 3). Of the few industries that had positive growth rates, the ones that performed better were administrative and support, waste management and remediation services (8.7 per cent), followed by agriculture, forestry, fishing and hunting (3.8 per cent) and wholesale trade (2.8 per cent).

Chart 2: Capital Productivity Growth Rates in Canada and the Provinces, Market Sector, 1997-2007
(Average Annual Growth Rates)



Source: CSLS Provincial Productivity Database, Appendix Tables, http://www.csls.ca/data/mfp_new.asp.

Consistent with the weak capital productivity growth at the market sector level, eight of the 15 two-digit NAICS industries ranked 7th or lower. Two industries, retail trade and information and cultural industries, had the worst capital productivity growth rates among all provinces. On the other hand, some industries did rather well, with four of the 15 two-digit NAICS industries at 3rd place or higher, but eight industries

ranked 7th or lower. New Brunswick's agriculture, forestry, fishing and hunting, along with wholesale trade, had the highest capital productivity growth in Canada.

New Brunswick's capital productivity level in the market sector in 2007 was 103.1 per cent of the Canadian level, down from 107.7 per cent in 1997, putting the province in 6th place. In 2007, 7 of the 15 two-digit NAICS industries in the province had capital productivity levels above the Canadian average. The industries with highest relative capital productivity levels were: administrative and support, waste and remediation (ASWMR) (446.3 per cent), followed by agriculture, forestry, fishing and hunting (180.0 per cent of the national level) and mining, and oil and gas extraction (154.8 per cent). The eight industries that had capital productivity levels lower than Canada's in 2007 were: finance, insurance, real estate, rental and leasing (70 per cent), followed by utilities (78.5 per cent), manufacturing (80.5 per cent), accommodation and food services (81.4 per cent), information and cultural industries (86.1 per cent), professional, scientific and technical services (86.7 per cent), other services (except public administration) (87.3 per cent), and retail trade (88.5 per cent).

New Brunswick's market sector had the 6th highest capital productivity level in Canada in 2007. This reflects the mediocre overall capital productivity level in the province, which ranked in the bottom half for nine industries. Despite a generally poor showing across industries, agriculture, forestry, fishing and hunting had the highest capital productivity level of all the provinces.

Table 3: Capital Productivity Levels and Growth Rates in New Brunswick, 1997-2007

	Compound Annual Growth Rate, 1997-2007	Rank out of 10 Provinces	Province's Capital Productivity Level Relative to Canada's, 1997	Province's Capital Productivity Level Relative to Canada's, 2007	Capital Productivity Level, 2007	Rank out of 10 Provinces, 2007
	(per cent)		(Canada=100)	(Canada=100)	(1997 Dollars)	
Market Sector	**-1.0**	**8**	**107.7**	**103.1**	**2.37**	**6**
Agriculture, Forestry, Fishing and Hunting	3.8	1	151.3	180.0	3.78	1
Mining, and Oil and Gas Extraction	-5.1	8	145.5	154.8	1.20	6
Utilities	-2.6	8	102.1	78.5	1.01	8
Construction	1.0	4	115.0	110.3	7.54	5
Manufacturing	-0.5	9	99.5	80.5	2.19	8
Wholesale Trade	2.8	1	90.9	121.8	3.87	2
Retail Trade	-3.8	10	117.9	88.5	4.05	8
Transportation and Warehousing	-3.9	9	128.4	105.0	2.53	4
Information and Cultural Industries	-1.8	10	108.9	86.1	1.66	9
FIRE*	-3.6	8	92.3	70.0	1.15	8
Professional, Scientific and Technical Services	-7.8	6	97.3	86.7	2.12	6
ASWMR**	8.7	2	146.3	446.3	13.75	2
Arts, Entertainment and Recreation	-2.7	3	96.6	116.4	2.40	4
Accommodation and Food Services	-3.1	9	107.1	81.4	3.50	8
Other Services (Except Public Administration)	-1.9	5	97.4	87.3	4.65	6
Absolute Equally Weighted Average Rank		6.2				5.7
Equally Weighted Market Sector Rank		**8**				**7**

Source: CSLS Provincial Productivity Database, Appendix Tables, http://www.csls.ca/data/mfp_new.asp.
*Finance, insurance, real estate, rental and leasing **Administrative and support, waste management and remediation services

