The Impact of the Oil Boom on Canada's Labour Productivity Performance, 2000-2012

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ABSTRACT

The objective of this article is to evaluate the impact of the oil and gas industry on labour productivity growth in Canada since 2000 through an exploration of the various channels, both direct and indirect, by which the oil and gas sector affects aggregate productivity. The article sheds light on the paradoxical lack of a direct negative contribution of the oil and gas sector to aggregate labour productivity growth despite the very large fall in productivity experienced by the sector. It highlights the divergent productivity growth paths for the oil and gas sectors in Alberta and Newfoundland and Labrador, which drove the aggregate productivity performance of these two provinces. The article also discusses how developments in the oil and gas industry, notably the increase in the price and production of petroleum, have affected productivity growth in other parts of the economy.

OIL AND GAS EXTRACTION IS ONE of Canada's most important, and controversial, industries. In 2010, it represented 4.8 per cent of nominal GDP, up from 3.0 per cent in 2000, and it accounted for 20 per cent of nominal GDP growth between those two years. As Canada enjoyed a large and increasing trade surplus in hydrocarbons, the rising price of petroleum contributed to improved terms of trade, and during 2000-2012 real gross domestic income (GDI) grew 0.4 percentage points per year faster than real GDP (2.3 per cent versus 1.9 per cent).

But labour productivity growth in the oil and gas sector has been dismal since 2000, as real output – measured by the value added of the industry – has remained weak while employment has surged. Real output per hour worked in oil and gas extraction fell 6.4 per cent per year between 2000 and 2012. Yet, paradoxically, despite this performance, the sector did not make a negative contribution to aggregate labour productivity growth.

The oil and gas sector is particularly important for two provinces – Alberta and Newfoundland and Labrador – yet the overall productivity performance of these provinces has been drastically different. Over the 2000-2012 period, Newfoundland and Labrador enjoyed the most rapid productivity growth in Canada

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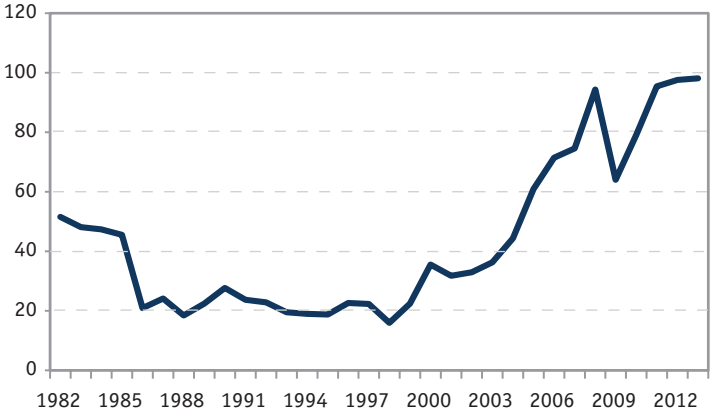
(Grand'Maison and Sharpe, 2013), while Alberta experienced the worst. Oil and gas extraction played a key role in the productivity performance of both provinces – positive in the case of Newfoundland and Labrador, and negative in the case of Alberta.

The objective of this article is to increase our understanding of the impact of developments in the oil and gas sector on labour productivity growth in Canada since 2000.[2] The article consists of five main sections. The first section sketches developments in the oil and gas sector, presents data on output, labour input and labour productivity in oil and gas extraction in Canada, Alberta, and Newfoundland and Labrador, and places the industry in the context of the business sector of these jurisdictions. The second section develops a framework for assessing both the direct and indirect impacts of oil and gas extraction on productivity. The third and fourth sections analyze, respectively, the direct and indirect effects of oil and gas extraction on business sector labour productivity growth in Canada, Alberta and Newfoundland and Labrador. A brief conclusion follows.

Chart 1
Real Oil Prices, 1982-2013
(2005 U.S. dollars per barrel)



Note: "Real oil prices" are the average spot prices (2010$/bbl) for crude oil based on WTI, Dubai, and Brent.
Source: World Bank, DataBank, Global Economic Monitor (GEM) Commodities.

The Oil Boom and Productivity in Oil and Gas Extraction

The Oil Boom

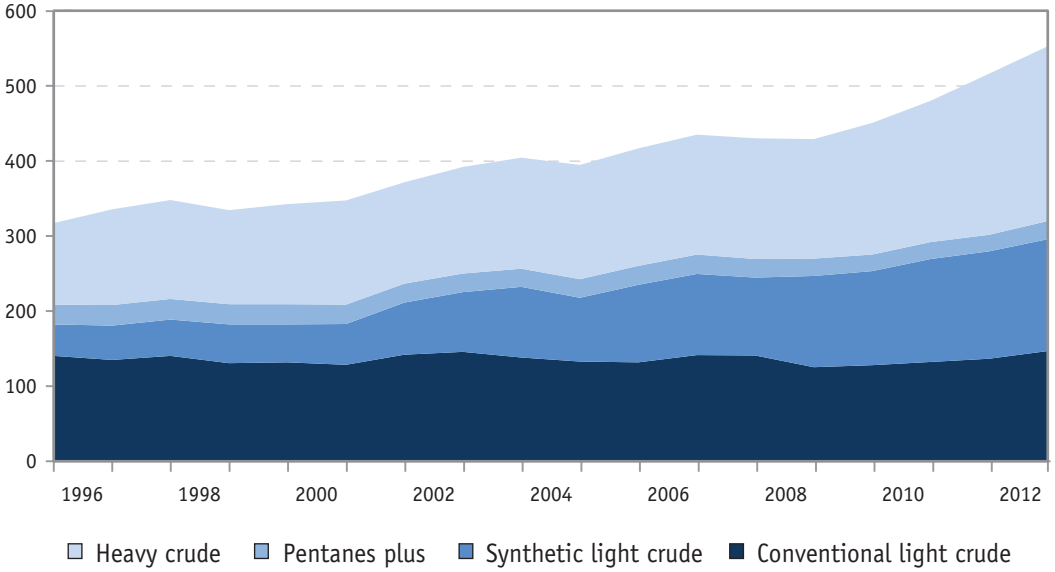
The first decade of the millennium saw a large and sustained increase in the world price of crude oil (Chart 1). From a low of around $20 per barrel from the mid-1980s to the end of the 1990s, the real world price increased to $35 in the year 2000, rose steadily to over $90 in 2008 and climbed to the $100 range more recently.

Canada was poised to take advantage of the opportunity this presented through exploitation of the Alberta oil sands and the offshore reserves of Newfoundland and Labrador. Production of oil expanded from 343 thousand cubic meters per day in 2000 to 516 thousand cubic meters per day in 2012 (Chart 2). While output of conventional light crude oil remained steady, production declined in Alberta, where producing wells reached exhaustion, and increased in Newfoundland and Labrador, where several new offshore platforms began production. Production of both synthetic light crude and heavy crude expanded rapidly. The increase came entirely from the oil sands, as production of conventional heavy crude in Alberta declined.

The bonanza brought about by the high price of oil, of course, mainly took the form of sales outside Canada. The volume of net exports of heavy crude doubled between 1997 and 2012, and that of light crude became positive by the end of the period (Chart 3). This along with the price hike made the trade balance in energy products increase from less

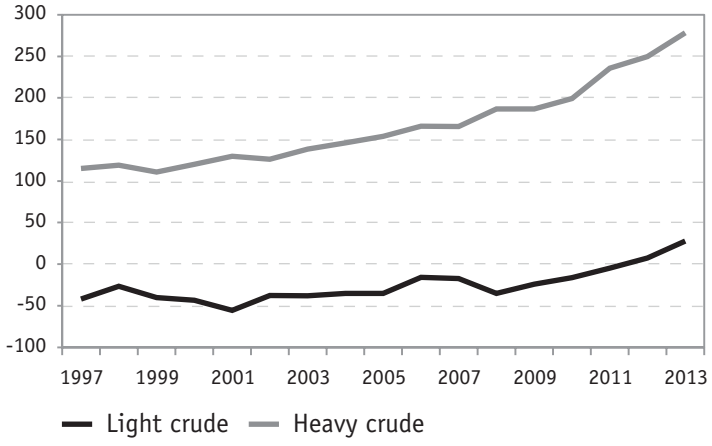
2 The main productivity measured used in this article is value-added labour productivity, defined as real GDP at basic prices per hour worked.

Chart 2
Production of Oil by Type, Canada, 1996-2013
(thousands of cubic meters per day)



Source: National Energy Board, Statistics, Crude Oil and Petroleum Products Statistics, Disposition of Domestic Crude.

