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**An Analysis of Quebec's Productivity Performance,
1997-2007: Superior Multifactor Productivity
Growth, Weak Capital Intensity Growth**

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An Analysis of Quebec's Productivity Performance, 1997-2007: Superior Multifactor Productivity Growth, Weak Capital Intensity Growth

Executive Summary

The report, based on the [CSLS Provincial Productivity Database](#), provides an overview of Quebec's productivity performance over the 1997-2007 period. The key findings are the following:

- Quebec 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, Quebec's performance ranks 6th among the provinces.
- Despite good labour productivity growth overall, two industries witnessed declining productivity: utilities (-1.5 per cent) and arts, entertainment and recreation (-0.4 per cent per year).
- Quebec's labour productivity level in 2007 was \$35.60 (1997 dollars) per hour, which represents 98.8 per cent of the Canadian level (which implies a labour productivity gap of 1.2 percentage points), up slightly from 98.3 per cent in 1997. The province had the 4th highest labour productivity level among the ten provinces in 2007.
- Labour productivity growth in the province was driven mainly by multifactor productivity growth, which accounted for 53.6 per cent of the increase experienced over the 1997-2007 period. Capital intensity growth accounted for 30.5 per cent of the growth. Finally, labour quality was responsible for 15.1 per cent of the labour productivity growth experienced in the province.
- Quebec had a labour productivity gap relative to Canada in nine of the 15 two-digit NAICS industries. The largest gap was in mining, oil and gas extraction, where labour productivity was below the national rate by 39.7 per cent in 2007. In contrast, labour productivity in utilities was 21.3 per cent above the national level.
- Capital productivity, defined as real GDP per unit of capital services, grew at a rate of 0.4 per cent per year in Quebec's market sector during the 1997-2007 period. Quebec ranked 2nd in growth of capital productivity and was one of only four provinces that saw an increase rather than a decline in the measure.
- Quebec's multifactor productivity in the market sector grew at an average rate of 0.9 per cent per year during the 1997-2007 period, well above the national average of 0.4 per cent per year. The province ranked 3rd in Canada, behind only Newfoundland and Nova Scotia.

An Analysis of Quebec's Productivity Performance, 1997-2007: Superior Multifactor Productivity Growth, Weak 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 Quebec'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 Quebec'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 Quebec's industry composition by nominal GDP and total hours worked. Sections three through nine detail Quebec'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.

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 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

³ For more information on how Statistics Canada calculates labour quality, see Gu *et al* (2002).

⁴ Also known as total factor productivity (TFP).

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 intensity⁶; 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 Quebec'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 Quebec, the industries that had the highest GDP shares in 2007 were manufacturing (22.8 per cent of GDP), FIRE (finance, insurance, real estate, rental and leasing) (13.6 per cent) and retail trade (8.5 per cent). In terms of actual hours worked, the three industries that had the highest shares in 2007 were manufacturing (19.2 per cent), retail trade (14.2 per cent), and other services (except public administration) (10.1 per cent).

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

Market Sector	1997				2007			
	GDP		Hours Worked		GDP		Hours Worked	
	Canada	Quebec	Canada	Quebec	Canada	Quebec	Canada	Quebec
Market Sector	100.0							
Agriculture, Forestry, Fishing and Hunting	3.2	2.4	5.4	3.5	2.1	2.3	3.4	2.8
Mining, and Oil and Gas Extraction	5.5	1.1	1.7	0.7	11.1	1.4	2.0	0.5
Utilities	4.2	5.8	0.9	0.9	3.0	5.5	0.8	1.0
Construction	7.0	6.3	7.9	6.1	9.0	7.9	10.1	6.9
Manufacturing	23.2	29.1	18.3	23.6	16.8	22.8	14.8	19.2
Wholesale Trade	7.1	6.7	7.4	7.4	7.1	7.4	6.9	7.1
Retail Trade	6.9	7.6	13.1	14.0	7.4	8.5	12.9	14.2
Transportation and Warehousing	6.2	5.7	6.3	5.9	5.6	5.3	6.6	6.2
Information and Cultural Industries	4.3	4.8	2.5	2.6	4.3	4.6	2.7	2.8
FIRE*	15.0	13.8	7.5	6.7	14.6	13.6	7.8	7.2
Professional, Scientific and Technical Services	4.9	4.4	6.3	5.7	6.2	5.9	7.9	7.3
ASWMR**	2.5	2.5	4.0	3.9	3.3	3.7	5.7	5.4
Arts, Entertainment and Recreation	0.9	1.0	1.5	1.5	0.9	1.1	1.9	1.8
Accommodation and Food Services	3.2	3.0	7.8	7.9	2.8	3.1	7.0	7.3
Other Services (Except Public Administration)	5.7	5.8	9.4	9.6	5.8	6.8	9.5	10.1

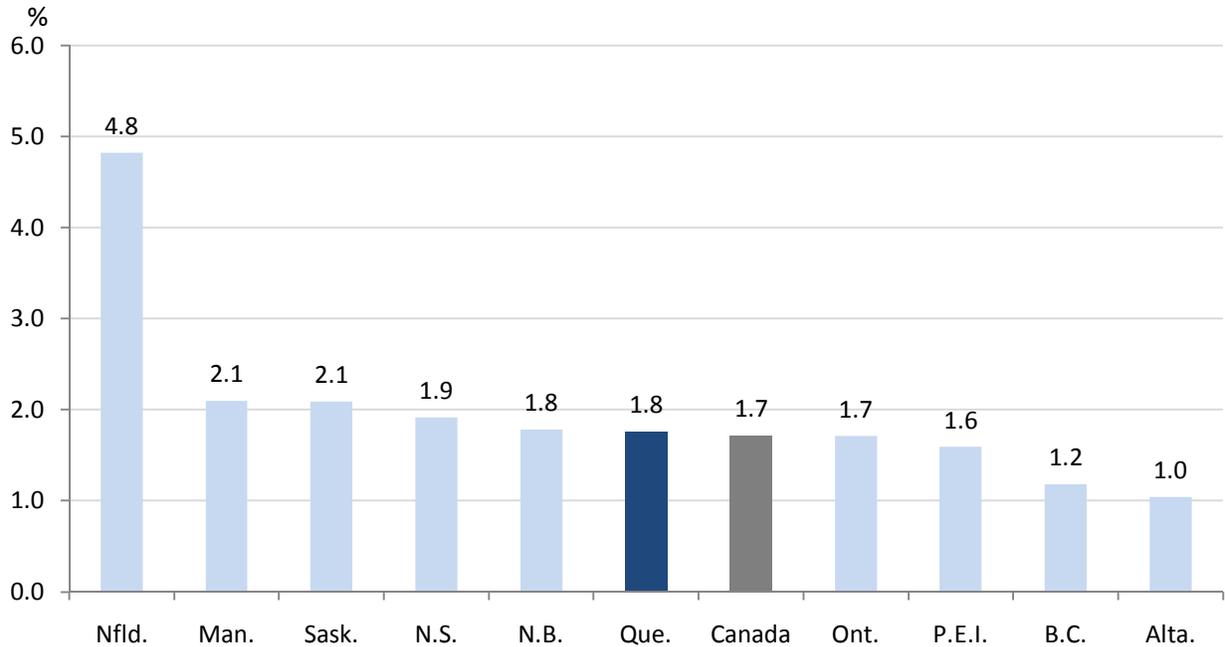
Source: Shares calculated by the CSLS, based on Statistics Canada data (Cansim Table 383-0011).