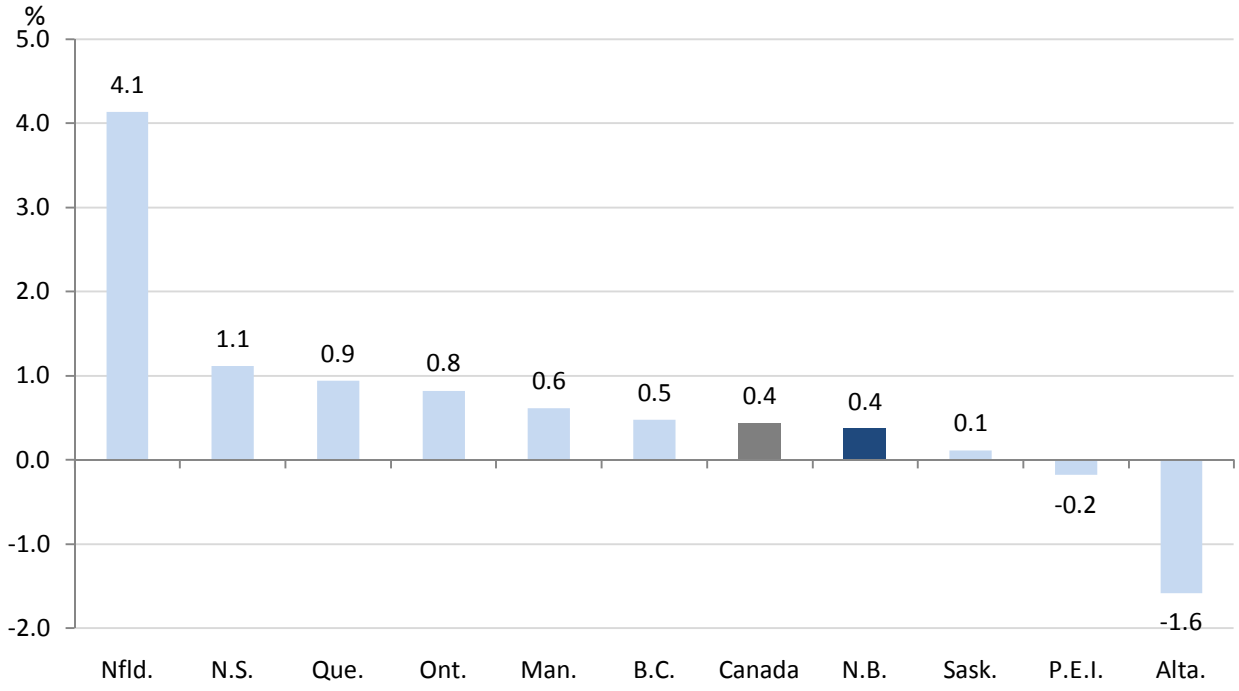
V. Multifactor Productivity

New Brunswick's multifactor productivity in the market sector grew at an average rate of 0.37 per cent per year during the 1997-2007 period, slightly below the national average of 0.44 per cent per year. The province ranked 7th in Canada (Chart 3).

The industry that experienced the highest multifactor productivity growth rate in New Brunswick was agriculture, forestry, fishing and hunting (5.6 per cent per year), followed by wholesale trade (4.0 per cent), and construction (3.1 per cent) (Table 4). The industries that had the lowest multifactor productivity growth rates were the arts, entertainment and recreation industry (-5.8 per cent per year), mining, and oil and gas extraction (-5.0 per cent), and utilities (-2.3 per cent).

New Brunswick experienced low multifactor productivity growth in many industries. Of the 15 two-digit NAICS industries, only three were ranked 3rd or higher while 11 were ranked at 7th place or lower. Despite the generally poor showing, two New Brunswick industries had the highest multifactor growth rate among all provinces: agriculture, forestry, fishing and hunting and the wholesale trade.

Chart 3: Multifactor Productivity Growth in Canada and the Provinces, Market Sector, 1997-2007
(Average Annual Growth Rates)



Source: CSLS Provincial Productivity Database, Appendix Tables, http://www.csls.ca/data/mfp_new.asp.

The province's multifactor productivity level in 2007 was 88.5 per cent of the Canadian level, down slightly from 89.0 per cent in 1997. In 2007, only 2 of the 15 two-digit NAICS industries in New Brunswick had multifactor productivity higher than the national level. The industries with the highest relative multifactor productivity levels were: agriculture, forestry, fishing and hunting (158.9 per cent of the national average) and wholesale trade (102.1 per cent). In contrast, the industries with lowest relative

multifactor productivity levels were arts, entertainment and recreation (67.5 per cent of the national average), other services (74.7 per cent) and utilities (75.2 per cent).

In terms of multifactor productivity levels, New Brunswick's market sector ranked 7th in Canada in 2007. The province fared poorly in several industries with 9 of the 15 two-digit NAICS industries ranking 7th or below, and was ranked 3rd or above in only 2 industries. In 2007, New Brunswick had the lowest in accommodation and food services.

Table 4: Multifactor Productivity Levels and Growth Rates in New Brunswick, 1997-2007