Chart 3
Net Exports of Oil, 1997-2013
(thousands of cubic meters per day)



Source: National Energy Board, Statistics, Crude Oil and Petroleum Products, Disposition of Domestic Crude Oil and Imports.

than $20 billion before the year 2000 to more than $60 billion by 2008, giving a tremendous boost to the current account balance. Although after the financial crisis of 2008 the current account balance turned sharply negative, net revenues from energy products remained strongly positive through 2013.

While there was a large hike in the price of petroleum coupled with a steady increase in output, the price of natural gas dropped sharply following higher prices in the mid-2000s and output of gas declined steadily after 2007. This pattern gave rise to an increasing share of oil in the gross output of the oil and gas extraction sector, both in nominal and real terms. By 2012, petroleum accounted for 90 per cent of the oil and gas sector's nominal output, up from about 60 per cent in 2002. Similarly, petroleum's share of the oil and gas sector's real output rose from two-thirds to more than three-quarters. The oil and gas extraction industry is treated as a single industry by Statistics Canada (NAICS code 211), and hence in the analysis of output and productivity in this article (Exhibit 1).

Productivity in Oil and Gas Extraction

Real GDP

In 2012, real GDP or value added in the oil and gas extraction subsector was $91.3 billion (chained 2007 dollars) in Canada, up from $78.5 billion in 2000, which represents an average annual growth of 1.3 per cent (Table 1). Between 2000 and 2012, real GDP in the oil and gas extraction subsector grew by 2.5 and 0.7 per cent per year, in Newfoundland and Labrador and Alberta, respectively.[3]

Since 2007, Statistics Canada has broken the output of the oil and gas extraction sector into conventional and non-conventional oil extraction (primarily the oil sands in Northern Alberta). Conventional oil and gas extraction output was $58.9 billion 2007 dollars, about two-thirds of total oil and gas production, and down 14.5 per cent from $68.9 billion in 2007 when it represented nearly four-fifths. Non-conventional oil extraction has risen 53 per cent from $19.6 billion 2007 dollars in 2007 to $30.0 billion in 2012 and now accounts for just over one-third of the total real value added in the oil and gas sector.

Labour Input

Employment in the oil and gas extraction subsector in Canada was 65.4 thousand in 2012, up from 26.5 thousand in 2000, an average annual rate of increase of 7.8 per cent (Table 2). Employment growth in the subsector was nearly six times faster than the growth experienced by the overall business sector (1.3 per cent per year), and resulted in the oil and gas extraction subsector more than doubling its share of total business sector employment to 0.47 per cent in 2012 from 0.22 per cent in 2000. Similarly, Newfoundland and Labrador and Alberta experienced employment growth in their oil and gas extraction subsectors of 6.4 and 8.1 per cent per year, respectively, well above total employment growth in both provinces.

Conventional oil and gas extraction employed 49.2 thousand in 2012, accounting for 75 per cent of total oil and gas extraction employment, up from 34.6 thousand in 2007, when it represented 65.0 per cent of total oil and gas employment. Perhaps surprisingly, given the growing importance of oil sands output, employment in non-conventional oil extraction has fallen, from 18.2 thousand in 2007 to 16.3 thousand in 2012, with its employment share down from 35 per cent to 25 per cent. This development may reflect the growing importance of the less labour-intensive steam-assisted gravity drainage (SAGD) technology for the extraction of bitumen from the oil sands.

Exhibit 1
A Breakdown of Mining, Quarrying and Oil and Gas Extraction (NAICS Code 21) by NAICS Code

21	Mining, Quarrying and Oil and Gas Extraction	
	(Breakdown by NAICS Codes)	
211	Oil and Gas Extraction	
	211113	Conventional Oil and Gas Extraction
	211114	Non-conventional Oil and Gas extraction
212	Mining and Quarrying (except Oil and Gas)	
	2121	Coal Mining
	2122	Metal Ore Mining
	2123	Non-metallic Mineral Mining and Quarrying
213	Support Activities for Mining and Oil and Gas Extraction	
	Support Activities for Oil and Gas Extraction, combining	
	213111	Oil and Gas Contract Drilling
	213118	Services to Oil and Gas Extraction
	Support Activities for Mining, combining	
	213117	Contract Drilling (except Oil and Gas)
	213119	Other Support Activities for Mining

Source: Statistics Canada 2012.

3 Throughout this article, estimates for Newfoundland and Labrador's oil and gas extraction subsector refer to estimates for oil and gas extraction plus support activities for mining and oil and gas extraction.

Table 1
Real GDP in Oil and Gas Extraction, Canada, Alberta, and Newfoundland and Labrador, 2000-2012

	Canada			NFLD	Alberta
	Total	Conventional	Non-conventional		
	(millions, chained 2007 dollars)				
2000	78,504	..	..	3,733	62,253
2001	77,150	..	..	3,542	58,151
2002	82,855	..	..	7,694	59,538
2003	84,251	..	..	8,767	59,581
2004	84,870	..	..	8,490	60,964
2005	84,294	..	..	8,370	59,982
2006	86,498	..	..	8,180	62,101
2007	88,513	68,933	19,580	9,630	62,840
2008	85,554	65,265	20,228	9,051	60,215
2009	82,053	57,987	23,278	6,988	59,821
2010	84,751	57,770	25,655	7,066	61,472
2011	87,893	58,363	27,747	6,917	63,563
2012	91,285	58,946	30,048	5,015	67,712
	Compound Annual Growth Rates, per cent				
2000-2012	1.3	..	..	2.5	0.7
2000-2007	1.7	..	..	14.5	0.1
2007-2012	0.6	-3.1	8.9	-12.2	1.5

Note: Estimates for Newfoundland and Labrador refer to oil and gas extraction plus support activities for mining and oil and gas extraction.

Source: CSLS calculations based on Statistics Canada data.

Labour Productivity

The labour productivity performance of the oil and gas extraction subsector has been dismal (Table 3). At the national level, the subsector saw a decline in labour productivity of 6.4 per cent per year between 2000 and 2012. This abysmal productivity performance follows from the evolution of real output and labour input growth presented earlier. With a massive increase in labour input between 2000 and 2012 (total hours worked increased by 8.2 per cent per year), and weak output gains (1.3 per cent per year), output per hour worked plummeted sharply.

The decline in labour productivity was particularly sharp in Alberta (-7.1 per cent per year). Newfoundland and Labrador's oil and gas extraction sector saw its productivity decline at a rate of -4.8 per cent per year.

Despite the subsector's negative labour productivity growth, the absolute level of labour productivity in oil and gas extraction remained very high, almost thirteen times the business sector average in 2010. This was true for Canada, Alberta and Newfoundland and Labrador.

The oil and gas extraction industry in Alberta comprises two very different sectors, conventional oil and gas and the oil sands, each with very different productivity performance. Labour productivity in conventional oil and gas extraction fell 10.3 per cent per year during the 2007-2012 period, while in non-conventional oil and gas extraction it increased by 10.7 per cent per year. Thus the fall in labour productivity in oil and gas extraction, at least during the 2007-2012 period, was entirely driven by conventional oil and gas extraction, as employment surged 42 per cent and real output fell 15 per cent.

Table 2
Employment in Oil and Gas Extraction, Canada, Alberta, and Newfoundland and Labrador, 2000-2012

	Canada			NFLD	Alberta
	Total	Conventional	Non-conventional		
	(thousands of jobs)				
2000	26.5			1.3	22.5
2001	29.7			0.9	25.2
2002	30.0			1.1	25.4
2003	30.9			1.2	26.4
2004	35.2			1.4	30.4
2005	42.7			1.5	36.6
2006	45.9			2.0	39.3
2007	52.8	34.6	18.2	2.0	44.4
2008	64.6	46.4	18.2	2.1	54.8
2009	61.7	42.3	19.3	1.4	54.3
2010	55.3	41.4	13.9	2.1	49.5
2011	62.8	47.1	15.7	2.8	55.7
2012	65.4	49.1	16.3	3.1	57.3
	Compound Annual Growth Rates, per cent				
2000-2012	7.8	..	..	6.4	8.1
2000-2007	10.3	..	..	9.1	10.2
2007-2012	4.4	7.3	-2.2	7.5	5.2

Note: Estimates for Newfoundland and Labrador refer to oil and gas extraction plus support activities for mining and oil and gas extraction.

Source: CSLS calculations based on Statistics Canada data.

Two factors are at play in the collapse of labour productivity in conventional oil and gas since 2007. First, yields are decreasing in the exploitation of conventional oil and gas deposits in Western Canada as the easily accessed reserves and basins have been increasingly exploited. Second, high oil prices have made it profitable to exploit lower quality, and hence higher cost, oil and gas deposits.

The robust labour productivity growth in non-conventional oil production, a very promising and little known development, likely reflects two factors. First, the increasing importance of stream-assisted gravity drainage (SAGD) technology for extraction of bitumen, which is less labour intensive than mining of the oil sands, has likely reduced labour requirements per unit of output. Second, given that the oil sands have now been in production for a number of decades, the industry is benefiting from process improvements through learning-by-doing.