*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 Quebec's market sector during the 1997-2007 period. This is somewhat better than the national average of 1.7 per cent per year (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 Quebec was the agriculture, forestry, fishing and hunting (3.8 per cent per year), followed by wholesale trade (3.4 per cent), and other services (except public administration) (3.3 per cent) (Table 2). The industry that had the lowest labour productivity growth rate was in the utilities industry (-1.5 per cent), followed by the arts, entertainment and recreation (-0.4 per cent) and mining, and oil and gas extraction (-0.1 per cent).

Compared to the other provinces, Quebec had average labour productivity growth rates at the industry level during this period. The province ranked 3rd or higher in only two of the 15 two-digit NAICS industries, and also came 7th or below in four industries. This means that nine of the 15 industries were ranked 4th through 6th, indicating that Quebec was in the middle in most industries when it came to growth. Overall, Quebec experienced the 6th highest rate among provinces. Quebec had the lowest labour productivity growth rate of any province in the information and cultural industries (1.3 per cent).

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

Quebec did not achieve the highest or second highest ranking in any industry, though it achieved a 3rd place ranking in manufacturing (2.4 per cent) and arts, entertainment and recreation (-0.4 per cent).

Quebec's labour productivity level in 2007 was \$35.60 (1997 dollars) per hour, which represents 98.8 per cent of the Canadian level, up slightly from 98.3 per cent in 1997. The province had the 4th highest labour productivity level in Canada in 2007, behind Newfoundland, Alberta and Ontario.

At the industry level, Quebec enjoyed a high equally weighted labour productivity level rank. In 2007, six of the 15 two-digit NAICS industries had higher productivity in the province than the national level. The highest relative level was in utilities (121.3 per cent of the national level), followed by construction (121.1 per cent) and arts, entertainment and recreation (116.9 per cent). The lowest relative productivity level was in mining, oil and gas extraction (60.3 per cent of the national level), followed by wholesale trade (90.0 per cent) and information and cultural industries (92.9). Quebec was ranked 3rd or higher in seven industries, and ranked 7th or lower in only three industries.

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

Market Sector	Compound Annual Growth Rate, 1997-2007	Rank	Province's Labour Productivity Level Relative to Canada's, 1997	Province's Labour Productivity Level Relative to Canada's, 2007	Labour Productivity Level, 2007	Rank, 2007
	(per cent)		(Canada=100)	(Canada=100)	(1997 Dollars)	
Market Sector	1.8	6	98.3	98.8	35.6	4
Agriculture, Forestry, Fishing and Hunting	3.8	6	112.2	107.4	29.2	5
Mining, and Oil and Gas Extraction	0.1	5	47.4	60.3	47.5	8
Utilities	-1.5	8	128.8	121.3	163.3	4
Construction	2.2	4	115.8	121.1	38.6	2
Manufacturing	2.4	3	95.9	97.1	46.4	3
Wholesale Trade	3.4	6	93.0	90.0	37.7	7
Retail Trade	2.9	9	101.5	97.2	21.4	5
Transportation and Warehousing	0.4	5	96.3	93.8	29.8	5
Information and Cultural Industries	1.3	10	110.1	92.9	63.8	9
FIRE*	1.1	8	101.0	96.8	68.1	5
Professional, Scientific and Technical Services	1.4	5	96.5	97.4	26.3	3
ASWMR**	1.1	4	98.9	106.9	21.2	2
Arts, Entertainment and Recreation	-0.4	3	107.6	116.9	18.9	1
Accommodation and Food Services	1.7	4	90.7	96.9	13.3	3
Other Services (Except Public Administration)	3.3	4	94.8	106.0	17.2	2
Absolute Equally Weighted Average Rank		5.6				4.3
Equally Weighted Market Sector Rank		6				3

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

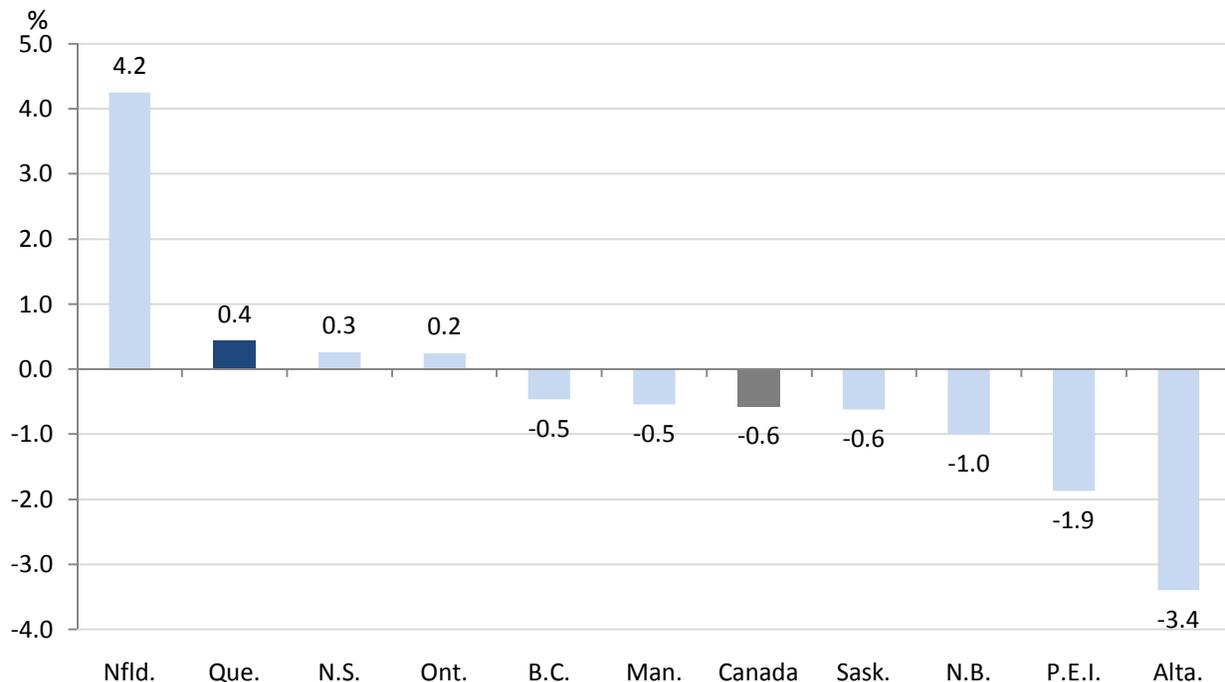
*Finance, insurance, real estate, rental and leasing **Administrative and support, waste management and remediation services