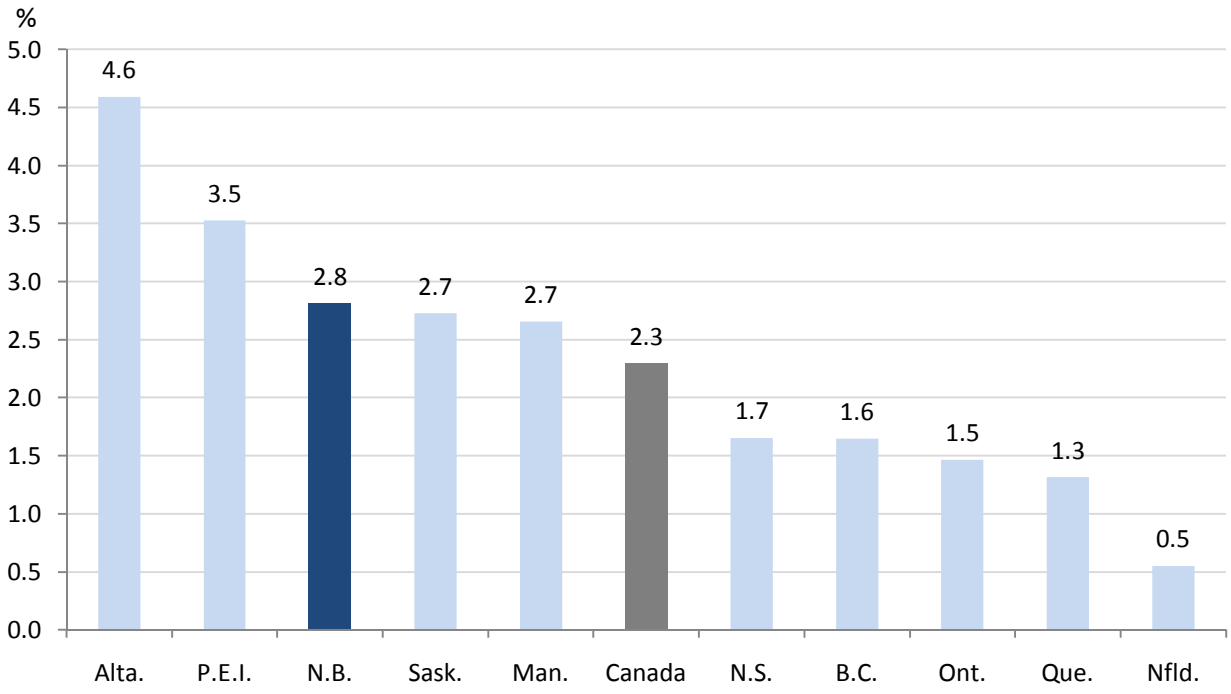
	Compound Annual Growth Rate, 1997-2007	Rank out of 10 provinces	Province's Multifactor Productivity Level Relative to Canada's		Rank of 10 provinces, 2007
	(per cent)		1997 (Canada=100)	2007 (Canada=100)	
Market Sector	**0.4**	**7**	**89.0**	**88.5**	**7**
Agriculture, Forestry, Fishing and Hunting	5.6	1	118.5	158.9	2
Mining, and Oil and Gas Extraction	-5.0	8	100.1	97.8	7
Utilities	-2.3	8	92.5	75.2	9
Construction	3.1	2	80.2	92.6	4
Manufacturing	-0.1	9	93.0	77.1	7
Wholesale Trade	4.0	1	86.0	102.1	3
Retail Trade	1.6	9	88.2	83.7	8
Transportation and Warehousing	-1.3	8	87.5	80.7	8
Information and Cultural Industries	1.2	8	101.0	98.3	6
FIRE*	-1.4	8	92.2	80.1	8
Professional, Scientific and Technical Services	-1.2	7	90.1	85.7	5
ASWMR**	0.4	4	82.9	89.9	6
Arts, Entertainment and Recreation	-5.8	9	100.0	67.5	9
Accommodation and Food Services	0.0	8	88.7	83.6	10
Other Services (Except Public Administration)	0.1	9	83.2	74.7	9
Absolute Equally Weighted Average Rank		6.6			6.7
Equally Weighted Market Sector Rank		**10**			**8**

Source: CSLS Provincial Productivity Database, Appendix Tables, http://www.csls.ca/data/mfp_new.asp.
*Finance, insurance, real estate, rental and leasing **Administrative and support, waste management and remediation services

VI. Capital Intensity

Capital intensity, defined as capital services per hour worked (unadjusted for labour quality), grew at an average rate of 2.8 per cent per year in New Brunswick's market sector. This was well above the national average of 2.3 per cent per year. New Brunswick ranked 3rd among the ten provinces in terms of capital intensity growth, behind only Alberta and Prince Edward Island (Chart 4).

Chart 4: Capital Intensity Growth in Canada and the Provinces, Market Sector, 1997-2007
(Average Annual Growth Rates)



Source: CSLS Provincial Productivity Database, Appendix Tables, http://www.csls.ca/data/mfp_new.asp.

During this period, the industry that experienced the highest capital intensity growth was professional, scientific and technical services (9.5 per cent per year), followed by retail trade (7.8 per cent) and information and cultural industries (6.3 per cent) (Table 5). Conversely, the industries that had the lowest growth rates were: administrative and support, waste management and remediation services (-9.0 per cent), arts, entertainment and recreation (-2.9 per cent), and mining, and oil and gas extraction (-0.3 per cent).

In 2007, two of the 15 two-digit NAICS industries had capital intensity levels above the Canadian levels. Industries with high relative levels included: finance, insurance, real estate, rental and leasing (138.0 per cent of the Canadian level), and information and cultural industries (126.5 per cent). The industries that had the lowest relative levels were administrative and support, waste management and remediation services (14.4 per cent of the Canadian level), mining, oil and gas extraction (23.1 per cent), and arts, entertainment and recreation (53.2 per cent).

At the industry level, New Brunswick enjoyed stronger capital intensity growth rates than Canada as a whole during the 1997-2007 period. The province ranked 3rd or above in seven of the 15 two-digit NAICS industries, but ranked 7th or below in four industries. The retail trade and information and cultural industries each had the higher capital intensity growth rates than in any other province.

