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CENTRE FOR THE STUDY OF LIVING STANDARDS

An Analysis of Alberta's Productivity, 1997-2007: Falling Productivity in Mining, and Oil and Gas Extraction Severely Dampens Market Sector Labour Productivity Growth

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Executive Summary

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

- Alberta's labour productivity grew at an average annual rate of 1.0 per cent during the 1997-2007 period, well below the national average of 1.7 per cent per year. In terms of labour productivity, Alberta's performance ranked 10th among the provinces due to poor performance in its largest sector, mining, and oil and gas extraction. However, Alberta ranked 1st using the equally weighted rankings due to strong growth in most industries.
- The following two industries in Alberta enjoyed the highest labour productivity growth rates in Canada when compared to equivalent industries in the other provinces: retail trade (4.9 per cent per year), and information and cultural industries (5.3 per cent).
- Labour productivity growth in both Alberta and Canada was driven mainly by increases in capital intensity. However, capital intensity growth played a much larger role in Alberta, where it amounted to over 100 per cent of growth as multifactor productivity experienced a decline. Indeed capital intensity growth was the fastest among the ten provinces.
- Alberta's labour productivity level was $39.4 (1997 dollars) per hour in 1997, which represents 109.3 per cent of the Canadian level. This, in turn, implies a positive labour productivity differential of 9.3 percentage points. The differential was caused by high capital intensity, and reduced by below average multifactor productivity and labour quality.
- Alberta had a lower labour productivity level than the national average in only 3 of the 15 two-digit NAICS industries: mining, and oil and gas extraction, wholesale trade and arts, entertainment and recreation. In every case the below average multifactor productivity level was the main cause.
- Capital productivity in Alberta's market sector declined at a rate of 3.4 per cent per year during the 1997-2007 period, the worst performance among the provinces. This reflected a rapid growth in capital stock and hence capital intensity.
- Alberta's multifactor productivity declined at an average rate of 1.6 per cent per year during the 1997-2007 period, well below the national average and the lowest growth rate experienced by any province

An Analysis of Alberta's Productivity, 1997-2007: Falling Productivity in Mining, and Oil and Gas Extraction Severely Dampens Market Sector Labour Productivity 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 Alberta'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 Alberta'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 Alberta's industry composition by nominal GDP and total hours worked. Sections three through nine detail Alberta'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 input aggregate vary whether we are calculating MFP using a gross output basis or a value

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

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 Alberta'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 shares for 1997 and 2007. In Alberta, the industry that had the highest GDP share in 2007 was mining, and oil and gas extraction (34.0 per cent of the province's nominal GDP in the market sector), followed by construction (11.9 per cent) and finance, insurance, real estate, rental and leasing (8.9 per cent). In terms of total hours worked, the three industries that had the highest contributions in 2007 were construction (18.0 per cent of total hours worked), retail trade (11.2 per cent), and other services (excluding public services) (8.8 per cent).

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

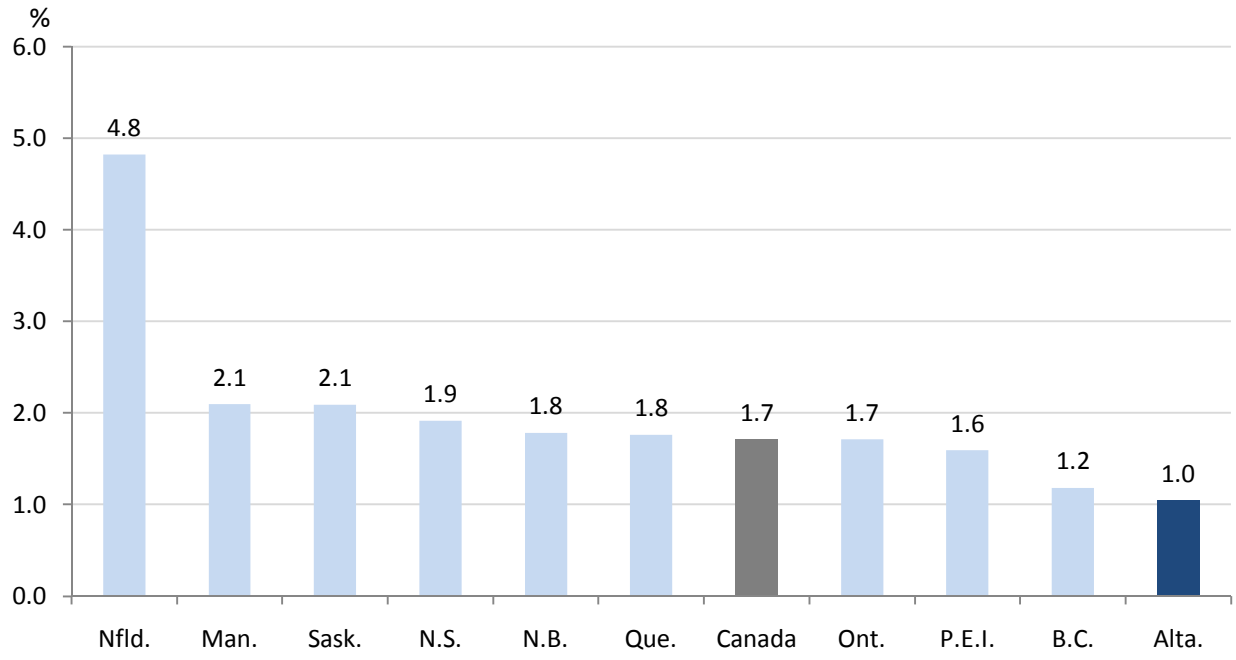
	1997				2007			
	GDP		Hours Worked		GDP		Hours Worked	
	Canada	Alberta	Canada	Alberta	Canada	Alberta	Canada	Alberta
Market Sector	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Agriculture, Forestry, Fishing and Hunting	3.2	3.5	5.4	8.4	2.1	1.7	3.4	3.5
Mining, and Oil and Gas Extraction	5.5	24.9	1.7	7.5	11.1	34.0	2.0	8.5
Utilities	4.2	3.1	0.9	0.5	3.0	1.9	0.8	0.5
Construction	7.0	8.5	7.9	10.2	9.0	11.9	10.1	18.0
Manufacturing	23.2	13.0	18.3	9.9	16.8	8.7	14.8	8.4
Wholesale Trade	7.1	6.0	7.4	7.1	7.1	5.0	6.9	6.3
Retail Trade	6.9	5.2	13.1	11.5	7.4	5.2	12.9	11.2
Transportation and Warehousing	6.2	6.7	6.3	7.4	5.6	5.4	6.6	7.0
Information and Cultural Industries	4.3	3.2	2.5	2.1	4.3	2.8	2.7	1.7
FIRE*	15.0	10.7	7.5	6.0	14.6	8.9	7.8	5.9
Professional, Scientific and Technical Services	4.9	5.0	6.3	7.3	6.2	5.4	7.9	8.1
ASWMR**	2.5	2.0	4.0	3.4	3.3	2.2	5.7	4.3
Arts, Entertainment and Recreation	0.9	0.7	1.5	1.4	0.9	0.5	1.9	1.6
Accommodation and Food Services	3.2	3.1	7.8	8.4	2.8	2.3	7.0	6.1
Other Services (Except Public Administration)	5.7	4.4	9.4	8.8	5.8	4.0	9.5	8.8