Business Sector Productivity

During the 2000-2012 period Alberta had the slowest business sector labour productivity growth of all provinces (0.45 per cent per year), while Newfoundland and Labrador had the fastest (1.66 per cent per year) (Chart 4). How do we explain the very different productivity growth performance of the two major oil-producing provinces? Oil and gas extraction, which plays a major role in both economies, experienced a drastic decline in labour productivity in both economies. Nonetheless, business sector labour productivity growth was weak in Alberta and quite strong in Newfoundland and Labrador; this disparity is related to differences in the contribution of

Table 3

Labour Productivity in Oil and Gas Extraction, Canada, Alberta, and Newfoundland and Labrador, 2000-2012

	Canada			NFLD	Alberta
	Total	Conventional	Non-conventional		
	(chained 2007 dollars per hour worked)				
2000	1,419.14	..	..	1,185.29	1,320.39
2001	1,209.10	..	..	1,570.23	1,065.56
2002	1,309.83	..	..	3,002.05	1,107.13
2003	1,271.71	..	..	3,413.18	1,045.65
2004	1,125.37	..	..	2,507.79	934.88
2005	887.85	..	..	2,244.96	731.54
2006	870.84	..	..	1,608.71	733.01
2007	797.16	946.54	512.43	1,910.69	676.39
2008	613.89	648.74	521.88	1,700.43	517.60
2009	642.24	659.46	584.45	1,967.78	534.47
2010	713.95	649.66	861.43	1,377.66	583.85
2011	654.51	579.53	826.27	985.78	538.86
2012	639.48	548.80	850.21	654.04	545.29
	Compound Annual Growth Rates, per cent				
2000-2012	-6.4	..	..	-4.8	-7.1
2000-2007	-7.9	..	..	7.1	-9.1
2007-2012	-4.3	-10.3	10.7	-19.3	-4.2

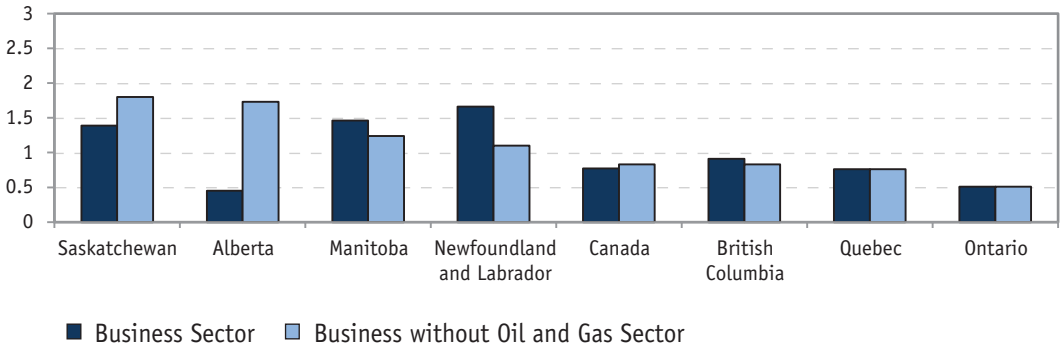
Note: Estimates for Newfoundland and Labrador refer to oil and gas extraction plus support activities for mining and oil and gas extraction.

Source: CSLS calculations based on Statistics Canada data.

Chart 4

Labour Productivity Growth in Canada and the Provinces, Business Sector and Business Sector excluding Oil and Gas Extraction Activities, 2000-2012

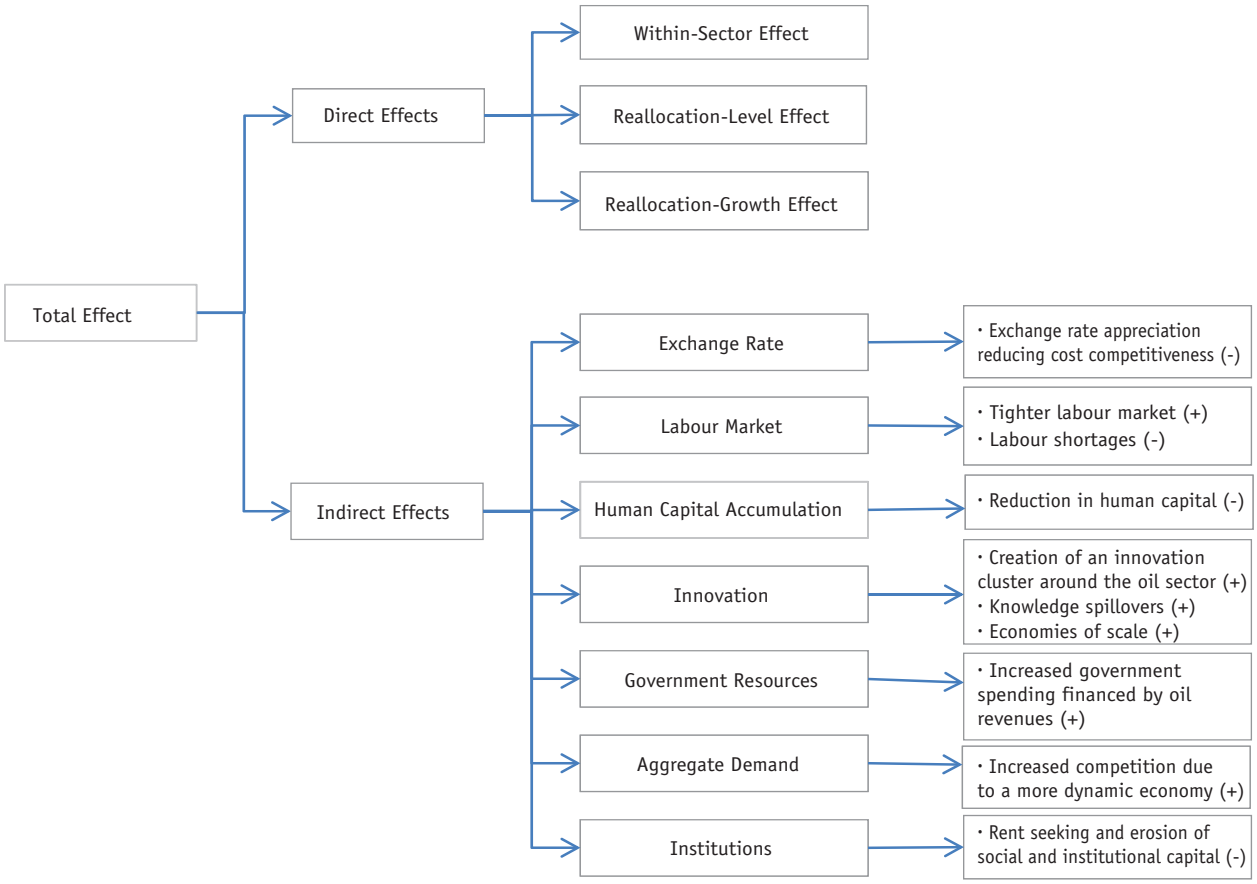
(per cent)



Source: CSLS calculations based on Statistics Canada data.

oil and gas extraction to aggregate labour productivity growth between the two provinces. The contribution of the oil and gas extraction subsector to business sector labour productivity growth was *positive* in Newfoundland and Labrador while it was *negative* in Alberta. These matters are explored in the following sections.

Exhibit 2
The Effect of Oil and Gas Extraction on Aggregate Productivity Growth in Canada



A Framework for Analyzing the Impact of Oil and Gas Extraction on Canadian Productivity Growth

Exhibit 2 provides a schema for identifying and quantifying the different ways in which developments in and arising from the oil and gas industry impact, both directly and indirectly, aggregate productivity growth. This is the framework used to identify the direct contribution and the indirect effects of the oil and gas sector on productivity growth.

The next section provides empirical estimates of the direct contribution, and the section following discusses and presents evidence regarding the indirect effects, both for Canada as a whole and for Alberta and Newfoundland and Labrador, the two provinces where the oil and gas sector is most important.

Assessing the Direct Contribution of Oil and Gas Extraction to Business Sector Labour Productivity Growth

The contribution of the oil and gas extraction subsector to business sector labour productivity growth is broken down into three components using labour productivity growth decomposition formulas.[4] The three components of the direct contribution of a sector to productivity growth are:

- The **within-sector effect (WSE)** is the labour productivity growth rate of the sector, scaled to reflect the share of the sector in the aggregate.