Table 5: Capital Intensity Levels and Growth Rates in New Brunswick, 1997-2007

	Compound Annual Growth Rate, 1997-2007	Rank out of 10 Provinces	Province's Capital Intensity Level Relative to Canada's		Capital Intensity Level, 2007	Rank out of 10 Provinces, 2007
	(per cent)		1997 (Canada=100)	2007 (Canada=100)	(1997 Dollars)	
Market Sector	**2.8**	**3**	**72.0**	**75.7**	**11.9**	**7**
Agriculture, Forestry, Fishing and Hunting	3.7	4	64.9	75.6	9.8	8
Mining, and Oil and Gas Extraction	0.3	8	32.1	23.1	23.5	8
Utilities	1.5	3	64.0	81.5	85.1	7
Construction	2.5	5	62.9	78.3	3.7	6
Manufacturing	1.4	3	87.0	94.6	16.6	5
Wholesale Trade	1.7	8	85.1	68.4	9.0	8
Retail Trade	7.8	1	67.4	93.1	4.5	4
Transportation and Warehousing	4.2	2	60.1	69.7	9.2	9
Information and Cultural Industries	6.3	1	87.4	126.5	45.0	3
FIRE*	6.0	3	98.4	138.0	59.1	3
Professional, Scientific and Technical Services	9.5	5	86.8	93.7	10.3	8
ASWMR**	-9.0	9	50.7	14.4	0.9	9
Arts, Entertainment and Recreation	-2.9	9	100.2	53.2	4.2	9
Accommodation and Food Services	3.8	3	78.4	98.4	3.1	7
Other Services (Except Public Administration)	3.7	5	81.3	87.2	2.7	6
Absolute Equally Weighted Average Rank		4.6				6.7
Equally Weighted Market Sector Rank		**2**				**9**

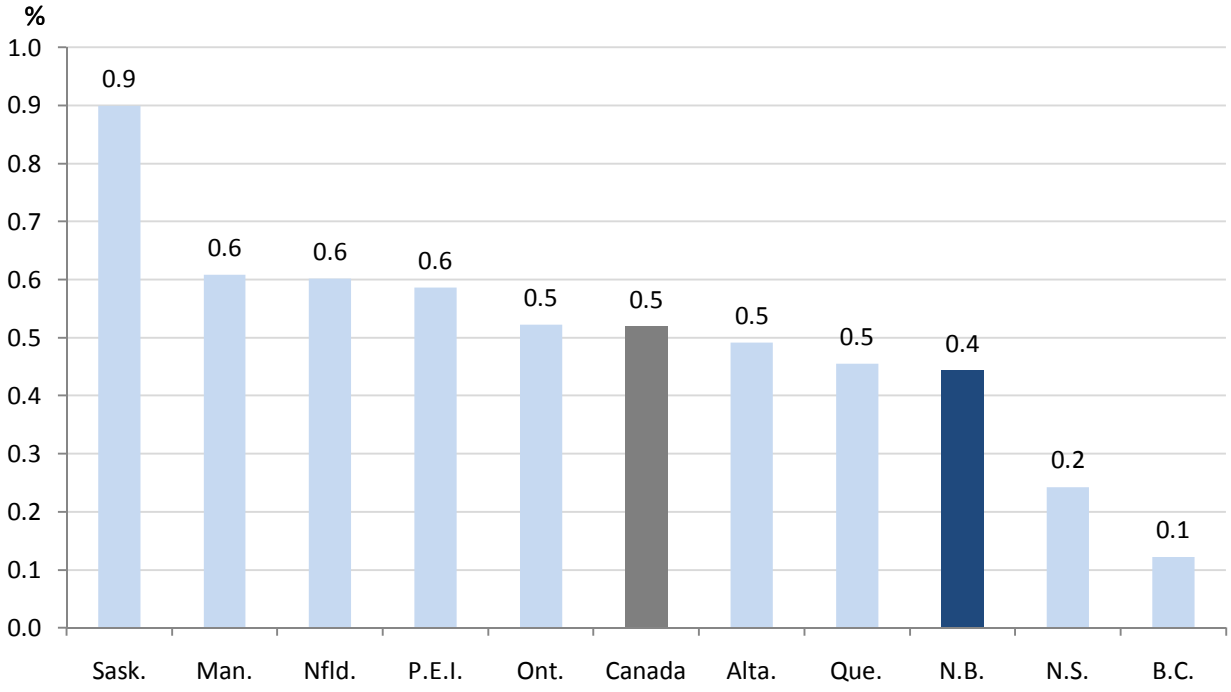
Source: CSLS Provincial Productivity Database, Appendix Tables, http://www.csls.ca/data/mfp_new.asp.
*Finance, insurance, real estate, rental and leasing **Administrative and support, waste management and remediation services

New Brunswick's capital intensity level in 2007 was 75.7 per cent of the Canadian level, up from 72.0 per cent in 1997. According to the market sector rank the province had the 4th lowest capital intensity level in Canada in 2007. This overall poor showing stems from 7 of the 15 two-digit NAICS industries having capital intensity levels ranked 7th or below, with only 2 industries ranked in the top 3.

VII. Labour Quality

New Brunswick experienced slow labour quality growth in the market sector during the 1997-2007 period. The province grew at an average rate of 0.4 per cent per year, while the national average was 0.5 per cent per year. As a consequence, the province ranks 8th in Canada in terms of labour quality growth (Chart 5).

Chart 5: Labour Quality Growth in Canada and the Provinces, Market Sector, 1997-2007
(Average Annual Growth Rates)



Source: CSLS Provincial Productivity Database, Appendix Tables, http://www.csls.ca/data/mfp_new.asp.