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 1.0 per cent per year in Alberta's market sector during the 1997-2007 period, which was well below the national average of 1.7 per cent per year. Alberta ranked last among the provinces in terms of labour productivity growth (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 period in question, the industry that experienced the highest labour productivity growth rate in Alberta was agriculture, forestry, fishing and hunting (7.3 per cent per year), followed by information and cultural industries (5.3 per cent), and retail trade (4.9 per cent) (Table 2). The industry that had the lowest labour productivity growth rate was mining, and oil and gas extraction (-4.3 per cent per year), followed by arts, entertainment and recreation (-2.2 per cent), and utilities (-1.4 per cent).

In terms of labour productivity growth, the province ranked 7th or below in only three of the 15 two-digit NAICS industries, none of which ranked 10th. Furthermore, it ranked 3rd or above in seven of the 15 two-digit NAICS industries. In particular, Alberta ranked 1st in the following two industries: retail trade and information and cultural industries. Strong relative growth rates were reflected in Alberta attaining the highest equally weighted market sector rank for labour productivity growth; while the market sector in total performed poorly, this was largely due to the productivity performance of one industry, the negative productivity growth mining, and oil and gas extraction, which accounted for a third of nominal GDP.

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

Alberta's labour productivity level in 2007 was $39.40 (1997 dollars) per hour, which represents 109.3 per cent of the Canadian level, down from 116.8 per cent in 1997. Alberta had the 2nd highest labour productivity level in Canada in 2007, below only Newfoundland.

In 2007, 12 of the 15 two-digit NAICS industries in Alberta had labour productivity levels above Canada's. The industries with the highest relative labour productivity levels in the province were: utilities (135.8 per cent of the Canadian level), information and cultural industries (127.7 per cent), and construction (124.8 per cent). The industries that had the lowest levels in the province were: arts, entertainment and recreation (79.1 per cent of the Canadian level), wholesale trade (92.6 per cent), and mining, and oil and gas extraction (95.5 per cent).

In terms of labour productivity levels, the province ranked 3rd or above in 10 of the 15 two-digit NAICS industries. Alberta had six industries ranked 1st among all the provinces: construction, manufacturing, retail trade, finance, insurance, real estate, rental and leasing, administrative and support, waste management and remediation services and accommodation and food services. There were no industries ranked lower than 6th in Alberta. On an equally weighted basis, Alberta's market sector had the highest productivity level in Canada.

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

	Compound Annual Growth Rate, 1997-2007	Provincial Ranking	Province's Labour Productivity Level Relative to Canada's (Canada=100)		Labour Productivity Level, 2007	Provincial Ranking, 2007
	(per cent)		1997	2007	(1997 Dollars)	
Market Sector	**1.0**	**10**	**116.8**	**109.3**	**39.4**	**2**
Agriculture, Forestry, Fishing and Hunting	7.3	3	81.7	109.4	29.7	4
Mining, and Oil and Gas Extraction	-4.3	7	118.2	95.5	75.2	6
Utilities	-1.4	7	141.7	135.8	182.8	2
Construction	3.0	2	110.1	124.8	39.8	1
Manufacturing	2.2	4	120.4	119.4	57.1	1
Wholesale Trade	2.7	8	102.6	92.6	38.8	6
Retail Trade	4.9	1	99.7	115.6	25.5	1
Transportation and Warehousing	1.3	2	107.7	114.7	36.4	2
Information and Cultural Industries	5.3	1	102.5	127.7	87.6	2
FIRE*	2.0	4	102.5	107.7	75.7	1
Professional, Scientific and Technical Services	1.8	3	100.9	106.1	28.6	2
ASWMR**	0.8	5	106.3	110.8	21.9	1
Arts, Entertainment and Recreation	-2.2	4	87.4	79.1	12.8	6
Accommodation and Food Services	2.4	2	105.5	120.3	16.6	1
Other Services (Except Public Administration)	1.9	6	103.1	100.8	16.4	4
Absolute Equally Weighted Average Rank		3.9				2.7
Equally Weighted Market Sector Rank		1				1