IV. Capital Productivity

Capital productivity, defined as real GDP per unit of capital services, grew at a rate of 0.4 per cent per year in Quebec's market sector during the 1997-2007 period, ranking 2nd among the provinces. In contrast, Canada's capital productivity declined 0.6 per cent per year over the period (Chart 2).

In Quebec, 10 of the 15 two-digit NAICS industries had negative capital productivity growth rates during the period. The industry that had the worst performance was the professional, scientific and technical services (-5.2 per cent per year), followed by other services except public administration (-3.0 per cent) and wholesale trade (-2.8 per cent) (Table 3). Of the few industries that had positive growth rates, the best performing sectors were agriculture, forestry, fishing and hunting (2.7 per cent), followed by information and cultural industries (2.4 per cent) and administrative and support, waste management and remediation services (2.3 per cent).

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



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

At the industry level, Quebec ranked 3rd or higher in seven industries and 7th or lower in three industries. Using the equally weighted market sector ranking, Quebec had experienced the highest capital productivity growth in the country. The province ranked 2nd in growth of capital productivity using the total market sector ranking and was one of only four provinces that saw an increase rather than a decline in the measure. The wholesale trade in Quebec had the worst capital productivity growth rates among all provinces. In contrast, professional, scientific and technical services had the highest capital productivity growth in Canada.

Quebec's capital productivity level in the market sector in 2007 was 108.8 per cent of the Canadian level, up from 98.4 per cent in 1997, putting the province in 5th place. In 2007, nine of the 15 two-digit NAICS industries in the province had capital productivity levels above the Canadian average. The industries with highest capital productivity levels relative to the national average were: mining and oil and gas (314.3 per cent of the national level), administrative and support, waste and remediation (ASWMR) (190.2 per cent), and arts, entertainment and recreation (120.5 per cent). The six industries that had capital productivity levels lower than Canada's in 2007 were: construction (67.6 per cent), other services (except public administration) (70.6 per cent), wholesale trade (82.7 per cent), retail trade (84.6 per cent), Finance, insurance, real estate, rental and leasing (89.7 per cent), and manufacturing (97.7 per cent).

Quebec's market sector had the 5th highest capital productivity level in Canada in 2007.¹⁰ Quebec did not rank 1st for capital productivity levels in any industry, however, the province did rank 2nd in mining, and oil and gas extraction and in accommodation and food services. Similarly, the province did not rank 10th for capital productivity levels in any industry, however, the province did rank 9th in construction and retail trade.

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

	Compound Annual Growth Rate, 1997-2007	Rank	Province's Capital Productivity Level Relative to Canada's		Capital Productivity Level, 2007	Provincial Ranking, 2007
	(per cent)		1997 (Canada=100)	2007 (Canada=100)	(1997 Dollars)	
Market Sector	0.4	2	98.4	108.8	2.50	5
Agriculture, Forestry, Fishing and Hunting	2.7	3	102.1	109.2	2.29	5
Mining, and Oil and Gas Extraction	-0.9	4	191.6	314.3	2.43	2
Utilities	1.2	2	95.9	108.2	1.40	4
Construction	-0.8	7	84.4	67.6	4.62	9
Manufacturing	2.0	3	94.2	97.7	2.66	6
Wholesale Trade	-2.8	10	108.1	82.7	2.63	8
Retail Trade	-1.0	6	84.6	84.6	3.87	9
Transportation and Warehousing	-2.4	4	108.8	103.8	2.50	5
Information and Cultural Industries	2.4	2	94.4	113.5	2.19	3
FIRE*	-1.6	4	96.3	89.7	1.47	4
Professional, Scientific and Technical Services	-5.2	1	88.0	103.6	2.53	3
ASWMR**	2.3	3	114.4	190.2	5.86	3
Arts, Entertainment and Recreation	-1.9	2	92.2	120.5	2.48	3
Accommodation and Food Services	-0.3	4	110.6	111.8	4.81	2
Other Services (Except Public Administration)	-3.0	8	88.1	70.6	3.76	8
Absolute Equally Weighted Average Rank		4.2				4.9
Equally Weighted Market Sector Rank		1				4

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 The province's equally-weighted market sector rank was slightly lower, 4th, only behind Ontario, British Columbia and Nova Scotia.