During the period in question, the industries that experienced the highest labour quality growth rates were the arts, entertainment and recreation (1.2 per cent per year), followed by other services (except public administration) (1.1 per cent) and the transportation and warehousing (0.6 per cent) (Table 6). The industry that had the lowest labour quality growth rate was: accommodation and food services (-0.3 per cent per year), followed by information and cultural industries and wholesale trade (both grew at -0.1 per cent).

Low market sector labour quality growth did not manifest itself in most industries, as 8 of the 15 two-digit NAICS industries were ranked 3rd or above when compared to other provinces. In fact, labour quality growth was the 2nd highest in the country using the equally weighted market sector rank. The province fared particularly poorly relative to other provinces in accommodation and food services where the lowest growth rate among all the provinces was attained. New Brunswick achieved the highest labour quality growth of any province in other services (excluding public administration).

Table 6: Labour Quality Levels and Growth Rates in New Brunswick, 1997-2007[10]

	Compound Annual Growth Rate, 1997-2007	Rank	Province's Labour Quality Level Relative to Canada's		Rank, 2007
	(per cent)		1997 (Canada=100)	2007 (Canada=100)	
Market Sector	**0.4**	**8**	**100.0**	**99.3**	**7**
Agriculture, Forestry, Fishing and Hunting	0.6	6	100.0	97.3	6
Mining, and Oil and Gas Extraction	0.1	2	100.0	101.1	2
Utilities	-0.1	8	100.0	98.1	8
Construction	0.0	7	100.0	99.1	7
Manufacturing	0.6	2	100.0	102.1	2
Wholesale Trade	-0.1	8	100.0	96.0	8
Retail Trade	0.2	3	100.0	100.7	3
Transportation and Warehousing	0.6	3	100.0	101.9	3
Information and Cultural Industries	-0.1	9	100.0	93.4	9
FIRE*	0.6	2	100.0	101.4	2
Professional, Scientific and Technical Services	0.1	8	100.0	95.1	8
ASWMR**	0.4	3	100.0	104.5	3
Arts, Entertainment and Recreation	1.2	2	100.0	112.7	2
Accommodation and Food Services	-0.3	10	100.0	94.9	10
Other Services (Except Public Administration)	1.1	1	100.0	106.7	1
Absolute Equally Weighted Average Rank		4.9			4.9
Equally Weighted Market Sector Rank		**2**			**2**

Source: CSLS Provincial Productivity Database, Appendix Tables, http://www.csls.ca/data/mfp_new.asp.
*Finance, insurance, real estate, rental and leasing **Administrative and support, waste management and remediation services

[10] Labour quality levels are not shown here because they are assumed to be the same across all provinces in the base year, 1997 (Sharpe and Thomson, 2010a). They differ after 1997, incorporating the different labour quality growth rates experienced by the provinces and Canada. For example, labour quality in New Brunswick's market sector grew at an average annual rate of 0.4 per cent over the 1997-2007 period, while Canada's labour quality grew at an average annual rate of 0.5 per cent. As a consequence, New Brunswick's labour quality level was 99.3 per cent of the Canadian level in 2007.

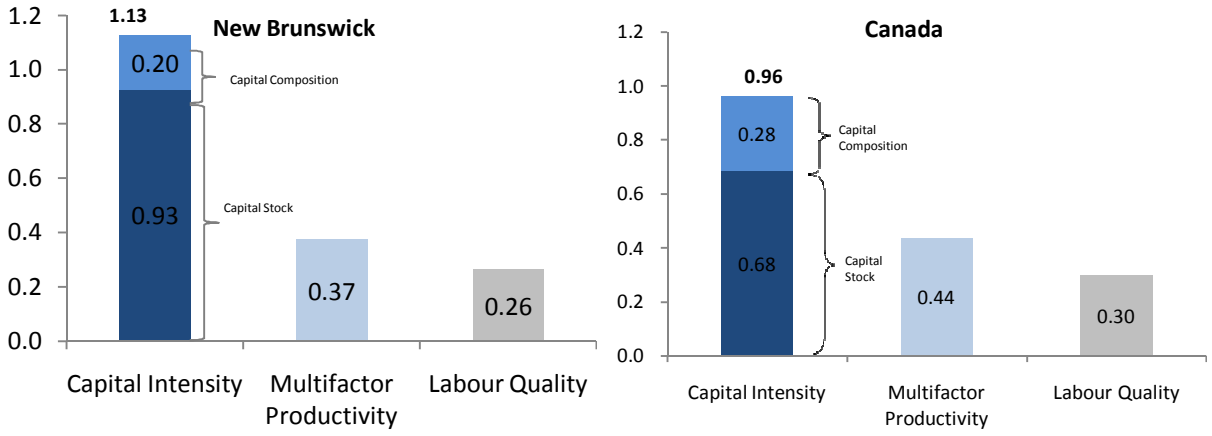
VIII. Sources of Labour Productivity Growth in the Market Sector

New Brunswick's labour productivity grew at an average rate of 1.8 per cent per year during the 1997-2007 period, somewhat better than the national average of 1.7 per cent per year. Charts 6 and 7 show both the percentage point and per cent contributions to labour productivity growth by the sources of growth for New Brunswick and Canada over the aforementioned period.