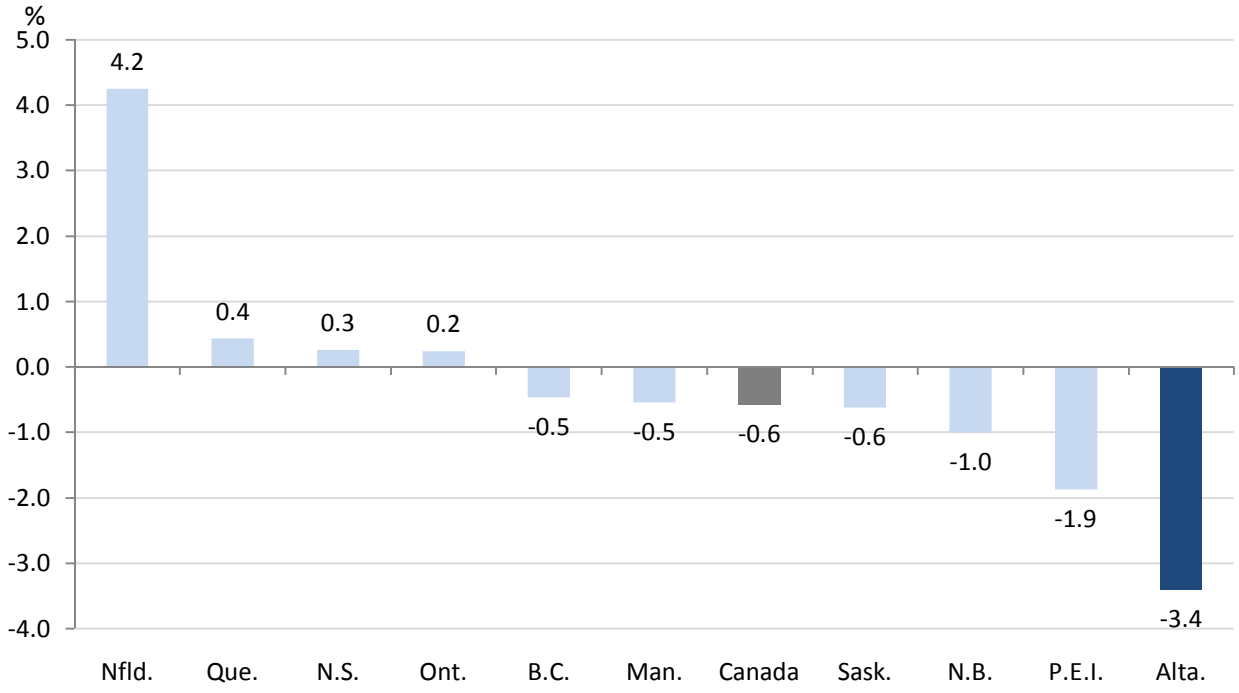
Source: CSLS Provincial Productivity Database, Appendix Tables, http://www.csls.ca/data/mfp_new.asp.
*Finance, insurance, real estate, rental and leasing **Administrative and support, waste management and remediation services

IV. Capital Productivity

Capital productivity, defined as real GDP per unit of capital services, declined at a rate of 3.4 per cent per year in Alberta's market sector during the 1997-2007 period, far below the national average and well below every other province. Alberta ranked 10th in Canada in terms of capital productivity growth (Chart 2).

In Alberta, 11 of the 15 two-digit NAICS industries had negative capital productivity growth rates during the period. The industries that experienced the worst performances were: professional, scientific and technical services (-8.6 per cent per year), Mining, and Oil and Gas extraction (-8.3 per cent), and arts, entertainment and recreation (-7.7 per cent) (Table 3). The industries that had the best performances were: construction (12.3 per cent per year), agriculture, forestry, fishing and hunting (2.3 per cent), and retail trade (2.3 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.

At the industry level, most industries in Alberta fared poorly compared to their counterparts in other provinces. In fact, nine of the 15 two-digit NAICS industries ranked 7th or below. The following three industries were ranked 10th in Canada in terms of capital productivity growth rates: manufacturing, transportation and warehousing, and accommodation and food services. Only two industries ranked 3rd or above, construction ranked 1st, and retail trade ranked 2nd.

Alberta's capital productivity level in the market sector in 2007 was 61.0 per cent of the Canadian level, down from 81.4 per cent in 1997. Only two of the 15 two-digit NAICS industries in the province had

capital productivity levels above the Canadian average: construction (232.9 per cent of the Canadian level) and retail trade (132.5 per cent). The industries with the lowest capital productivity levels in the province were: administrative and support, waste management and remediation services (59.7 per cent of the Canadian level), other services (except public administration) (69.5 per cent) and utilities (69.8 per cent).

Alberta's low market sector capital productivity level manifested itself in many industries, as reflected in eight of the 15 two-digit NAICS industries being ranked 7th or below. In particular, Alberta ranked 10th place in the following three industries: manufacturing, transportation and warehousing and accommodation and food services. The main exception to the overall low capital productivity levels at the industry level was construction, which ranked 1st in Canada.

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

	Compound Annual Growth Rate, 1997-2007	Provincial Ranking	Province's Capital Productivity Level Relative to Canada's (Canada=100)		Capital Productivity Level, 2007	Provincial Ranking, 2007
	(per cent)		1997	2007	(1997 Dollars)	
Market Sector	**-3.4**	**10**	**81.4**	**61.0**	**1.40**	**10**
Agriculture, Forestry, Fishing and Hunting	2.3	5	85.4	87.9	1.84	8
Mining, and Oil and Gas Extraction	-8.3	9	93.4	70.5	0.55	9
Utilities	-2.7	9	91.7	69.8	0.90	9
Construction	12.3	1	84.1	232.9	15.91	1
Manufacturing	0.6	7	79.5	71.8	1.96	10
Wholesale Trade	-2.2	9	98.6	80.2	2.55	9
Retail Trade	2.3	2	95.4	132.5	6.07	2
Transportation and Warehousing	-2.5	6	82.4	77.8	1.87	10
Information and Cultural Industries	-0.6	7	99.0	88.4	1.70	7
FIRE*	-1.8	5	102.3	93.4	1.53	3
Professional, Scientific and Technical Services	-8.6	7	109.7	89.6	2.19	5
ASWMR**	-6.9	9	92.1	59.7	1.84	9
Arts, Entertainment and Recreation	-7.7	8	98.9	70.3	1.45	7
Accommodation and Food Services	-0.6	5	76.8	75.3	3.24	10
Other Services (Except Public Administration)	-3.3	9	89.5	69.5	3.70	9
Absolute Equally Weighted Average Rank		6.5				7.2
Equally Weighted Market Sector Rank		**9**				**10**