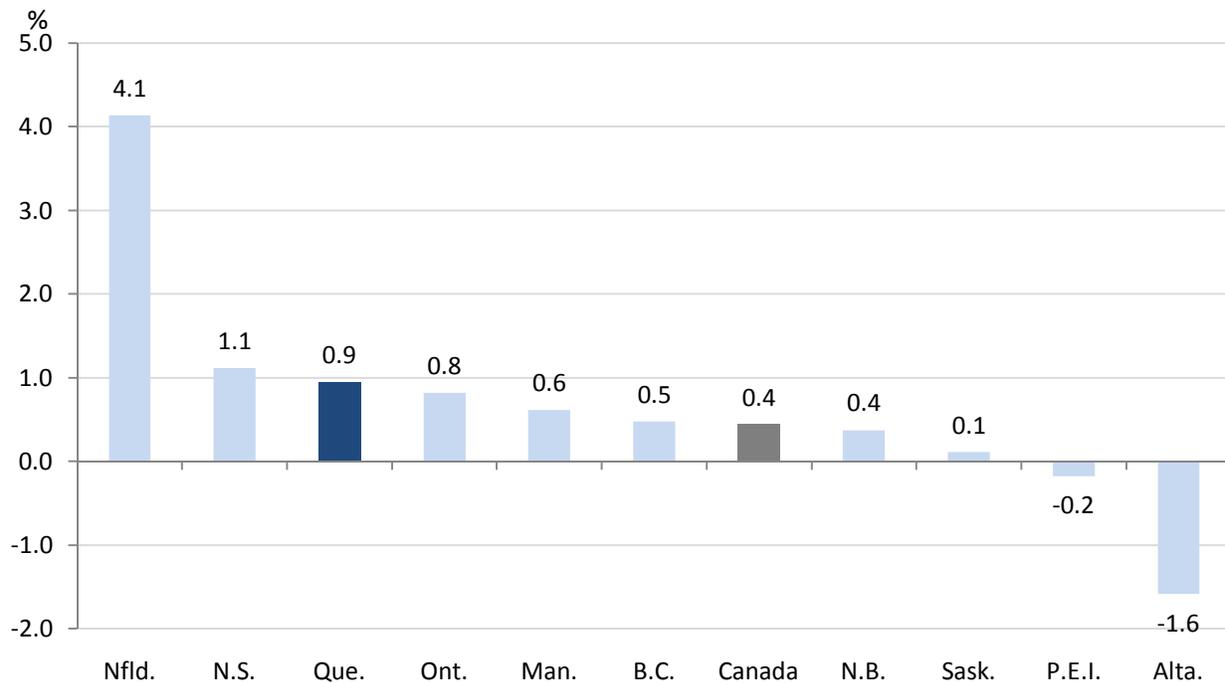
V. Multifactor Productivity

Quebec's multifactor productivity in the market sector grew at an average rate of 0.9 per cent per year during the 1997-2007 period, well above the national average of 0.4 per cent per year. The province ranked 3rd in Canada with regards to multifactor growth (Chart 3).

The industry that experienced the highest multifactor productivity growth rate in Quebec was agriculture, forestry, fishing and hunting (2.9 per cent per year), followed by manufacturing and manufacturing and cultural industries (1.9 per cent) (Table 4). The industries that had the lowest multifactor productivity growth rates were the arts, entertainment and recreation and transportation and warehousing (-0.8 per cent each), professional, scientific and technical services and finance, insurance, real estate, rental and leasing (-0.6 per cent).

Compared to the other provinces, Quebec had strong multifactor productivity growth rates during the period. Indeed, the province ranked 1st using the equally weighted market sector rank. Of the 15 two-digit NAICS industries, six were ranked 3rd or higher while only two were ranked at 7th place or lower. Administrative and support, waste management and remediation services had the best multifactor productivity growth rates among all provinces.

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



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

The province's multifactor productivity level in 2007 was 103.3 per cent of the Canadian level, up from 98.2 per cent in 1997. In 2007, eight of the 15 two-digit NAICS industries in Quebec had multifactor productivity levels above those of Canada. The industries with the highest relative multifactor

productivity levels were: mining, oil and gas extraction (194.2 per cent of the national average), administrative and support, waste management and remediation services (127.5 per cent) and arts, entertainment and recreation (118.6). In contrast, the industries with the lowest relative multifactor productivity levels were the wholesale trade (87.5 per cent), followed by finance, insurance, real estate, rental and leasing (93.4 per cent) and retail trade (93.4 per cent).

In terms of multifactor productivity levels, Quebec's market sector ranked 3rd in Canada in 2007. Quebec ranked higher than five provinces in market sector multifactor productivity levels. The province fared quite well in all industries with; six of the 15 two-digit NAICS industries ranking 3rd or above, and was not ranked below 7th in any industry. In 2007, Quebec had the highest relative multifactor productivity levels in arts, entertainment and recreation, as well as administrative and support, waste management and remediation services.

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

Market Sector	Compound Annual Growth Rate, 1997-2007	Rank out of 10 provinces	Province's Multifactor Productivity Level Relative to Canada's, 1997	Province's Multifactor Productivity Level Relative to Canada's, 2007	Rank out of 10 provinces, 2007
	(per cent)		(Canada=100)	(Canada=100)	
Market Sector	0.9	3	98.2	103.3	3
Agriculture, Forestry, Fishing and Hunting	2.9	5	104.9	108.6	4
Mining, and Oil and Gas Extraction	-0.3	4	122.6	194.2	4
Utilities	0.6	2	101.4	110.4	2
Construction	1.5	5	105.2	103.8	2
Manufacturing	1.9	2	95.0	96.0	4
Wholesale Trade	1.2	7	96.9	87.5	7
Retail Trade	1.7	7	97.4	93.4	6
Transportation and Warehousing	-0.8	6	99.1	96.0	6
Information and Cultural Industries	1.9	4	100.5	104.7	3
FIRE*	-0.6	6	99.1	93.4	4
Professional, Scientific and Technical Services	-0.6	3	97.2	98.2	3
ASWMR**	1.4	1	106.6	127.5	1
Arts, Entertainment and Recreation	-0.8	2	104.7	118.6	1
Accommodation and Food Services	1.2	3	94.8	100.7	4
Other Services (Except Public Administration)	1.6	5	92.9	96.9	6
Absolute Equally Weighted Average Rank		4.1			3.8
Equally Weighted Market Sector Rank		1			2