New Brunswick's labour productivity growth was driven mainly by capital intensity growth, which accounted for 1.13 percentage points of the overall labour productivity growth (or, alternatively, 63.4 per cent of total growth). The contribution of capital intensity to labour productivity growth can be broken down into two components: capital composition growth, which was responsible for 0.20 percentage points of labour productivity growth (11.3 per cent), and capital stock growth, which accounted for 0.93 percentage points (52.1 per cent). Multifactor productivity contributed 0.37 percentage points to the annual growth rate (20.9 per cent). Finally, a small increase in labour quality was responsible for 0.26 percentage points of the labour productivity growth experienced in the province (14.8 per cent).

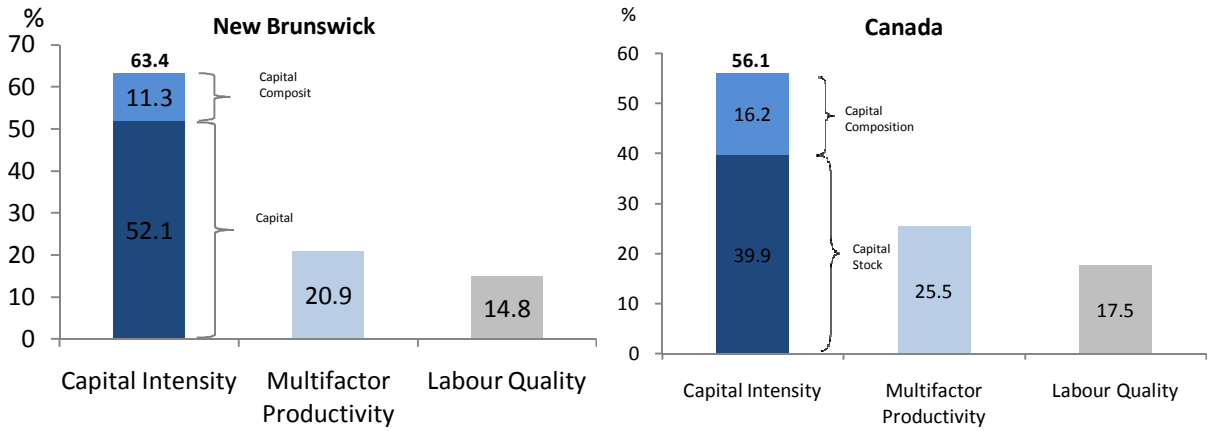
Comparing the two charts, it can be seen that the driver of labour productivity growth in New Brunswick and in Canada were fairly different. Increased capital stock explains only 39.3 per cent of the labour productivity growth in Canada, and yet it explains 52.1 per cent of New Brunswick's labour productivity growth. Multifactor productivity was responsible 25.5 per cent of growth for the nation, but only 20.9 per cent for New Brunswick. Labour quality accounted for a higher proportion of Canadian labour productivity growth than it did in New Brunswick (17.5 versus 14.8 per cent), and this held for capital composition as well (16.2 versus 11.3 per cent). Capital intensity was thus the only factor that proportionally contributed more to New Brunswick's growth rather than the national rate.

Chart 6: Percentage Point Contribution to Labour Productivity Growth by the Source of Labour Productivity Growth in the Market Sector in New Brunswick and in Canada, 1997 to 2007



Source: CSLS Provincial Productivity Database, Appendix Table 17, http://www.csls.ca/data/mfp_new.asp.

Chart 7: Per Cent Contribution to Labour Productivity Growth by the Source of Labour Productivity Growth in the Market Sector in New Brunswick and in Canada, 1997 to 2007



Source: CSLS Provincial Productivity Database, Appendix Table 17, http://www.csls.ca/data/mfp_new.asp.
Note: Numbers may not sum to 100 due to rounding.

Table 7 details the contributions in absolute and per cent terms of capital intensity, MFP, and labour quality growth to labour productivity growth in New Brunswick over the 1997-2007 period at the two-digit NAICS industry level.

Table 7: Contributions to Labour Productivity Growth at the Industry Level by Source in New Brunswick, 1997-2007