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

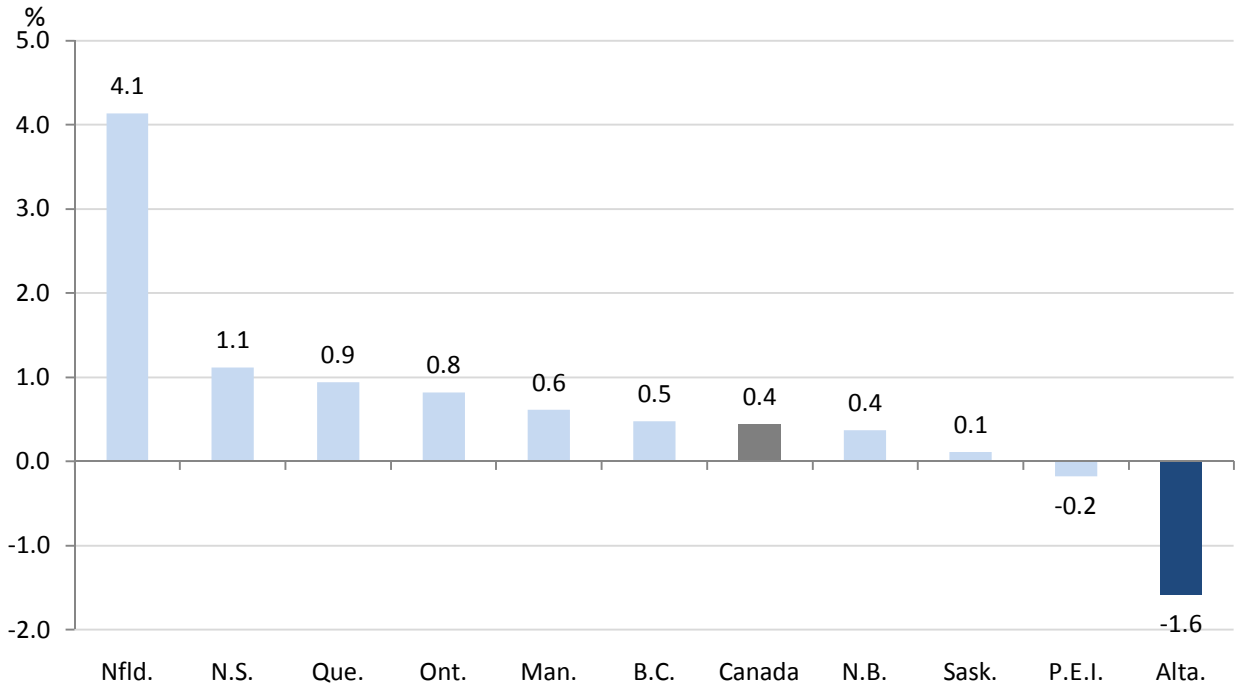
V. Multifactor Productivity

Alberta's multifactor productivity in the market sector declined at a rate of 1.6 per cent per year during the 1997-2007 period, a growth rate far lower than the national average, which grew at an average annual rate of 0.4 per cent. The province ranked last in Canada in terms of multifactor productivity growth (Chart 4).

The industry that experienced the highest multifactor productivity growth rate in Alberta was construction (4.6 per cent per year), followed by retail trade (4.4 per cent), and agriculture, forestry, fishing and hunting (3.1 per cent). The industries that had the lowest multifactor productivity growth rates were mining, and oil and gas extraction (-7.4 per cent per year), arts, entertainment and recreation (-3.7 per cent), and utilities (-2.4 per cent).

Although the province ranked last in Canada in terms of its market sector rank, its equally-weighted market sector rank was significantly higher, at 4th place. Of the 15 two-digit NAICS industries, five were ranked at 7th place or lower, and none of those ranked 10th. In contrast, six industries were ranked 3rd or higher. Two industries, construction and retail trade, were ranked 1st in Canada. Again, the poor overall performance was driven by the massive decline in multifactor productivity in mining, and oil and gas extraction.

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 was 81.6 per cent of the Canadian level in 2007, down from 100.0 per cent in 1997. Consistent with this low level at the market sector, at the industry level only six

of the 15 two-digit NAICS industries in Alberta had multifactor productivity level above Canada's. The industries with the highest relative multifactor productivity levels in the province were: construction (146.4 per cent of the Canadian level), retail trade (123.0 per cent), and accommodation and food services (107.2 per cent). In contrast, the industries with the lowest relative multifactor productivity levels in the province were: Mining, and Oil and Gas extraction (73.7 per cent of the Canadian level), arts, entertainment and recreation (74.7 per cent), and utilities (80.5 per cent).

Despite the second-worst multifactor productivity level ranking, Alberta did quite well using the equally weighted market sector, with a rank of 4th. At the industry level, six of the 15 two-digit NAICS industries ranked 3rd or above, while only three ranked 7th or below. In particular, Alberta's construction, retail trade and accommodation and food services industries ranked 1st in Canada. Again, the low multifactor productivity level of mining, and oil and gas extraction caused by the exploitation of increasingly capital intensive oil sands projects explains this situation.