Table 4

CSLS Labour Productivity Growth Decomposition for Canada, 2000-2012

A) Two-digit NAICS Decomposition

	WSE	RLE	RGE	Total
	(percentage point contribution to aggregate labour productivity growth)			
Business Sector Industries	0.61	0.49	-0.29	0.77
Mining and Oil and Gas Extraction	-0.32	0.45	-0.18	-0.06
All Other Industries Combined	0.94	0.04	-0.10	0.88

B) Three-digit Breakdown of Mining and Oil and Gas Extraction

	WSE	RLE	RGE	Total
	(percentage point contribution to aggregate labour productivity growth)			
Mining and Oil and Gas Extraction	-0.44	0.88	-0.50	-0.05
Oil and Gas Extraction	-0.37	0.85	-0.48	0.00
Mining and Quarrying (except oil and gas)	-0.07	0.04	-0.02	-0.05
Support Activities for Mining and Oil and Gas Extraction	0.00	0.00	0.00	0.00

Note: Contributions do not add up exactly to business sector labour productivity due to the use of chained dollar estimates instead of constant dollar estimates.

Source: CSLS calculations based on Statistics Canada data.

- The **reallocation-level effect (RLE)** measures the effect of a shift of resources in or out of a sector whose productivity level differs from the average.
- The **reallocation-growth effect (RGE)** measures the effect of a shift of resources into a sector that has a rate of productivity growth that differs from the aggregate rate of productivity growth.

Canada

Business sector output per hour in Canada grew at a 0.77 per cent average annual rate from 2000 to 2012 (Table 4, Panel A). In contrast, labour productivity in the mining and oil and gas extraction industry fell at a 3.51 per cent average annual rate. The level of real GDP per hour worked in mining and oil and gas in 2012 was $233 (chained 2007 dollars), 4.9 times the business sector average. Between 2000 and 2012, the share of hours worked of the mining and oil and gas sector rose 0.8 percentage points from 1.4 per cent to 2.2 per cent of total business sector hours worked. The combination of the high labour productivity level and significant change in the hours share means that the mining and oil and gas sector had important effects on aggregate productivity growth.

The decomposition formula reveals that despite the strong negative within-sector contribution from mining and oil and gas extraction (-0.32 percentage points), the sector only made a relatively small negative contribution to overall business sector labour productivity growth (-0.06 percentage points). This result was due to the very large positive reallocation level effect (0.45 percentage points), reflecting the large influx of workers into this very high productivity level sector. This very important positive reallocation effect of the oil and gas sector on productivity is seldom recognized.

4 This article presents estimates calculated using the CSLS formula, while the unabridged version of this article uses two formulas: one developed by CSLS, and the Generalized Exactly Additive Decomposition (GEAD) formula. Further information on these formulas can be found in Sharpe and Waslander (2014), de Avillez (2012), Reinsdorf (2014), and Tang and Wang (2012).

Table 5
CSLS Contributions from Conventional and Non-conventional Oil and Gas Extraction to Labour Productivity Growth in Canada, 2007-2012

	WSE	RLE	RGE	Total
	(percentage point contribution to aggregate labour productivity growth)			
Business Sector	0.05	0.78	-0.38	0.49
Oil and Gas Extraction	-0.29	0.50	-0.26	-0.04
Conventional Oil and Gas Extraction	-0.52	0.53	-0.24	-0.22
Non-conventional Oil and Gas Extraction	0.23	-0.03	-0.02	0.18
	(per cent contribution to aggregate labour productivity growth)			
Business Sector	10.6	158.0	-77.4	100.0
Oil and Gas Extraction	-58.1	102.3	-51.9	-7.7
Conventional Oil and Gas Extraction	-104.9	108.0	-47.9	-44.7
Non-conventional Oil and Gas Extraction	46.7	-5.6	-4.1	37.0

Source: CSLS calculations based on Statistics Canada data.

Because of the negative productivity growth within the mining and oil and gas sector, there was a negative reallocation growth effect (-0.18 percentage points). Consequently, the net reallocation effect of 0.27 percentage points (0.45 - 0.18 = 0.27) was less than the reallocation level effect, but still large enough to offset most of the negative contribution of the within-sector productivity growth (-0.32 percentage points).

Breaking down mining and oil and gas extraction into its three subsectors (Table 4, Panel B), it is interesting to note that although the overall contribution of the sector remains the same (-0.05 percentage points), the greater level of disaggregation captures within-sector and reallocation effects that were not captured at the two-digit level. In particular, oil and gas extraction experienced a massive reallocation level effect (0.88 percentage points). This effect was completely offset by the negative within-sector and reallocation growth effects (-0.37 and -0.48 percentage points, respectively), resulting in an overall contribution of zero to business sector labour productivity growth. In other words, oil and gas extraction – despite experiencing negative productivity growth during the period – did not make a negative contribution to aggregate labour productivity growth.

A breakdown of labour productivity growth of the oil and gas extraction into conventional and non-conventional oil and gas extraction is only available for the 2007-2012 period (Table 5). But a decomposition of oil and gas extraction productivity for this period provides fascinating insights into recent developments in the sector. It shows that conventional oil and gas extraction has made a significant negative contribution to labour productivity growth in the business sector (-0.22 points), while the oil sands have made a positive contribution (0.18 points). This result derives from the very large negative contribution of the within-sector effect in conventional oil and gas extraction (-0.52 points), following from the sector's very large fall in labour productivity. In contrast, the oil sands made a large positive within-sector contribution to business sector labour productivity growth (0.23 points) because of the sector's robust labour productivity growth.

Alberta

Business sector output per hour in Alberta grew at a 0.45 per cent average annual rate from 2000

Table 6

CSLS Labour Productivity Growth Decomposition for Alberta, 2000-2012

A) Two-digit NAICS Decomposition

	WSE	RLE	RGE	Total
	(percentage point contribution to aggregate labour productivity growth)			
Business Sector Industries	-0.25	1.21	-0.61	0.45
Mining and Oil and Gas Extraction	-1.32	1.00	-0.48	-0.79

B) Three-digit Breakdown of Mining and Oil and Gas Extraction

	WSE	RLE	RGE	Total
	(percentage point contribution to aggregate labour productivity growth)			
Mining and Oil and Gas Extraction	-1.83	2.84	-1.77	-0.75
Oil and Gas Extraction	-1.81	2.86	-1.77	-0.72
Mining and Quarrying (except oil and gas)	-0.02	-0.01	0.01	-0.02
Support Activities for Mining and Oil and Gas Extraction	0.01	-0.01	0.00	-0.01

Source: CSLS calculations based on Statistics Canada data.

to 2012 (Table 6). In contrast, labour productivity in the mining and oil and gas extraction fell at a 4.02 per cent average annual rate. Alberta's level of real GDP per hour worked in mining and oil and gas extraction in 2012 was $246 (chained 2007 dollars), 3.6 times the business sector average. Between 2000 and 2012, the share of hours worked of the mining and oil and gas sector rose 2.3 percentage points from 6.8 per cent to 9.1 per cent of total business sector hours worked.

The decomposition formula reveals that the strong reallocation level effect (with a contribution of 1.00 percentage points) was not enough to offset the negative within-sector effect (-1.32 percentage points) and the negative reallocation growth effect (-0.48 percentage points). This resulted in a strongly negative contribution of mining and oil and gas extraction to labour productivity growth in Alberta's business sector (-0.79 percentage points or -176.1 per cent). The sector's overall reallocation effect was positive (1.00 - 0.48 = 0.52), reflecting once again the large influx of workers into this high-productivity sector.

Breaking down mining and oil and gas extraction into its three subsectors (Table 6, Panel B), it is interesting to note (once again) that the overall contribution of the sector remains (roughly) the same, but the greater level of disaggregation captures within-sector and reallocation effects that were not captured at the two-digit level. In particular, oil and gas extraction experienced a massive reallocation level effect (2.86 percentage points). This effect was completely offset by the negative within-sector and reallocation growth effects (-1.81 and -1.77 percentage points, respectively), resulting in an overall contribution of -0.72 percentage points to business sector labour productivity growth.

Newfoundland and Labrador

Business sector output per hour in Newfoundland and Labrador grew at a 1.66 per cent average annual rate from 2000 to 2012 (Table 7). In contrast, labour productivity in mining and oil and gas extraction fell at a 3.36 per cent average annual rate. The level of real GDP per hour worked in mining and oil and gas extraction in the province in 2012 was $429 (chained 2007 dollars), 6.3 times the business sector average. Between 2000 and 2012, the share of hours worked of the mining and oil and gas sector rose

Table 7
CSLS Labour Productivity Growth Decomposition for Newfoundland and Labrador, 2000-2012

A) Two-digit NAICS Decomposition

	WSE	RLE	RGE	Total
	(percentage point contribution to aggregate labour productivity growth)			
Business Sector Industries	0.63	2.79	-1.17	1.66
Mining and Oil and Gas Extraction	-0.89	2.70	-1.05	0.77

B) Three-digit Breakdown of Mining and Oil and Gas Extraction

	WSE	RLE	RGE	Total
	(percentage point contribution to aggregate labour productivity growth)			
Mining and Oil and Gas Extraction	-0.89	2.70	-1.05	0.77
Oil and Gas Extraction	-0.89	2.24	-1.08	0.27
Mining and Quarrying (except oil and gas)	0.02	0.50	-0.01	0.50

Note: Estimates for Newfoundland and Labrador refer to oil and gas extraction plus support activities for mining and oil and gas extraction.