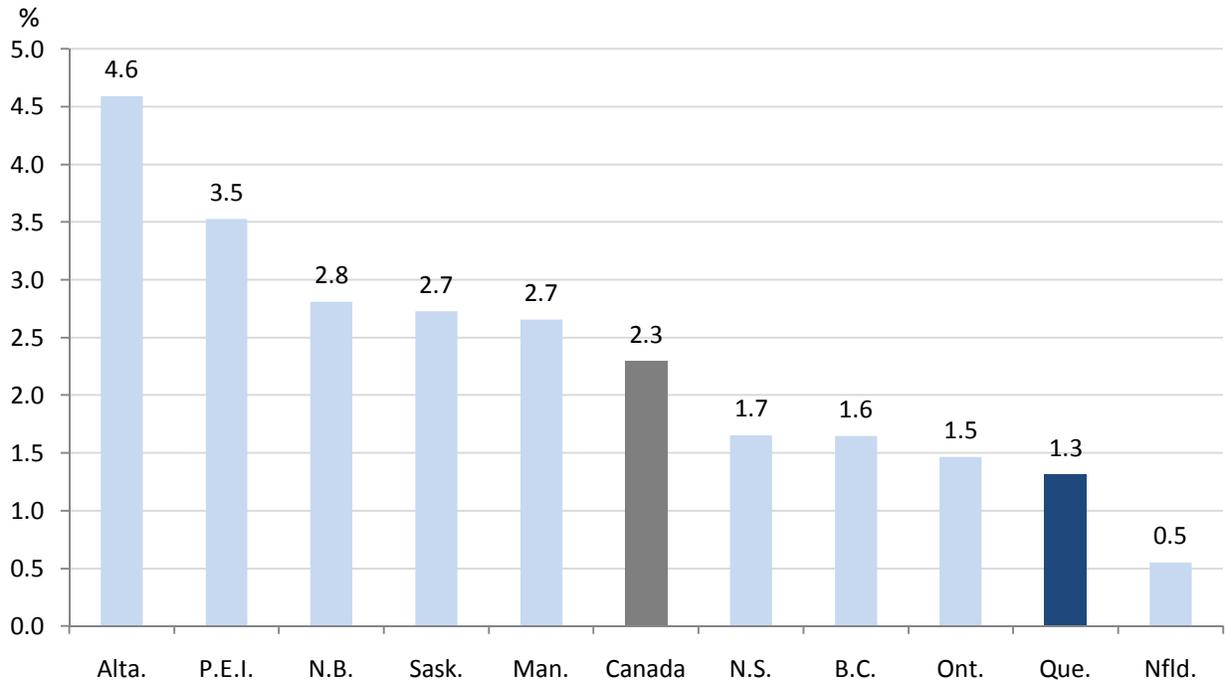
Source: CSLs Provincial Productivity Database, Appendix Tables, http://www.csls.ca/data/mfp_new.asp.

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

VI. Capital Intensity

Capital intensity, defined as capital services per hour worked (unadjusted for labour quality), grew at an average rate of 1.3 per cent per year in Quebec's market sector. This was well below the national average of 2.3 per cent per year. Quebec ranks 9th among the ten provinces in terms of capital intensity growth (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 industries that experienced the highest capital intensity growth were: professional, scientific and technical services (7.0 per cent), and other services except public administration (6.5 per cent per year) and wholesale trade (6.3 per cent) (Table 5). Conversely, the industries that had the lowest growth rates were: utilities (-2.7 per cent), administrative and support, waste management and remediation services (-1.2 per cent), and information and cultural industries (-1.1 per cent).

Compared to the other provinces, Quebec had somewhat lower capital intensity growth rates than Canada as a whole during the 1997-2007 period. The province ranked 7th or below in eight of the 15 two-digit NAICS industries, but ranked 3rd or above in two industries. On the one hand, utilities and information and cultural industries had the worst capital intensity growth rates among all the provinces. On the other hand, the wholesale trade, had the strongest capital intensity growth rate in Canada.

In 2007, six of the 15 two-digit NAICS industries had capital intensity levels above the national level. Industries with high relative levels included: construction (179.2 per cent of the national) other services

except public administration (150.1 per cent), and retail trade 114.9 (per cent). The industries that had the lowest relative levels were mining, and oil and gas extraction (19.2 per cent) and administrative and support, waste management and remediation services (56.2 per cent). The low level of capital intensity in mining and oil and gas extraction likely reflects a composition effect where the industry average nationally is skewed higher by capital intensive oil extraction; Quebec has no oil extraction but does engage in mining, which is less capital intensive.

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

Market Sector	Compound Annual Growth Rate, 1997-2007	Rank	Province's Capital Intensity Level Relative to Canada's, 1997	Province's Capital Intensity Level Relative to Canada's, 2007	Capital Intensity Level, 2007	Rank, 2007
	(per cent)		(Canada=100)	(Canada=100)	(1997 Dollars)	
Market Sector	1.3	9	100.0	90.8	14.3	3
Agriculture, Forestry, Fishing and Hunting	1.0	9	109.7	98.4	12.7	5
Mining, and Oil and Gas Extraction	1.1	6	24.7	19.2	19.5	9
Utilities	-2.7	10	134.3	112.1	117.0	5
Construction	3.0	4	137.5	179.2	8.4	1
Manufacturing	0.3	5	102.1	99.4	17.5	3
Wholesale Trade	6.3	1	86.4	108.8	14.4	5
Retail Trade	3.9	7	120.1	114.9	5.5	1
Transportation and Warehousing	2.9	5	88.7	90.3	11.9	5
Information and Cultural Industries	-1.1	10	118.0	83.0	29.6	10
FIRE*	2.7	8	105.1	107.9	46.2	6
Professional, Scientific and Technical Services	7.0	8	109.7	94.0	10.4	7
ASWMR**	-1.2	8	86.8	56.2	3.6	7
Arts, Entertainment and Recreation	1.6	6	116.3	97.0	7.6	6
Accommodation and Food Services	2.1	8	81.9	86.7	2.8	9
Other Services (Except Public Administration)	6.5	3	107.5	150.1	4.6	1
Absolute Equally Weighted Average Rank		6.5				5.3
Equally Weighted Market Sector Rank		10				4