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

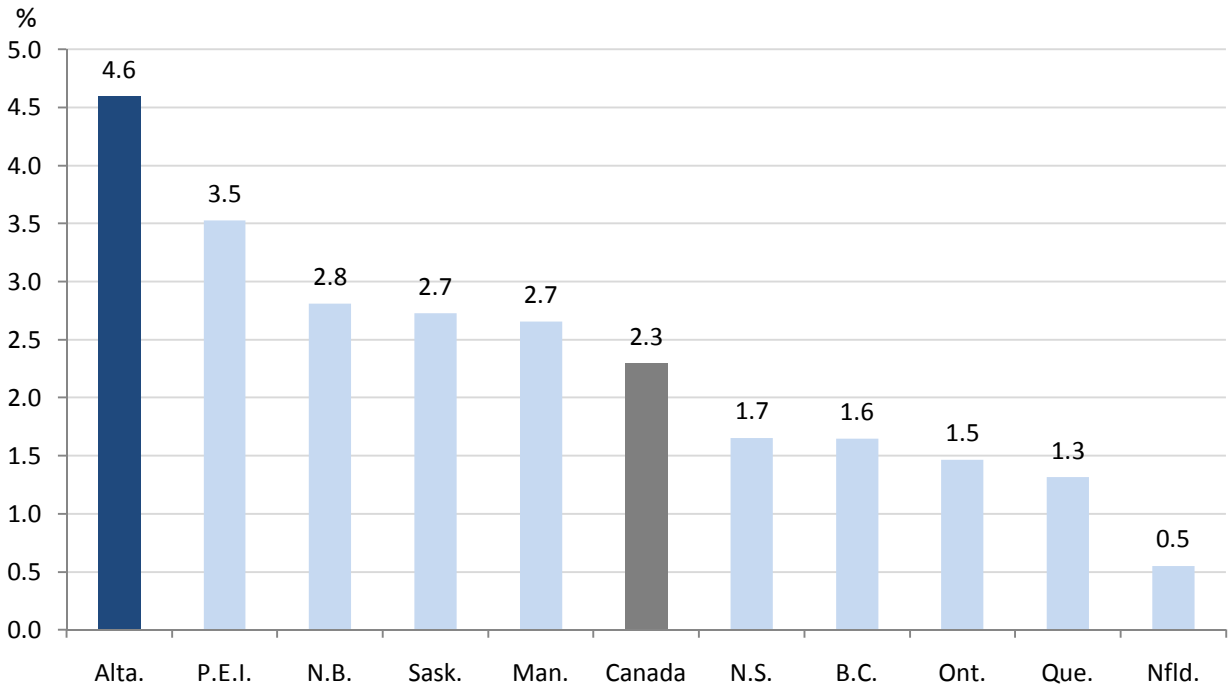
	Compound Annual Growth Rate, 1997-2007	Provincial Ranking	Province's Multifactor Productivity Level Relative to Canada's (Canada=100)		Provincial Ranking, 2007
	(per cent)		1997	2007	
Market Sector	**-1.6**	**10**	**100.0**	**81.6**	**9**
Agriculture, Forestry, Fishing and Hunting	3.4	3	86.8	94.3	6
Mining, and Oil and Gas Extraction	-7.4	9	97.4	73.7	9
Utilities	-2.4	9	100.1	80.5	8
Construction	4.6	1	109.8	146.4	1
Manufacturing	1.4	5	101.4	97.5	3
Wholesale Trade	0.9	8	101.7	89.2	6
Retail Trade	4.4	1	98.6	123.0	1
Transportation and Warehousing	-0.5	4	99.1	99.0	4
Information and Cultural Industries	1.6	5	101.1	102.3	4
FIRE*	0.0	3	102.7	102.7	2
Professional, Scientific and Technical Services	-0.6	3	103.3	104.4	2
ASWMR**	-0.9	7	103.4	98.3	4
Arts, Entertainment and Recreation	-3.7	5	88.8	74.7	6
Accommodation and Food Services	1.5	2	97.9	107.2	1
Other Services (Except Public Administration)	0.5	8	100.0	93.6	7
Absolute Equally Weighted Average Rank		4.9			4.3
Equally Weighted Market Sector Rank		**4**			**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

VI. Capital Intensity

Capital intensity, defined as capital services per hour worked (unadjusted for labour quality), grew at an average rate of 4.6 per cent per year in Alberta's market sector during the 1997-2007 period, below the national average of 2.3 per cent per year. Alberta ranked 1st among the ten provinces in terms of capital intensity growth, and well ahead of the nearest province (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 the period, the industries that experienced the highest capital intensity growth rates in the province were professional, scientific and technical services (11.5 per cent per year), administrative and support, waste management and remediation services (8.2 per cent), and arts, entertainment and recreation (6.0 per cent). Conversely, the industries that had the lowest growth rates in the province were construction (-8.2 per cent per year), utilities (1.4 per cent), and manufacturing (1.5 per cent).

Alberta's top market sector ranking manifested itself at the industry level with seven of the 15 two-digit NAICS industries ranked 3rd or higher, and only two ranked 7th or below. While no industry ranked 1st, there were five ranked 2nd: agriculture, forestry, fishing and hunting, manufacturing, wholesale trade, information and cultural industries and administrative and support, waste management and remediation services. Though most industries in Alberta high capital intensity growth relative to their counterparts in other provinces, construction was an important exception ranking 10th, the only industry in Alberta to do so.

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

	Compound Annual Growth Rate, 1997-2007	Provincial Ranking	Province's Capital Intensity Level Relative to Canada's (Canada=100)		Capital Intensity Level, 2007	Provincial Ranking, 2007
	(per cent)		1997	2007	(1997 Dollars)	
Market Sector	**4.6**	**1**	**143.4**	**179.1**	**28.1**	**1**
Agriculture, Forestry, Fishing and Hunting	4.9	2	95.4	124.4	16.1	3
Mining, and Oil and Gas Extraction	4.4	4	126.4	135.5	137.7	1
Utilities	1.4	4	155.0	194.5	203.0	1
Construction	-8.2	10	130.9	53.6	2.5	9
Manufacturing	1.5	2	152.0	166.4	29.2	1
Wholesale Trade	5.0	2	104.1	115.5	15.2	3
Retail Trade	2.6	9	104.1	87.2	4.2	5
Transportation and Warehousing	3.9	3	131.3	147.3	19.4	1
Information and Cultural Industries	6.0	2	104.6	146.5	52.2	1
FIRE*	3.9	6	100.0	115.2	49.3	4
Professional, Scientific and Technical Services	11.5	4	91.7	118.4	13.1	4
ASWMR**	8.2	2	115.2	185.5	11.9	1
Arts, Entertainment and Recreation	6.0	3	88.0	112.6	8.8	4
Accommodation and Food Services	3.0	4	137.9	159.8	5.1	1
Other Services (Except Public Administration)	5.4	4	115.4	145.0	4.4	2
Absolute Equally Weighted Average Rank		4.1				2.7
Equally Weighted Market Sector Rank		**1**				**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