	Labour Productivity	Capital Intensity			MFP	Labour Quality
		Total	Capital Composition	Capital Stock		
	Percentage Point Contributions to Labour Productivity Growth					
Market Sector	**1.8**	**1.1**	**0.2**	**0.9**	**0.4**	**0.3**
Agriculture, Forestry, Fishing and Hunting	7.6	1.6	1.5	0.1	5.6	0.4
Mining, and Oil and Gas Extraction	-4.8	0.1	0.0	0.1	-5.0	0.1
Utilities	-1.1	1.2			-2.3	0.0
Construction	3.5	0.4	0.0	0.4	3.1	0.0
Manufacturing	0.9	0.7	0.1	0.5	-0.1	0.3
Wholesale Trade	4.5	0.6	0.3	0.3	4.0	-0.1
Retail Trade	3.8	2.0	-0.1	2.1		0.1
Transportation and Warehousing	0.2	1.1	0.2	0.9	-1.3	0.5
Information and Cultural Industries	4.4	3.3	1.0	2.2	1.2	-0.1
FIRE*	2.2	3.4	1.1	2.3	-1.4	0.2
Professional, Scientific and Technical Services	0.9	2.0	0.1	1.9	-1.2	0.1
ASWMR**	-1.1	-1.8	-2.2	0.4	0.4	0.4
Arts, Entertainment and Recreation	-5.5	-0.6			-5.8	0.8
Accommodation and Food Services	0.7	0.9	-0.1	1.0	0.0	-0.2
Other Services (Except Public Administration)	1.8	0.7	0.2	0.6	0.1	0.9
	Per Cent Contributions to Labour Productivity Growth					
Market Sector	**100.0**	**63.7**	**11.3**	**52.1**	**20.9**	**14.8**
Agriculture, Forestry, Fishing and Hunting	100.0	20.4	19.3	1.1	73.4	4.7
Mining, and Oil and Gas Extraction	100.0	-1.7	-0.4	-1.3	103.4	-1.9
Utilities	100.0	-102.3			199.4	0.6
Construction	100.0	11.3	0.9	10.4	87.6	0.7
Manufacturing	100.0	72.8	15.8	56.7	-7.4	34.4
Wholesale Trade	100.0	13.5	7.6	5.9	87.9	-1.9
Retail Trade	100.0	53.4	-1.8	55.4		3.9
Transportation and Warehousing	100.0	565.4	92.7	468.3	-702.0	244.8
Information and Cultural Industries	100.0	74.0	23.9	49.0	26.8	-1.6
FIRE*	100.0	157.9	49.7	105.8	-66.2	10.4
Professional, Scientific and Technical Services	100.0	217.1	8.7	207.4	-126.9	12.2
ASWMR**	100.0	169.1	209.9	-39.9	-34.9	-35.3
Arts, Entertainment and Recreation	100.0	10.5			104.0	-14.9
Accommodation and Food Services	100.0	140.7	-9.2	150.3	-3.9	-36.4
Other Services (Except Public Administration)	100.0	42.2	10.3	31.6	8.3	49.0

Source: CSLS Provincial Productivity Database, Appendix Tables, http://www.csls.ca/data/mfp_new.asp.
Note: Per cent contributions may not sum to 100 due to rounding.
*Finance, insurance, real estate, rental and leasing **Administrative and support, waste management and remediation services

IX. Sources of Labour Productivity Level Differential by Industry

New Brunswick's labour productivity level in 2007 was 78.1 per cent of the Canadian level, which implies a labour productivity gap of 21.9 percentage points. Table 8 shows that the gap was caused almost equally by the market sector's below average capital intensity and multifactor productivity levels, which were responsible for 10.7 and 10.9 percentage points of the gap, respectively (or 48.8 and 49.5 per cent of the gap). Labour quality accounted for only 0.4 percentage points of the gap (1.7 per cent).[11]

New Brunswick had a negative labour productivity gap in 13 of the 15 two-digit NAICS industries. Within many industries, both capital intensity and multifactor productivity made large negative contributions to the differential. The levels of capital intensity and multifactor productivity each lower labour productivity relative to the national level in 13 industries, and labour quality adversely affects labour productivity in seven industries. Capital intensity was the largest contributor to the gap in three of the 13 industries with gaps, while multifactor productivity was the most responsible in the other 10.

Table 8: Sources of the Labour Productivity Gap Relative to Canada for New Brunswick at the Two-Digit Industry Level, 2007

			Percentage Point Contributions to Labour Productivity Gap			Percent Contributions to Labour Productivity Gap			
	Labour Productivity Relative Level	Labour Productivity Gap	Capital Intensity	Multifactor Productivity	Labour Quality	Labour Productivity	Capital Intensity	Multifactor Productivity	Labour Quality
Market Sector	**78.1**	**-21.9**	**-10.7**	**-10.9**	**-0.4**	**100.0**	**48.8**	**49.5**	**1.7**
Agriculture, Forestry, Fishing and Hunting	136.1	36.1	-16.6	54.2	-1.6	100.0	-46.0	150.4	-4.5
Mining, and Oil and Gas Extraction	35.7	-64.3	-63.1	-1.4	0.2	100.0	98.2	2.1	-0.3
Utilities	64.0	-36.0	-12.6	-23.0	-0.4	100.0	35.0	64.0	1.0
Construction	86.4	-13.6	-5.8	-7.2	-0.6	100.0	42.7	52.9	4.5
Manufacturing	76.1	-23.9	-2.1	-22.8	1.0	100.0	8.9	95.4	-4.3
Wholesale Trade	83.4	-16.6	-16.6	1.9	-2.0	100.0	99.6	-11.5	11.8
Retail Trade	82.5	-17.5	-1.8	-16.1	0.4	100.0	10.5	92.0	-2.4
Transportation and Warehousing	73.2	-26.8	-9.5	-18.5	1.1	100.0	35.3	68.8	-4.2
Information and Cultural Industries	107.5	7.5	12.7	-1.8	-3.4	100.0	169.9	-24.5	-45.4
FIRE*	96.7	-3.3	17.8	-21.8	0.6	100.0	-534.2	652.7	-18.5
Professional, Scientific and Technical Services	81.3	-18.7	-1.0	-13.9	-3.8	100.0	5.4	74.3	20.2
ASWMR**	64.3	-35.7	-29.9	-8.6	2.9	100.0	83.9	24.2	-8.1
Arts, Entertainment and Recreation	61.9	-38.1	-13.8	-31.2	6.9	100.0	36.2	81.9	-18.1
Accommodation and Food Services	80.0	-20.0	-0.3	-16.1	-3.6	100.0	1.7	80.5	17.8
Other Services (Except Public Administration)	76.2	-23.8	-2.7	-25.5	4.4	100.0	11.4	106.9	-18.3

Source: CSLS Provincial Productivity Database, Appendix Tables, http://www.csls.ca/data/mfp_new.asp.
*Finance, insurance, real estate, rental and leasing **Administrative and support, waste management and remediation services

[11] Again, it is important to bear in mind that labour quality levels were assumed to be equal to 100.0 in all provinces and in Canada for the base year of 1997. They differ after 1997, incorporating the different labour quality growth rates experienced by the provinces and Canada.