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

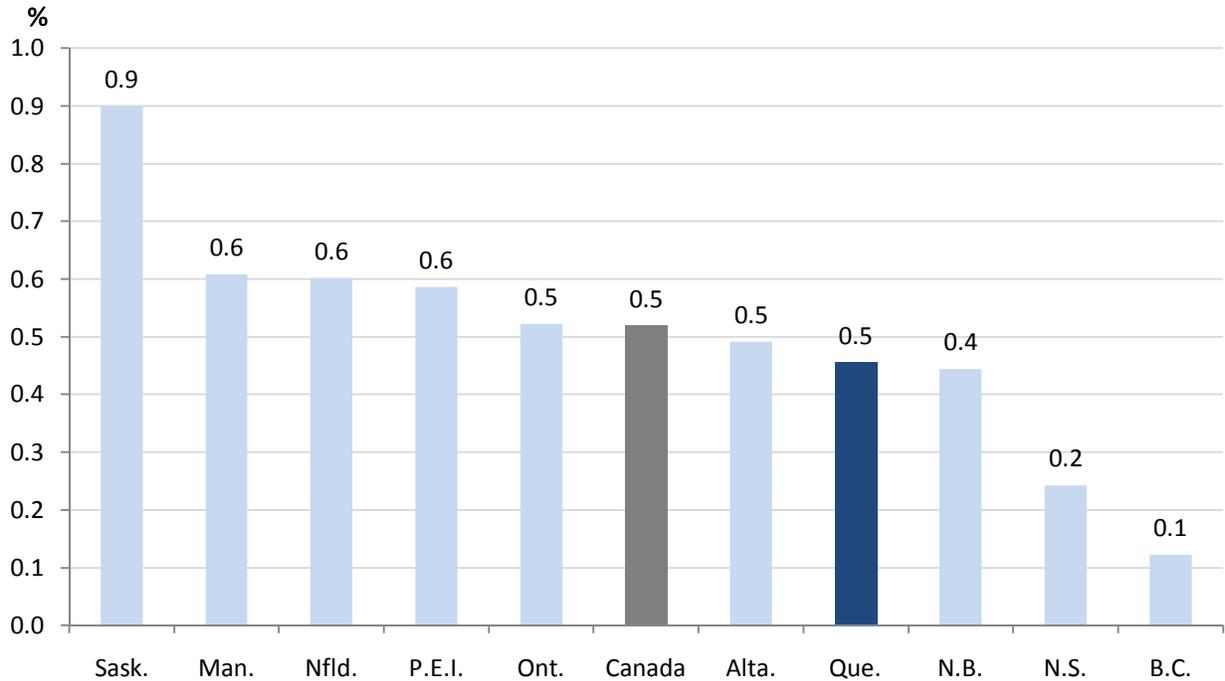
*Finance, insurance, real estate, rental and leasing **Administrative and support, waste management and remediation services

Quebec's capital intensity level in 2007 was 90.8 per cent of the Canadian level, down from 100.0 per cent in 1997. Quebec's capital intensity level was the 3rd highest in Canada, behind Alberta and Saskatchewan. This strong showing reflects having only three industries ranked lower than 7th. Three industries in Quebec had the highest capital intensity level compared to all provinces, construction, retail trade, and other services (other than public administration). However, information and cultural industries in Quebec had the lowest capital intensity of any province.

VII. Labour Quality

Quebec experienced below-average labour quality growth in the market sector during the 1997-2007 period. The province grew at an average rate of 0.46 per cent per year, while the national average was 0.52 per cent per year. The province ranked 7th for labour quality growth in Canada (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 in the agriculture, forestry, fishing and hunting (0.9 per cent per year), professional, scientific and technical services (0.7 per cent), and manufacturing (0.6 per cent) (Table 6). The industries that had the lowest labour quality growth rates were: administrative and support, waste management and remediation services (-0.3 per cent), arts, entertainment and recreation and construction (-0.1 per cent each).

Quebec experienced slightly below average labour quality growth rates in the market sector during the 1997-2007 period, surpassing only three provinces. However, Quebec ranks 3rd using the equally weighted market sector rank, which implies that smaller industries in Quebec actually experienced much better growth. There were five industries ranked 7th or lower and five ranked 3rd or higher. The province notably attained the highest growth in labour quality in manufacturing compared to all provinces.

Table 6: Labour Quality Levels and Growth Rates in Quebec, 1997-2007¹¹

Market Sector	Compound Annual Growth Rate, 1997-2007	Rank	Province's Labour Quality Level Relative to Canada's, 1997	Province's Labour Quality Level Relative to Canada's, 2007	Rank, 2007
	(per cent)		(Canada=100)	(Canada=100)	
Market Sector	0.5	7	100.0	99.4	6
Agriculture, Forestry, Fishing and Hunting	0.9	3	100.0	99.6	3
Mining, and Oil and Gas Extraction	0.1	4	100.0	100.6	4
Utilities	0.4	2	100.0	103.0	2
Construction	-0.1	9	100.0	97.8	9
Manufacturing	0.6	1	100.0	102.4	1
Wholesale Trade	0.3	3	100.0	99.8	3
Retail Trade	0.1	4	100.0	100.0	4
Transportation and Warehousing	0.6	4	100.0	101.3	4
Information and Cultural Industries	0.1	8	100.0	95.2	8
FIRE*	0.3	7	100.0	98.7	7
Professional, Scientific and Technical Services	0.7	3	100.0	100.6	3
ASWMR**	-0.3	8	100.0	97.0	8
Arts, Entertainment and Recreation	-0.1	8	100.0	99.3	8
Accommodation and Food Services	0.1	6	100.0	99.3	6
Other Services (Except Public Administration)	0.2	6	100.0	98.2	6
Absolute Equally Weighted Average Rank		5.1			5.1
Equally Weighted Market Sector Rank		3			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 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 Quebec's market sector grew at an average annual rate of 0.46 per cent over the 1997-2007 period, while Canada's labour quality grew at an average annual rate of 0.52 per cent. As a consequence, Quebec's labour quality level was 99.4 per cent of the Canadian level in 2007.

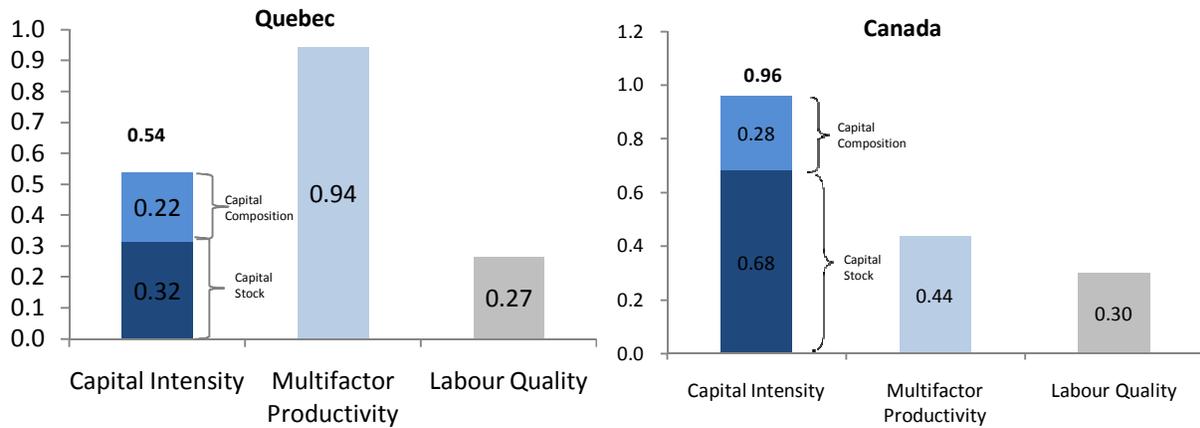
VIII. Sources of Labour Productivity Growth in the Market Sector

Quebec'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 Quebec and Canada over the aforementioned period.