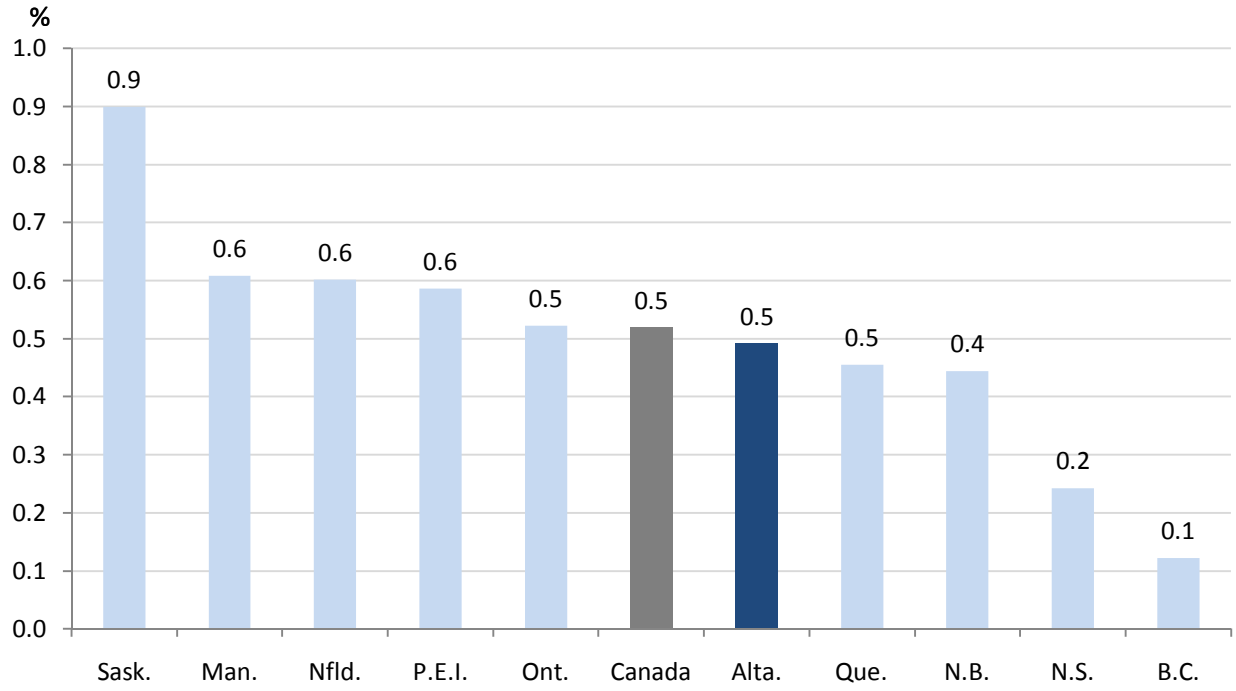
Alberta's capital intensity level was 179.1 per cent of the Canadian level in 2007, up from 143.4 per cent in 1997. Of the 15 two-digit NAICS industries, 13 had levels above the national average in 2007. The industries with the highest relative capital intensity levels in the province were utilities (194.5 per cent of the Canadian level), administrative and support, waste management and remediation services (185.5 per cent), and manufacturing (166.4 per cent).

In terms of capital intensity levels, Alberta's market sector ranked 1st in Canada in 2007 (the province also ranked 1st according to the equally-weighted market sector ranking). A very high proportion, 13 of the 15 two-digit NAICS industries in the province, ranked 4th or above. Seven of the industries were ranked 1st in Canada, including: mining, and oil and gas extraction, utilities, manufacturing, transportation and warehousing, information and cultural industries, administrative and support, waste management and remediation services and accommodation and food services. The lowest rank was in construction, which ranked 9th.

VII. Labour Quality

Alberta's labour quality grew at an average rate of 0.5 per cent per year during the 1997-2007 period, roughly the same as the national average. The province ranked 6th 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 in the province were agriculture, forestry, fishing and hunting (1.4 per cent per year), information and cultural industries (0.7 per cent), and transportation and warehousing (0.4 per cent). The industries that had the lowest labour quality growth rates were administrative and support, waste management and remediation services (-0.4 per cent per year), retail trade (-0.2 per cent) and finance, insurance, real estate, rental and leasing (-0.2 per cent).

Industries in Alberta generally ranked poorly for labour quality growth. Alberta had six industries ranked 3rd or above, but six ranked 7th or below. There were three industries where Alberta did especially poorly, ranking last out of all provinces: retail trade, finance, insurance, real estate, rental and leasing and administrative and support, waste management and remediation services. The two strong exceptions to Alberta's generally poor performance were agriculture, forestry, fishing and hunting and mining, and oil and gas extraction, both of which ranked 1st.

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

	Compound Annual Growth Rate, 1997-2007	Provincial Ranking	Province's Labour Quality Level Relative to Canada's (Canada=100)		Rank, 2007
	(per cent)		1997	2007	
Market Sector	**0.5**	**6**	**100.0**	**99.72**	**6**
Agriculture, Forestry, Fishing and Hunting	1.4	1	100.0	104.6	1
Mining, and Oil and Gas Extraction	0.2	1	100.0	101.9	1
Utilities	0.2	4	100.0	101.1	4
Construction	0.1	6	100.0	99.5	6
Manufacturing	0.2	7	100.0	97.6	7
Wholesale Trade	0.1	6	100.0	97.7	6
Retail Trade	-0.2	10	100.0	96.5	10
Transportation and Warehousing	0.4	7	100.0	100.0	7
Information and Cultural Industries	0.7	3	100.0	101.1	3
FIRE*	-0.2	10	100.0	94.4	10
Professional, Scientific and Technical Services	0.4	6	100.0	97.9	6
ASWMR**	-0.4	10	100.0	96.0	10
Arts, Entertainment and Recreation	0.3	5	100.0	103.6	5
Accommodation and Food Services	0.2	5	100.0	99.6	5
Other Services (Except Public Administration)	0.1	7	100.0	97.3	7
Absolute Equally Weighted Average Rank		5.9			5.9
Equally Weighted Market Sector Rank		**7**			**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

[10] Labour quality levels are not shown here because they are assumed to be the same (and equal to 100.0) across all provinces and in Canada 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 Alberta's market sector grew at an average annual rate of 0.49 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, Alberta's labour quality level was 99.72 per cent of the Canadian level in 2007.