Source: CSLS calculations based on Statistics Canada data.

3.3 percentage points from 3.0 per cent to 6.3 per cent of total business sector hours worked.

The decomposition formula reveals that despite the strong negative within-sector labour productivity growth in mining and oil and gas (-0.89 percentage points), the sector actually made a significant positive contribution (0.77 percentage points). This result was due to the extremely large positive reallocation level effect (2.70 percentage points), which was more than enough to offset both the negative within-sector effect and the negative reallocation growth effect (-1.05 percentage points). The positive combined reallocation effect (2.70 - 1.05 = 1.65) reflected the large influx of workers into this very high productivity sector.

Contribution estimates for Newfoundland and Labrador's oil and gas extraction subsector could not be calculated due to data confidentiality issues. The CSLS, however, was able to compute contribution estimates for oil and gas extraction plus support activities for mining and quarrying and oil and gas extraction (Table 7, Panel B). These show that the very strong reallocation level effect of the mining and oil and gas sector is largely due to the oil and gas extraction subsector. However, the mining subsector also makes a contribution (0.50 percentage point), as it has a higher than average productivity level and increased its share of hours worked.

Assessing the Indirect Effects of Oil and Gas Extraction on Business Sector Labour Productivity Growth

This section investigates the indirect effects of oil and gas extraction on the aggregate productivity performance of Canada, Alberta, and Newfoundland and Labrador during the 2000-2012 period. These effects are: 1) the exchange rate effect; 2) the effect on the labour market; 3) the impact on human capital accumulation; 4) the effect on innovation; 5) the effect on government resources, which interacts with the other effects; and 6) the effect on aggregate demand.

Exchange Rate Effects: the Dutch Disease

Canada exported $73 billion nominal dollars worth of crude oil and crude bitumen in 2012,

up from $19 billion in 2000. The massive increase in both the volume and the price of oil exported put upward pressure on the exchange rate, which rose from $0.73 U.S. in 2000 to $1.04 U.S. in 2012. This appreciation has had important implications for the productivity performance of the non-oil and gas sector, as discussed in this section.

There is an extensive literature on the effects of resource sectors on national and regional economies. The term "Dutch Disease", named after the experience of the Netherlands following discovery of an enormous natural gas field in 1961, is commonly used to describe this effect. The Dutch Disease focuses on the effect a resource price boom or exploitation of rich deposits may have, primarily through the exchange rate, on the manufacturing sector, which many regard as vital for economic development. In other words, newfound resource riches may damage the engine of long-term growth of the economy.

Resource riches can be disastrous but also quite beneficial. Much depends on the general setting, on institutions and policies. It is important to be cautious when attributing developments in the economy at large to a resource boom, as adverse developments outside the oil and gas sector may be due to factors unrelated to natural resources and resource development may lead to positive spin-offs in manufacturing instead of displacing the industry.

The Canadian Experience

Labour productivity in manufacturing advanced at only 0.7 per cent per year on average between 2000 and 2012 in Canada, down from 2.9 per cent per year between 1981 and 2000. This development reflected a decline in real output in manufacturing at a rate of 1.2 per cent per year in 2000-2012, down from growth of 3.3 per cent per year in 1981-2000. In 2000-2012, employment in manufacturing fell by 1.9 per cent per year. A fall in demand and hence output, either in the growth rate or in absolute terms, has negative short- and long-term implications for productivity growth. Short-term effects include less spreading of overhead costs, greater labour hoarding, less learning by doing and fewer economies of scale. Long-term effects include less investment in human capital, R&D, and physical capital (Spiro, 2013; Rao and Li, 2013).

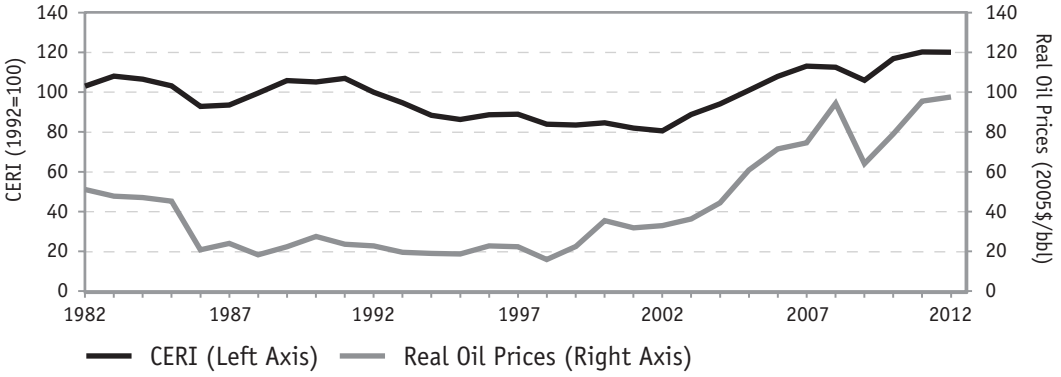
The cause of the lack of output growth is to be sought at least in part in the appreciation of the exchange rate, and this in turn is associated with oil and gas. There are three links in the nexus between oil and gas and manufacturing that need to be investigated:

- The degree to which the appreciation of the exchange rate is due to the price of and external trade in oil;
- The degree to which the deterioration of the cost competitiveness of the manufacturing sector is driven by the exchange rate; and
- The degree to which the loss of cost competitiveness in manufacturing affects output and productivity.

As regards the first linkage, the appreciation of the Canadian dollar effective exchange rate after 2002 coincided with and follows the same pattern as the rise in real oil prices (Chart 5). The effective exchange rate appreciated 39.7 per cent between 2002 and 2008, driven by a 186.4 per cent increase in real oil prices. Both indicators declined in 2008-2009 as the great world recession set in, but recovered fully in the next two years. Similarly, using quarterly data for 1994-2013, Courchene (2014) found a positive correlation of 0.94 between the price of crude oil and the Canada-U.S. exchange rate. This suggests that the Canadian dollar has increasingly become a petro currency.

While this evidence is suggestive, it is not definitive, and it does not show what part of the appreciation is due to oil. Beine *et al.*

Chart 5
Canadian Dollar Effective Exchange Rate Index (CERI) (1992=100) and Real Oil Prices (2005 U.S. Dollars per Barrel), 1982-2012



Note: "Real oil prices" are the average spot prices (2005$/bbl) for crude oil based on WTI, Dubai, and Brent.
Source: World Bank, DataBank, Global Economic Monitor (GEM) Commodities; and the Bank of Canada.

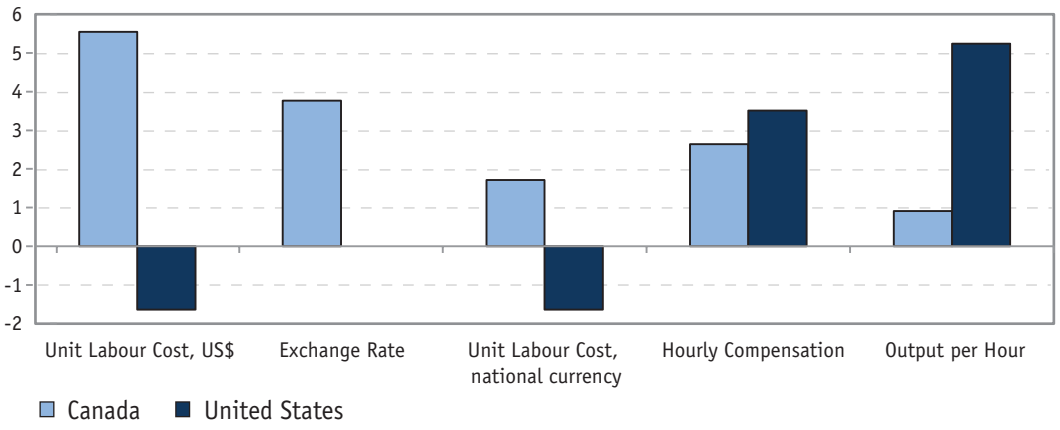
(2012) argues that much of the appreciation in the Canadian dollar between 2002 and 2008 was due the weakness in the U.S. dollar that was unrelated to changes in energy and commodity prices. They estimate that 58 per cent of the appreciation of the Canada-U.S. bilateral exchange rate between 2002 and 2008 was due to the weakness of the U.S. component, while only 42 per cent was due to the strength of the Canadian component, which they regard as being related to energy price movements. Similarly, Carney (2012), former Governor of the Bank of Canada, estimated that half of the appreciation of the Canada-U.S. exchange rate was due to the rise of global commodity prices, and about 40 per cent was due to the depreciation of the U.S. dollar against other major currencies.