Quebec's labour productivity growth was driven mainly by multifactor productivity growth, which accounted for 0.94 percentage points of the overall labour productivity growth (or, alternatively, 53.6 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 0.22 percentage points of labour productivity growth (12.6 per cent), and capital stock growth, which accounted for 0.32 percentage points (18.0 per cent). Finally, a small increase in labour quality was responsible for 0.27 percentage points of the labour productivity growth experienced in the province (15.1 per cent).

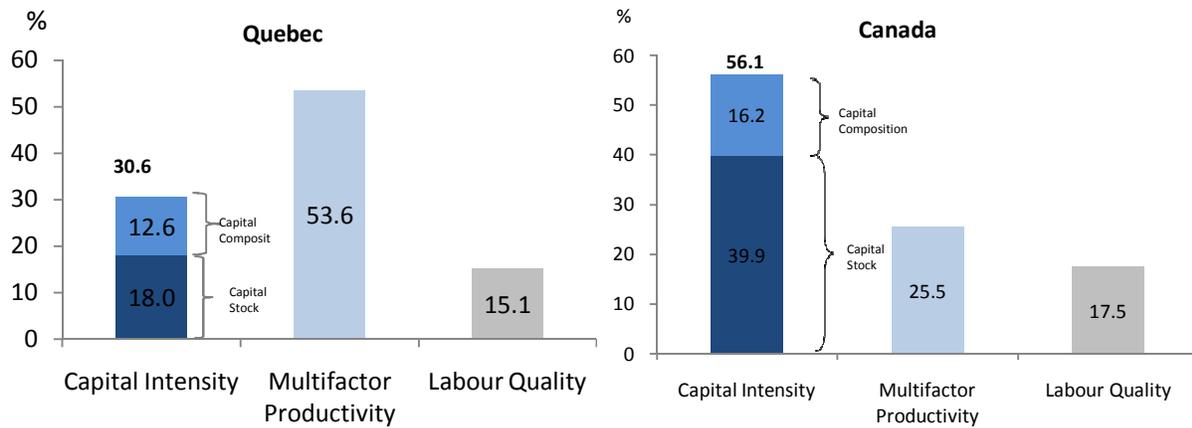
Comparing the two charts, it can be seen that the driver of labour productivity growth in Quebec and in Canada were quite different. Whereas multifactor productivity was the main driver of labour productivity in Quebec, capital intensity growth was the main driver nationally. Multifactor productivity explains only 25.5 per cent of the labour productivity growth in Canada, and yet it explains 53.6 per cent of Quebec's labour productivity growth. Conversely, capital intensity growth was responsible for only 30.5 per cent of the growth in labour productivity for Quebec and 56.1 per cent for Canada. Labour quality explains 17.5 per cent of labour productivity growth in Canada, and about the same in Quebec, 15.1 per cent.

Chart 6: Percentage Point Contribution to Labour Productivity Growth by the Source of Labour Productivity Growth in the Market Sector in Quebec 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 Quebec 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 Quebec 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 Quebec, 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	0.5	0.2	0.3	0.9	0.3
Agriculture, Forestry, Fishing and Hunting	3.8	0.5	2.7	-2.2	2.9	0.4
Mining, and Oil and Gas Extraction	0.1	0.3	-1.5	1.8	-0.3	0.1
Utilities	-1.5	-2.2	-0.2	-2.0	0.6	0.1
Construction	2.2	0.8	0.0	0.7	1.5	-0.1
Manufacturing	2.4	0.1	-0.5	0.6	1.9	0.4
Wholesale Trade	3.4	1.9	0.2	1.8	1.2	0.2
Retail Trade	2.9	1.1	0.1	0.9		0.1
Transportation and Warehousing	0.4	0.9	0.3	0.6	-0.8	0.4
Information and Cultural Industries	1.3	-0.6	-0.3	-0.3	1.9	0.0
FIRE*	1.1	1.5	0.6	0.9	-0.6	0.1
Professional, Scientific and Technical Services	1.4	1.5	0.0	1.5	-0.6	0.6
ASWMR**	1.1	-0.1	0.0	-0.1	1.4	-0.2
Arts, Entertainment and Recreation	-0.4	0.5	0.3	0.2	-0.8	-0.1
Accommodation and Food Services	1.7	0.4	0.1	0.4	1.2	0.1
Other Services (Except Public Administration)	3.3	1.4	0.4	1.0	1.6	0.2
Per Cent Contributions to Labour Productivity Growth						
Market Sector	100.0	30.7	12.6	18.0	53.6	15.1
Agriculture, Forestry, Fishing and Hunting	100.0	13.2	70.6	-57.3	76.0	10.1
Mining, and Oil and Gas Extraction	100.0	241.4	-1037.0	1257.0	-182.1	41.2
Utilities	100.0	143.8	12.6	131.3	-39.0	-5.7
Construction	100.0	35.9	2.1	33.7	67.2	-3.6
Manufacturing	100.0	6.0	-21.0	27.0	78.7	14.8
Wholesale Trade	100.0	57.3	4.6	52.4	36.3	5.5
Retail Trade	100.0	36.5	4.0	32.3		2.8
Transportation and Warehousing	100.0	204.5	60.9	141.3	-199.7	96.9
Information and Cultural Industries	100.0	-47.7	-20.6	-26.9	147.2	1.4
FIRE*	100.0	143.1	59.4	82.0	-53.3	10.9
Professional, Scientific and Technical Services	100.0	104.2	-1.7	106.1	-42.9	38.9
ASWMR**	100.0	-7.7	-2.6	-5.1	128.0	-19.8
Arts, Entertainment and Recreation	100.0	-141.5	-85.3	-54.5	218.7	21.7
Accommodation and Food Services	100.0	24.8	3.5	21.2	68.6	6.2
Other Services (Except Public Administration)	100.0	43.0	11.1	31.3	50.5	5.6

Source: CSL 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

Quebec's labour productivity level in 2007 was 98.8 per cent of the Canadian level, which implies a labour productivity gap of 1.2 percentage points. Table 8 shows that the gap was caused predominantly by the market sector's low capital intensity level, which was responsible for 4.1 percentage points of the gap (or 342.7 per cent of the gap). Multifactor productivity was actually higher in Quebec than Canada, and reduced the differential by 3.2 percentage points (-273.3 per cent of the gap).¹² Labour quality accounted for 0.4 percentage points of the gap (30.6 per cent of the gap).