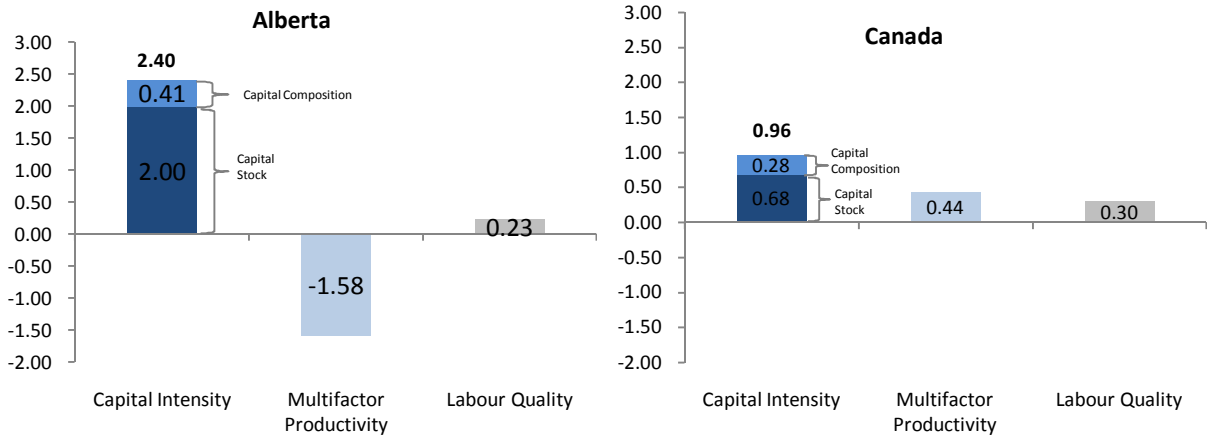
VIII. Sources of Labour Productivity Growth in the Market Sector

Alberta's labour productivity grew at an average rate of 1.0 per cent per year during the 1997-2007 period, the lowest in the country and well below the national average, which grew at an average annual rate of 1.7 per cent. Charts 6 and 7 show both the percentage point and per cent contributions to labour productivity growth by the sources of growth for Alberta and Canada over the 1997-2007 period.

Alberta's labour productivity growth was driven mainly by capital intensity, which accounted for 2.40 percentage points of the overall labour productivity growth (or, alternatively, 231.4 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 0.41 percentage points of labour productivity growth (39.1 per cent), and capital stock growth, which accounted for 2.00 percentage points (192.4 per cent). Labour quality growth was responsible for 0.23 percentage points of labour quality growth (22.1 per cent). There was a large negative contribution to growth from multifactor productivity growth; multifactor productivity was responsible for -1.58 percentage points of growth (-152.5 per cent).

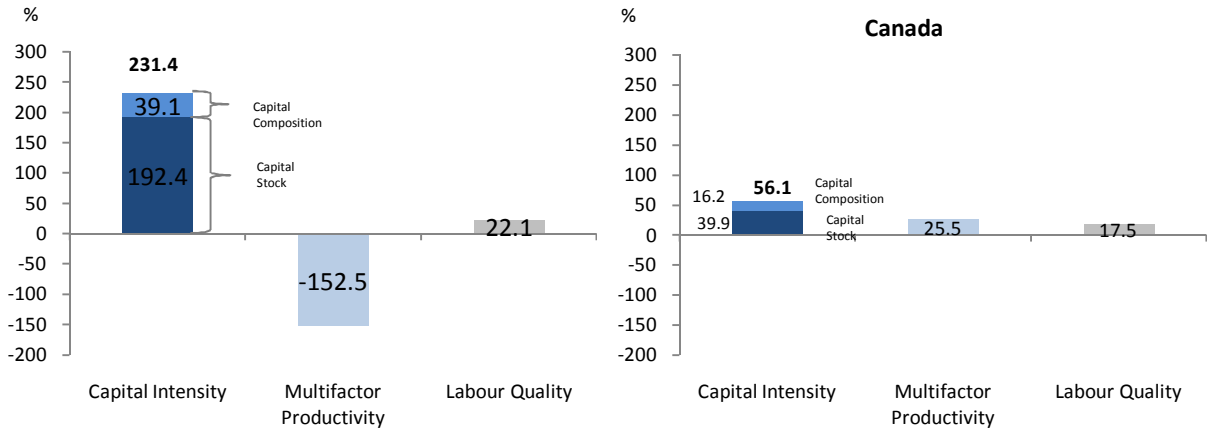
The causes of growth in labour productivity were very different between Canada and Alberta. Alberta's large negative multifactor productivity growth was a major difference compared to Canada, where multifactor productivity was responsible for over a quarter of growth. Alberta experienced capital intensity growth on a scale far beyond that enjoyed by Canada, and thus capital intensity was far more important to labour productivity growth for the former than the latter.

Chart 6: Percentage Point Contribution to Labour Productivity Growth by the Source of Labour Productivity Growth in the Market Sector in Alberta 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 Alberta 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 Alberta 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 Alberta, 1997-2007

	Labour Productivity	Capital Intensity			MFP	Labour Quality
		Total	Capital Composition	Capital Stock		
	Percentage Point Contributions to Labour Productivity Growth					
Market Sector	**1.0**	**2.4**	**0.4**	**2.0**	**-1.6**	**0.2**
Agriculture, Forestry, Fishing and Hunting	7.3	3.3	-0.6	3.9	3.4	0.4
Mining, and Oil and Gas Extraction	-4.3	3.3	0.2	3.1	-7.4	0.1
Utilities	-1.4	1.0	0.3	0.7	-2.4	0.0
Construction	3.0	-1.5	0.1	-1.6	4.6	0.1
Manufacturing	2.2	0.7	0.2	0.5	1.4	0.1
Wholesale Trade	2.7	1.8	0.1	1.7	0.9	0.0
Retail Trade	4.9	0.6	0.0	0.6		-0.2
Transportation and Warehousing	1.3	1.6	0.6	1.0	-0.5	0.3
Information and Cultural Industries	5.3	3.3	0.6	2.7	1.6	0.3
FIRE*	2.0	2.0	0.7	1.3	0.0	-0.1
Professional, Scientific and Technical Services	1.8	2.1	0.1	2.0	-0.6	0.3
ASWMR**	0.8	2.0	0.1	1.9	-0.9	-0.3
Arts, Entertainment and Recreation	-2.2	1.3	0.6	0.6	-3.7	0.3
Accommodation and Food Services	2.4	0.8	0.1	0.7	1.5	0.1
Other Services (Except Public Administration)	1.9	1.3	0.2	1.1	0.5	0.1
	Per Cent Contributions to Labour Productivity Growth					
Market Sector	**100.0**	**233.9**	**39.1**	**192.4**	**-152.5**	**22.1**
Agriculture, Forestry, Fishing and Hunting	100.0	45.2	-8.4	53.5	46.8	6.0
Mining, and Oil and Gas Extraction	100.0	-76.2	-4.3	-71.5	172.1	-1.6
Utilities	100.0	-76.0	-23.0	-52.3	175.9	-1.7
Construction	100.0	-50.4	3.6	-53.9	150.8	1.9
Manufacturing	100.0	32.2	10.0	22.0	63.0	4.4
Wholesale Trade	100.0	65.9	2.9	62.8	32.1	1.4
Retail Trade	100.0	12.5	0.5	12.0		-3.8
Transportation and Warehousing	100.0	120.4	46.1	72.4	-39.2	19.2
Information and Cultural Industries	100.0	63.3	11.8	50.8	29.8	5.6
FIRE*	100.0	101.5	35.3	64.6	2.3	-3.7
Professional, Scientific and Technical Services	100.0	114.6	6.8	106.7	-33.0	18.8
ASWMR**	100.0	260.9	8.0	251.8	-118.5	-39.7
Arts, Entertainment and Recreation	100.0	-57.6	-28.8	-27.1	167.9	-12.7
Accommodation and Food Services	100.0	33.7	4.9	28.6	60.8	4.9
Other Services (Except Public Administration)	100.0	66.2	8.0	57.5	28.3	5.0