As regards the second linkage in the chain of causation from oil and gas to productivity in manufacturing, unit labour cost in manufacturing expressed in U.S. dollars is a key metric of the cost competitiveness of the Canadian economy. Unit labour costs in U.S. dollars in Canada rose 80 per cent between 2000 and 2012 in Canada but declined by 20 per cent in the United States. This represented a massive deterioration in Canada's cost competitiveness.

Changes in unit labour costs in U.S. dollars reflect changes in the three factors: nominal labour costs, labour productivity, and the exchange rate. Chart 6 shows developments in these variables for Canada and the United States for the 2000-2012 period. Unit labour cost grew 5.5 per cent per year over the period in Canada, compared to a decline of 1.6 per cent in the United States, for a difference of 7.1 per cent per year. Just over one half of this decline is due to the 3.8 per cent average annual appreciation of the Canadian dollar. The difference in labour productivity growth (0.9 per cent vs. 5.2 per cent) contributed even more to the loss in Canada's cost competitiveness. The slower rate of hourly compensation increases in Canada (2.6 per cent vs. 3.5 per cent) offset the two negative developments only in small part.

It should be noted that the contribution of productivity performance to the fall in cost competitiveness is likely overestimated, as productivity growth is endogenous to demand conditions. To the degree that productivity growth is a function of output growth, the weak productivity growth

Chart 6
Unit Labour Cost in the Manufacturing Sector (US$), Canada-U.S. Comparison, 2000-2011
(compound annual growth rates, per cent)



Source: U.S. Bureau of Labor Statistics, International Labor Comparisons.

reflects the fall in output growth, which was in part caused by the appreciation of the Canadian dollar. It is well-known that changes in output are reflected in productivity performance; this is known as the Verdoorn Law.

One would expect that the U.S. and Canadian manufacturing sectors experienced the same structural phenomena in recent years. In principle, these structural phenomena – most importantly, the shift of low-skill manufacturing activities to emerging markets – should have affected the U.S. and Canadian manufacturing sectors roughly equally, *ceteris paribus*. However, Chart 7 evidences the divergence between the United States and Canada in terms of value added in the manufacturing sector. In particular, real GDP in the U.S. manufacturing sector was 20.7 per cent above its 2000 level in 2013, while real GDP in Canada's manufacturing sector was 14.0 per cent below its 2000 level in 2013. Coinciding with Canada's oil boom, much of the divergence between Canada and the United States occurred in 2002-2007, with real GDP in U.S. manufacturing rising dramatically and falling in Canada.

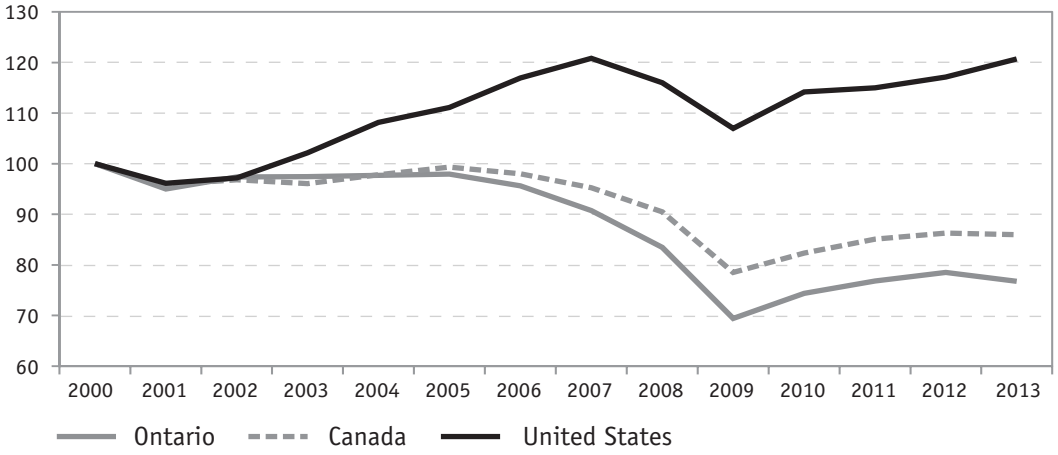
As regards the third issue, the appreciation of the Canadian dollar and loss of cost competitiveness was, of course, not the only factor leading to a fall in foreign demand for Canadian manufactured products. Weak economic growth in the United States, our major market, as well as the emergence of low-cost producers of manufactured goods, especially China, also played a role. These developments have been highlighted by Shakeri, Gray and Leonard (2012).

To sum up, there exists a causal link between the price and export of oil and output in manufacturing but it explains only a part of what happened to the latter industry. The appreciation of the Canadian dollar was quite large but also reflects a weakening of the U.S. dollar that was unrelated to oil. Both factors have been more or less equally responsible for the appreciation. The appreciation in turn accounts for a substantial part, but not the entire dramatic increase in relative unit labour cost in manufacturing. Some part of the increase in Canada's relative unit labour cost is due to the Canadian industry's failure to keep up with the rapid rate of increase in out-

Chart 7

Index of Real GDP in Manufacturing, Canada, Ontario and the United States, 2000-2013

(Index, 2000 = 100)



Source: Statistics Canada, CANSIM Tables 379-0030/31. BEA, GDP by Industry.

Note: Real GDP for the US is in 2009 Chained Dollars. Real GDP for Canada and Ontario is in 2007 Chained Dollars.

put per hour worked in the United States. Taken together, these two observations mean that a significant part, but less than one-half, of the decline of manufacturing output relative to that in the U.S. could be attributed to the effect of the oil boom on the Canadian exchange rate.

Labour Market Effects

In this section, we examine whether the oil and gas subsectors in Alberta and Newfoundland and Labrador are tightening labour market and affecting wages in these provinces.

According to Statistics Canada, Alberta had a job vacancy rate of 3.1 per cent in 2012, the highest in Canada and well above the national average of 1.7 per cent. The unemployment rate in Alberta was 4.6 per cent, the lowest in Canada and well below the national average of 7.3 per cent. The ratio of the unemployment rate to the job vacancy rate in Alberta was 1.48, also the lowest in Canada. These three measures of labour market conditions indicate that in 2012 Alberta had the tightest labour market of all provinces.

Between 2001 and 2012, average weekly earnings for the industrial aggregate grew at a 4.3 per cent average annual rate in Alberta, compared to 2.9 per cent in Canada. This trend resulted in a growing gap in wages between Alberta and Canada, with wages in Alberta rising from 102.8 per cent of the national average in 2001 to 119.6 per cent in 2012. All of Alberta's sectors have shown wage growth in excess of the national average. However, in certain sectors the difference has been small. Both vacancy rates and wages indicate that the labour market in Alberta was rather tight.

The oil and gas boom in Newfoundland and Labrador also has greatly tightened labour market conditions in the province, with potential effects on productivity. The unemployment rate plummeted from 18.1 per cent in 1997 to 12.5 per cent in 2012, while in St. John's it fell from 13.5 per cent in 1997 to 7.7 per cent in 2010. The tighter labour market in both provinces would have led to higher wages and skill shortages, giving producers a greater incentive to substitute capital for labour, boosting labour productivity.

Table 8
Summary of Absolute and Relative Rates of Educational Attainment

	Canada			Newfoundland and Labrador			Alberta		
	2000	2012	Change 00-12	2000	2012	Change 00-12	2000	2012	Change 00-12
High School Non-Completion Rate Ages 15-24									
Absolute	41.2	34.1	-7.1	42.3	35.8	-6.5	42.8	36.7	-6.1
Relative to Canada (%)	..	..	..	102.7	105.0	2.3	103.9	107.6	3.7
Post-Secondary Enrolment Rate for Under 25 Year Olds									
Absolute	28.5	39.1	10.7	24.2	38.4	14.2	24.5	30.3	5.8
Relative to Canada (%)	..	..	..	84.9	98.2	13.3	86.0	77.5	-8.5
Average Years of Schooling for Ages 15 and Over									
Absolute	13.5	14.0	0.5	13.3	13.8	0.5	13.4	13.8	0.4
Relative to Canada (%)	..	..	..	98.5	98.6	0.1	99.3	98.6	-0.7

In all, this evidence indicates a possible positive effect on labour productvity. One caveat needs consideration: If the labour market becomes too tight, skills shortages and production bottlenecks could appear, and these can be detrimental to productivity. However, there appers to be ample supply of labour available to Alberta's employers through interprovincial migration and immigration, while outmigration did continue in Newfoundland and Labrador. There have been no indications of a general labour shortage or widespread skill shortages in either province. Accordingly, we conclude as follows: Labour market tightening in Alberta and (to a lesser extent) Newfoundland and Labrador is likely to have had a positive effect on labour productivity in various sectors in these provinces through the greater incentives to substitute capital for labour.