X. Conclusion

During the 1997-2007 period, New Brunswick experienced a declining capital productivity (-1.0 per cent per year), below average multifactor productivity growth (0.4 per cent) and yet slightly above average labour productivity growth (1.8 percent). The increase in labour productivity was driven primarily by capital intensity growth surpassing the national rate (2.8 versus 2.3 per cent). The proportion of labour productivity growth caused by growth in multifactor productivity and and labour quality were lower in New Brunswick than in Canada as a whole.

New Brunswick's capital productivity level in 2007 was slightly above national level. The labour productivity level, however, was well below Canada's, with the labour productivity gap between New Brunswick's market sector and Canada's reaching 21.9 percentage points. This was due almost evenly to the low capital intensity land multifactor productivity levels in New Brunswick, which explains 48.4 and 49.5 per cent of the gap, respectively. Low labour quality explains the remaining portion.

Table 9 provides a summary of both levels (in 2007) and growth rates (for the 1997-2007 period) for the productivity measures discussed in this report, along with rankings that show how New Brunswick fared in comparison to the other provinces. A key observation is that New Brunswick combined generally weak growth rates with generally low levels. It is only through high capital intensity growth that labour productivity slightly outpaced the national rate and New Brunswick enjoys a higher level of capital productivity, but lower multifactor and labour productivity level.

Table 9: Summary of New Brunswick's Productivity Performance in the Market Sector

	Market Sector Growth, 1997 to 2007			Per Cent of the Canadian Level		Level Rankings, 2007	
	Compound Annual Growth Rate	Provincial Rank	Provincial Equally Weighted Rank	1997	2007	Provincial Rank	Provincial Equally Weighted Rank
Labour Productivity	1.8	5	4	77.5	78.1	8	8
Capital Productivity	-1.0	8	8	107.7	103.1	6	7
Multifactor Productivity	0.4	7	10	89.0	88.5	7	8
Capital Intensity	2.8	3	2	72.0	75.7	7	9
Labour Quality	0.4	8	2	n.a.	n.a.	n.a.	n.a.

Source: CSLS Provincial Productivity Database, Appendix Tables, http://www.csls.ca/data/mfp_new.asp.

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Appendix – A Growth Accounting Framework

The growth accounting framework used in this report assumes a Cobb-Douglas production function such that

$$Y = AK^{\alpha}L^{1-\alpha} \tag{1}$$

where *Y* is real output, *K* stands for capital services, *L* for labour input (quality adjusted hours), *A* for multifactor productivity and α is the share of output that takes the form of capital compensation. The labour input *L* can be decomposed into hours (*H*) and labour quality (*QL*):

$$L = H * QL \tag{2}$$

Capital services can be decomposed into capital stock (*SK*) and capital composition (*QK*):

$$K = SK * QK \tag{3}$$

Capital intensity (*KI*) is defined as:

$$KI = \frac{K}{H} \tag{4}$$

Using (1), (2), (3) and (4), the components of labour productivity *growth* can be decomposed as follows:

$$\Delta LP = \Delta Y - \Delta H = [\Delta QL * (1-\alpha)] + [\Delta KI * \alpha] + \Delta A \tag{5}$$

where *LP* stands for labour productivity and Δ is the percentage change. This equation was used in section eight.

The province's MFP levels relative to the Canadian levels (*Relative MFP*$_{p,i}$) were calculated using the equation below:

$$\ln\left(Relative\ MFP_{p,i}\right) = \ln\left(\frac{A_{p,i}}{A_{c,i}}\right) = \ln\left(\frac{Y_{p,i}}{Y_{c,i}}\right) - k_{p,c} * \ln\left(\frac{K_{P,i}}{K_{c,i}}\right) - \left(1-k_{p,c}\right) * \ln\left(\frac{L_{p,i}}{L_{c,i}}\right) \tag{6}$$

where $k_{p,c}$ is the average share of capital input between Canada and the province, and the subscripts *c, p* and *i* stand for Canada, province and industry, respectively.

Finally, the contributions to the relative labour productivity levels between the province and Canada (*Relative LP*$_{p,i}$) can be found using the following formula:

$$\ln\left(Relative\ LP_{p,i}\right) = \ln\left(\frac{A_{p,i}}{A_{c,i}}\right) + k_{p,c} * \ln\left(\frac{KI_{P,i}}{KI_{c,i}}\right) + \left(1-k_{p,c}\right) * \ln\left(\frac{QL_{p,i}}{QL_{c,i}}\right) \tag{7}$$

This equation was used in section nine. For a detailed discussion about the growth accounting framework used here, refer to Sharpe and Thomson (2010a).