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 Gap by Industry

Alberta's labour productivity level was 109.3 per cent of the Canadian level in 2007, which implies a positive labour productivity differential of 9.3 percentage points. Table 8 makes it clear that this differential was caused by the market sector's above average capital intensity level, which was responsible for 30.7 percentage points of the gap. The differential was significantly reduced by low multifactor productivity, which reduced the differential by 21.2 percentage points, and lower than average labour quality, which reduced the differential by 0.1 percentage points.[11]

Alberta had a labour productivity gap in only 3 of the 15 two-digit NAICS industries. In these three industries, the below average level of multifactor productivity was the main culprit with significant contributions to the gap. In the 12 industries with a positive differential, 10 were caused by high capital intensity and two by high multifactor productivity.

Table 8: Sources of the Labour Productivity Gap Relative to Canada for Alberta 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	**109.3**	**9.3**	**30.7**	**-21.2**	**-0.1**	**100.0**	**329.4**	**-227.8**	**-1.6**
Agriculture, Forestry, Fishing and Hunting	109.4	9.4	13.7	-6.1	1.9	100.0	144.9	-65.0	20.0
Mining, and Oil and Gas Extraction	95.5	-4.5	25.1	-29.9	0.3	100.0	-560.8	667.1	-6.3
Utilities	135.8	35.8	60.8	-25.3	0.3	100.0	169.9	-70.7	0.8
Construction	124.8	24.8	-17.3	42.6	-0.4	100.0	-69.8	171.6	-1.8
Manufacturing	119.4	19.4	23.7	-2.8	-1.5	100.0	121.9	-14.1	-7.7
Wholesale Trade	92.6	-7.4	5.0	-11.0	-1.4	100.0	-67.7	148.5	19.2
Retail Trade	115.6	15.6	-3.8	22.2	-2.8	100.0	-24.6	142.9	-18.3
Transportation and Warehousing	114.7	14.7	15.7	-1.0	0.0	100.0	107.0	-7.0	0.1
Information and Cultural Industries	127.7	27.7	24.6	2.6	0.5	100.0	88.8	9.3	1.9
FIRE*	107.7	7.7	7.7	2.8	-2.9	100.0	100.6	36.7	-37.3
Professional, Scientific and Technical Services	106.1	6.1	3.5	4.4	-1.8	100.0	56.9	72.1	-29.0
ASWMR**	110.8	10.8	15.9	-1.8	-3.3	100.0	146.5	-16.4	-30.1
Arts, Entertainment and Recreation	79.1	-20.9	2.8	-26.0	2.3	100.0	-13.3	124.5	-11.2
Accommodation and Food Services	120.3	20.3	13.0	7.6	-0.4	100.0	64.2	37.5	-1.8
Other Services (Except Public Administration)	100.8	0.8	9.5	-6.7	-2.0	100.0	1,190.5	-835.9	-254.6

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, Alberta experienced lower growth in the three productivity metrics – labour, capital and multifactor productivities – than the national average. Labour productivity grew at a rate of 1.0 per cent per year, compared to the national rate of 1.7 per cent. Growth in labour productivity was primarily driven by capital intensity growth, which was responsible for 231.4 per cent of growth, though growth was reduced by changes in multifactor productivity which was responsible for -152.5 per cent of labour productivity growth.

Alberta enjoyed the second highest labour productivity level in Canada, at 109.3 per cent of the national level, well above the national levels in 2007. Similarly, Alberta had the highest capital intensity levels in the country, at 179.1 per cent of the national rate, due to the importance of the capital intensive mining, and oil and gas extraction industry. Capital productivity however was only 61.0 per cent of the national rate and the lowest in the country. Multifactor productivity was only 81.6 per cent of the national rate. The province's positive labour productivity differential relative to Canada was entirely caused by high capital intensity, with both labour quality and multifactor productivity levels being lower than the Canadian average.

Table 9 provides a summary of both levels (in 1997 and 2007) and growth rates (for the 1997-2007 period) for the productivity measures discussed in this report, along with rankings that show how Alberta fared in comparison to the other provinces. A key observation is that labour productivity was greatly hampered by the lagging mining, and oil and gas extraction industry, as Alberta ranks first using the equally weighted measure and last using the market sector. Another core observation is the importance of capital intensity to Alberta; Alberta enjoyed the highest capital intensity level and the fastest rate of growth. Capital intensity growth was entirely responsible for Alberta's labour productivity growth.

Table 9: Summary of Alberta'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	1.0	10	1	116.8	109.3	2	1
Capital Productivity	-3.4	10	9	81.4	61.0	10	10
Multifactor Productivity	-1.6	10	4	100.0	81.6	9	4
Capital Intensity	4.6	1	1	143.4	179.1	1	1
Labour Quality	0.5	6	7	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), 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).