Human Capital Accumulation Effects

Accumulation of human capital is vital for the productivity growth of a nation in the long run. The oil and gas sector may influence productivity growth if it impacts on educational attainment, positively or negatively.

The oil and gas sector and its support activities create low-skill jobs with high wages which can attract youth away from schooling. This increases the opportunity cost of post-secondary education. There are two possible scenarios for the long-term effects. In the first scenario, the high wages are permanently attracting youths away from pursuing higher education. In the second scenario, the high wages are temporarily attracting youths from pursuing higher education. This temporary attraction allows youths to accumulate savings to fund their higher education. There may also be a positive effect if the emergence of a thriving oil and gas sector creates employment opportunities that require a high level of education where such jobs used to be scarce.

This section presents evidence regarding trends in educational attainment in Alberta and Newfoundland and Labrador between 2000 and 2012 and contrasts this with the experience in Canada generally.

Since 2000, there has been a significant fall in high school non-completion in all three jurisdictions, a positive factor for the overall quality of the labour force. However, it appears that the rate of decline in high school non-completion was somewhat slower in the two oil producing

provinces than at the national level. The relative high school non-completion rates in these provinces rose slightly, from 102.6 per cent of the national level for Newfoundland and Labrador in 2000 to 105.0 per cent in 2012 and from 103.7 per cent of the national level in Alberta in 2000 to 107.8 per cent in 2012. This suggests that the relatively tight labour market in Alberta and the greatly improved labour market in Newfoundland and Labrador may have enticed some young persons to take jobs rather than complete high school.

There has also been a significant upward trend in the post-secondary enrolment rate in all three jurisdictions since 2000, again a positive factor for the overall quality of the labour force. The rate of increase in the post-secondary enrolment rate was well above the national average in Newfoundland and Labrador, and well below in Alberta. Consequently, the relative enrolment rate in Newfoundland and Labrador rose significantly from 84.9 per cent of the national level in 2000 to 98.2 per cent in 2012. In contrast, the relative enrolment rate fell in Alberta from 86.0 per cent of the national average in 2000 to 77.3 per cent in 2012. It is quite surprising that Alberta has only around three students enroled in post-secondary education for every four students enrolled at the national level. The ample and well-paying employment opportunities in Alberta appear to lead to the postponement or the abandonment of post-secondary studies for many young people in the province.

Consistent with the other two education metrics discussed above, since 2000 there has been an upward trend in educational attainment in all three jurisdictions, again a positive factor for the overall quality of the labour force. In Canada, the average number of years of schooling has risen from 13.5 years in 2000 to 14.0 years in 2012. Alberta also saw a similar increase (from 13.4 years to 13.8 years), as did Newfoundland and Labrador (from 13.3 years to 13.8 years). The average number of years of schooling for both oil producing provinces remained below but close to that of Canada. Educational attainment is a measure of the stock rather than the flow of education. It cannot change very rapidly, and is affected by interprovincial migration as well as school completion in a province. It is therefore not a very sensitive measure for the question at issue in this section.

The strongest evidence of an effect of oil and gas on human capital accumulation is the increase in post-secondary enrollment in Newfoundland and Labrador, where the rate came very close to the national rate from a much lower level in the year 2000. It seems likely that the oil and gas sector is at the root of this development, not just for the employment opportunities it created and was expected to create, but also through its effect on the economy of the province and on government revenues.

For Alberta, the evidence suggests a negative effect on human capital accumulation of young people. While there has been continued progress in reducing the high school non-completion rate and in increasing post-secondary enrolment rates, the gains in human capital have been smaller than at the national level. This development was also found by Morissette, Chan and Lu (2013), which found that wage growth induced by increases in world oil prices reduced full-time university enrolment among young men in oil-producing provinces.

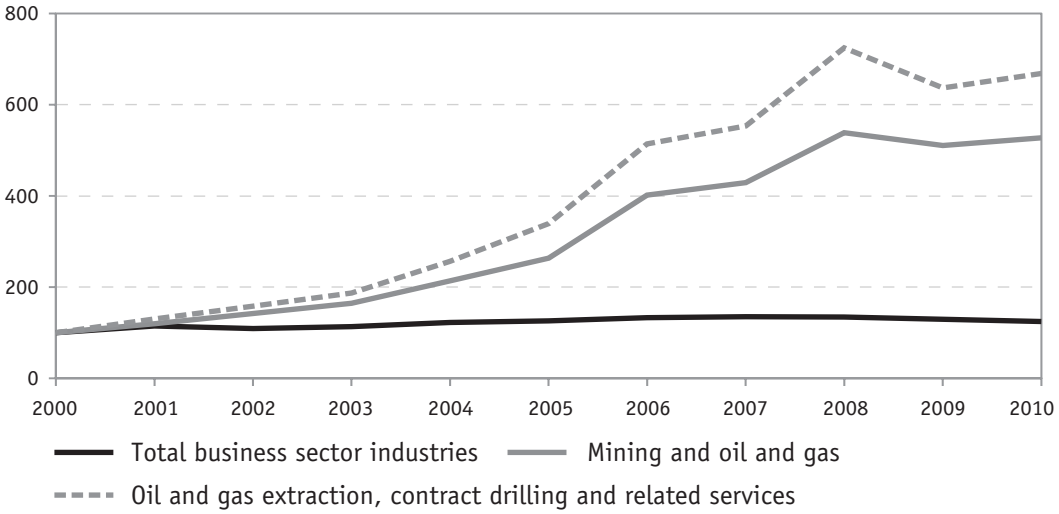
Innovation Effects: Business Expenditures on Research and Development

Productivity growth is driven by innovation, and innovation in turn is spurred by competition. There are several channels by which the rapid development of the oil and gas sector can foster innovation in the sector itself and in other sectors. First, the high profits arising from eco-

Chart 8

Trends in Nominal BERD Expenditures for Total Economy, Mining and Oil and Gas, and Oil and Gas Extraction, 2000-2010

(Index, 2000 = 100)



Sources: Statistics Canada, CANSIM Tables 358-0161 and 358-0024.

nomic rents in the oil and gas sector give firms the resources to undertake R&D. Second, technologies developed in the oil and gas sector can have spillover effects on other sectors. Third, a robust oil and gas sector can create greater opportunities throughout the economy, leading to more firms entering the market and fostering competition, spurring the adoption of best practices because of the increased competitive intensity. This section examines the first of these effects, using information about business expenditures on research and development (BERD).

Profits in oil and gas extraction and support activities in Canada were strong in the 2000s, rising from around $20 billion in 2000 to a peak of $37 billion in 2008 before plummeting with the financial crisis and fall in oil prices. Although oil prices have rebounded significantly since 2009, the weakness of natural gas prices has meant that total profits in the oil and gas sector had not regained their 2000 level by 2011. For much of the 2000s, the profit margin of the oil and gas sector was double that of the industrial aggregate. The high profits of the oil and gas sector between 2000 and 2008 meant that resources were available to expand R&D.

Indeed, increasing profits in the oil and gas sector led to a marked increase in its business expenditures for research and development (BERD) for both Canada and Alberta. Between 2000 and 2007, BERD expenditures grew in all industries, at 4.4 per cent annually for Canada. The oil and gas extraction, contract drilling and related services sub-sector charted impressive annual growth in R&D, at 27.7 per cent nationwide. Since 2007, however, BERD spending overall gradually declined. Canadian total industry spending fell 1.0 per cent per year, and in Newfoundland and Labrador it fell by 5.8 per cent per year.

Chart 8 shows BERD expenditure for the mining and oil and gas sectors as well as for the total economy. While total industry BERD has increased moderately since 2000, total expenditure within oil and gas extraction soared

from $129 million in 2000 to $839 million in 2010. As a result, BERD expenditure of Canada's oil and gas extraction sector increased as a proportion of total BERD spending for all industries, from 1 per cent to over 5 per cent.

In Alberta, virtually all mining and oil and gas business sector R&D spending falls within the oil and gas extraction, contract drilling and related services sector. Alberta itself accounts for most national BERD spending within the oil and gas extraction sector, at $478 million out of $821 million dollars in 2011 (58 per cent).

Between 2000 and 2007, BERD expenditures grew sharply in all Albertan industries, at 13.9 per cent per year, and a large part of this growth was contributed by the oil and gas contract extraction, contract drilling and related services subsector, where spending grew at an annual rate of 24.1 per cent. Since 2007, however, BERD spending has gradually declined, at an average annual rate of 1.6 per cent for Alberta, though only at 0.2 per cent for the mining and oil and gas extraction sector.