Quebec had a negative labour productivity gap in nine of the 15 two-digit NAICS industries. Capital intensity was the largest contributor to the gap in three of the nine industries with gaps, while multifactor productivity was the most responsible in the other six. The level of capital intensity lowers labour productivity relative to the national level in nine of 15 industries, while multifactor productivity and labour quality each do so in seven industries. Mining, oil and gas extraction must be singled out both for its high multifactor productivity and low capital intensity levels in Quebec; capital intensity was responsible for 91.9 per cent of the gap whereas multifactor productivity increased labour productivity relative to Canada by 52.1 percentage points.

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

	Labour Productivity		Percentage Point Contributions to Labour Productivity Gap			Percent Contributions to Labour Productivity Gap			
	Relative Level	Productivity Gap	Capital Intensity	Multifactor Productivity	Labour Quality	Labour Productivity	Capital Intensity	Multifactor Productivity	Labour Quality
Market Sector	98.8	-1.2	-4.1	3.2	-0.4	100.0	342.7	-273.3	30.6
Agriculture, Forestry, Fishing and Hunting	107.4	7.4	-0.9	8.5	-0.2	100.0	-12.4	114.9	-2.6
Mining, and Oil and Gas Extraction	60.3	-39.7	-91.9	52.1	0.1	100.0	231.8	-131.4	-0.4
Utilities	121.3	21.3	9.6	10.9	0.8	100.0	45.1	51.4	3.6
Construction	121.1	21.1	18.7	4.1	-1.7	100.0	88.6	19.6	-8.2
Manufacturing	97.1	-2.9	-0.2	-4.0	1.4	100.0	8.2	138.6	-46.8
Wholesale Trade	90.0	-10.0	2.7	-12.6	-0.1	100.0	-27.1	125.8	1.3
Retail Trade	97.2	-2.8	3.9	-6.7	0.0	100.0	-137.3	237.3	0.1
Transportation and Warehousing	93.8	-6.2	-3.2	-3.9	0.9	100.0	51.2	62.8	-14.1
Information and Cultural Industries	92.9	-7.1	-9.1	4.4	-2.3	100.0	129.7	-62.6	32.9
FIRE*	96.8	-3.2	4.1	-6.7	-0.6	100.0	-129.4	210.9	18.5
Professional, Scientific and Technical Services	97.4	-2.6	-1.3	-1.8	0.4	100.0	48.2	68.3	-16.5
ASWMR**	106.9	6.9	-15.9	25.1	-2.3	100.0	-230.5	364.1	-33.6
Arts, Entertainment and Recreation	116.9	16.9	-1.0	18.4	-0.5	100.0	-6.2	109.4	-3.2
Accommodation and Food Services	96.9	-3.1	-3.3	0.7	-0.5	100.0	105.1	-22.2	17.0
Other Services (Except Public Administration)	106.0	6.0	10.6	-3.2	-1.4	100.0	177.3	-54.2	-23.1

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

¹² 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, Quebec experienced comparatively high growth rates of capital productivity (0.4 per cent per year) and multifactor productivity (0.9 per cent), and above average labour productivity growth rates (1.8 per cent). The high growth rates in labour and capital productivity was driven by strong multifactor productivity growth. The per cent contribution to growth of capital stock, capital composition and labour quality to labour productivity growth were all lower in Quebec than in Canada as a whole.

Quebec's capital productivity level in 2007 was well above national level. The multifactor productivity level was also above the national level, standing at 103.3 per cent of the national level and ranking 3rd among all provinces. The labour productivity level in Quebec was slightly below that of Canada, creating a labour productivity gap of 1.2 percentage points. This was due mainly to the low capital intensity level in Quebec, which explains more than 100 per cent of the gap.

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 Quebec fared in comparison to the other provinces. A key observation is that, while Quebec performed strongly regarding capital and multifactor productivity growth and levels, performance was poor with regards to capital intensity growth and level. Another core observation is that growth was heavily driven by multifactor productivity.

Table 9: Summary of Quebec'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	Market Sector Rank	Equally Weighted Market Sector Rank	1997	2007	Market Sector Rank	Equally Weighted Market Sector Rank
Labour Productivity	1.8	6	6	98.3	98.8	4	3
Capital Productivity	0.4	2	1	98.4	108.8	5	4
Multifactor Productivity	0.9	3	1	98.2	103.3	3	2
Capital Intensity	1.3	9	10	100.0	90.8	3	4
Labour Quality	0.5	7	3	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

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

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):

$$L = H * QL \quad (2)$$

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

$$K = SK * QK \quad (3)$$

Capital intensity (KI) is defined as:

$$KI = \frac{K}{H} \quad (4)$$

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

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

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:

$$\ln(\text{Relative MFP}_{p,i}) = \ln\left(\frac{A_{p,i}}{A_{c,i}}\right) = \ln\left(\frac{Y_{p,i}}{Y_{c,i}}\right) - k_{p,c} * \ln\left(\frac{K_{p,i}}{K_{c,i}}\right) - (1 - k_{p,c}) * \ln\left(\frac{L_{p,i}}{L_{c,i}}\right) \quad (6)$$

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:

$$\ln(\text{Relative LP}_{p,i}) = \ln\left(\frac{A_{p,i}}{A_{c,i}}\right) + k_{p,c} * \ln\left(\frac{KI_{p,i}}{KI_{c,i}}\right) + (1 - k_{p,c}) * \ln\left(\frac{QL_{p,i}}{QL_{c,i}}\right) \quad (7)$$

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