As for Newfoundland and Labrador, business sector R&D expenditures grew by 13.4 per cent per year, $20 million in 2000 to $72 million in 2010. This was a faster rate than in Canada and than what the province experienced during the 1987-1997 period, when it grew 7.12 per cent per year. Lack of detail makes it impossible to determine if this increase came from the oil and gas sector or from other parts of the business sector.

Effects on Government Spending

A key characteristic of the oil and gas sector is that when prices are high, substantial rents are accrued to governments, who benefit from corporate and income taxes, as well as taxes and royalties from the resources themselves.[5] High government revenues permit increased expenditures, which can be allocated to productivity-enhancing investments such as postsecondary education or R&D. In this way, the oil and gas boom may indirectly improve productivity within the Canadian economy through increased government spending.

Total Revenues and Spending per Capita

In the recent period of rapid growth in Canada's oil and gas extraction industry, the provincial governments of Alberta and Newfoundland and Labrador have enjoyed fast-growing revenues. Since 1997, per capita government revenues have increased annually for these two provinces at 6.5 per cent and 4.8 per cent respectively, compared to 4.3 per cent for the provincial average. In 2009, per capita government revenues in Newfoundland and Labrador were 48 per cent greater than the average of the 10 provinces.

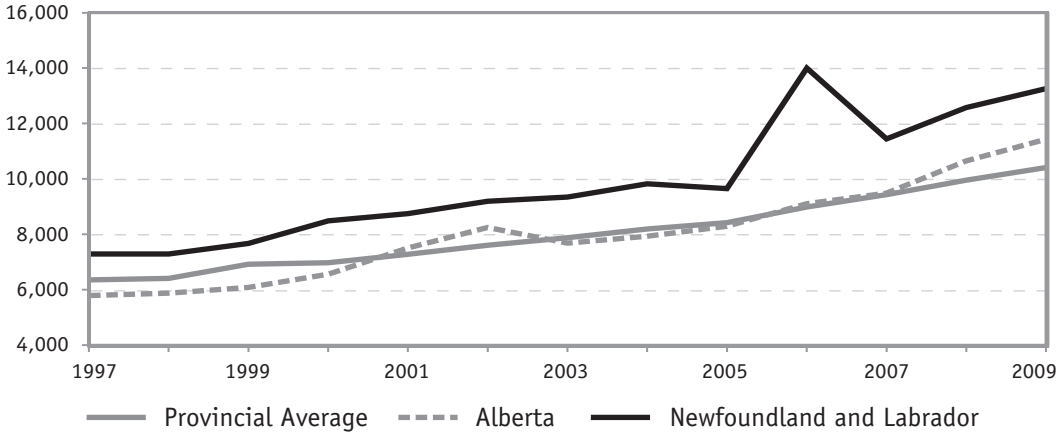
Increased revenues permit increased expenditures, including investments in productivity-enhancing activities. In the past 25 years, Alberta and Newfoundland and Labrador have both, on average, spent more per capita than the other provinces, and this remains true as of 2009 (Chart 9). While average expenditure per capita within the provinces grew annually at 4.2 per cent between 1997 and 2009; the growth rate for Alberta was 5.8 per cent per year, and 5.1 in Newfoundland and Labrador. As of 2009, provincial government spending in these provinces was 10 per cent and 27 per cent greater than the provincial average, respectively.

Expenditures on Post-secondary Education

Spending on postsecondary education is one of the principal ways in which governments may

5 A Conference Board of Canada (2012) study estimates that oil sands investment will generate $45.3 billion in federal revenues and $34.1 billion in provincial revenues between 2012 and 2035 on an inflation-adjusted basis.

Chart 9
Government Expenditure per Capita in Alberta and Newfoundland and Labrador, 1997-2009
(current dollars)



Source: Statistics Canada. CANSIM Table 385-0001.

attempt to boost productivity in the long run. Provincial responses in terms of this type of expenditure vary according to province. Postsecondary education spending per capita in Newfoundland and Labrador has consistently hovered around the provincial average since 1997, and as of 2009 had even fallen slightly, with postsecondary expenditure growing at just 4.9 per cent per year, compared to 5.6 per cent for all provinces. Alberta, on the other hand, has invested more aggressively in postsecondary education, with per capita expenditures growing at 7.0 per cent annually since 1997, and by 2009 was spending 22 per cent more than the provincial average (approximately $1,380 per person versus $1,130).

Support for R&D

Funding research and development is another channel by which governments may improve long-term productivity. This funding may be for government R&D, support for higher education or for business R&D. Newfoundland and Labrador and Alberta are among the top three provinces where government funding for R&D has grown the fastest, at 11.7 and 8.4 per cent annually, compared with a (weighted) provincial average of 6.7 per cent per year. This indicates that these two provinces are using the additional government revenues arising from oil and gas exploitation for productivity enhancement.

Demand Effects

The development of the oil and gas sector has important effects on others sectors of the economy, both in the province of production and in other provinces. The oil and gas sector purchases intermediate inputs and capital equipment from other sectors and the incomes generated in the oil and gas sectors are in turn spent on goods and services. Such effects boost demand for goods and services, which affects capacity utilization, a key determinant of productivity growth. Unfortunately, estimates of capacity utilization rates are not available by province, so the impact of the oil and gas sector on capacity utilization in Alberta and Newfoundland and Labrador cannot be assessed.

Investment in the oil and gas sector increased from $21 billion in 2000 to $41 bil-

lion by 2005 and $59 billion in 2012. The Conference Board of Canada (2012), in a study of the economic benefits of oil sands investment for Canada's regions, estimated the supply chain effects of the oil sands. The study found that between 2012 and 2035 the expected investment of $364 billion on oil sand development is expected to generate 1.45 million person years of employment through supply chain effects that will be felt across a wide range of industries. While around two-thirds of the benefits will accrue to Alberta, Ontario will receive 14.8 per cent, British Columbia 6.7 per cent and Quebec 3.9 per cent. This increased demand will have positive implication for productivity growth through increased rates of capacity utilization and economies of scale and scope.

The oil boom generated large amounts of income. Governments claimed a large share of the natural resource rents, and spent some of this on R&D and education, as discussed earlier. A good part of the natural resource rents, however, is collected by the industry as profits and remuneration of employees. These incomes are in turn spent on goods and services, boosting output, capacity utilization and productivity.

Conclusion

The article has five main conclusions. First, the oil and gas sector did indeed experience a major fall in labour productivity growth since 2000, -6.4 per cent per year between 2000 and 2012. This development is largely explained by high oil prices which made it profitable to develop reserves where more labour was needed to extract a barrel of oil, including both conventional deposits and the oil sands.

Second, despite the negative within-sector labour productivity growth in the oil and gas sector, the overall contribution of the sector to business sector labour productivity was small. This was because of a large positive reallocation effect. In 2010, the average labour productivity in the sector was 10 times the all-industry average. This meant that the rise in the share of total business sector hours worked in the oil and gas sector from 0.4 per cent in 2000 to 0.8 per cent in 2010 offset the negative within sector productivity effect.

Third, the oil and gas sector did have a negative effect on manufacturing productivity and hence on business sector labour productivity growth through its effect on the value of the Canadian dollar, a phenomenon known as Dutch Disease. It is estimated that around one half of the appreciation of the exchange rate was due to domestic factors, especially commodity price increases, mostly oil and gas prices. This development in turn led to a major decline in Canada's international cost competitiveness, resulting in a fall in exports of manufactured products.

Falls in output growth in manufacturing are closely associated with falls in productivity. Manufacturing output growth in Canada fell from 3.3 per cent per year in the 1981-2000 period to -1.2 per cent in the 2000-2012 period while output per hour growth in the sector fell from 2.9 to 0.7 per cent per year. With only 15 per cent of total hours worked in 2012, manufacturing accounted for 40 per cent of the post-2000 fall-off in business sector labour productivity growth.

Fourth, the oil and gas sector was found to have positive productivity impacts though various mechanisms. The increased economic activity related to the oil and gas sector boosted wages, which would lead to greater substitution of capital for labour, increasing labour productivity. The increased profits of oil firms boosted R&D spending. Higher government revenues from the oil and gas sector lead to greater spending on education and R&D. However, because the oil and gas sector is concentrated in Alberta and Newfoundland and Labrador, these effects

were largely regional in nature and had limited effects at the national level. Demand from the industry for inputs and investment goods, and from the personal income of the workforce of the industry has boosted activity throughout the economy and particularly in the major oil-producing provinces, with positive effects on productivity.

Fifth, enrolment in post-secondary education of young people did not keep up with national trends in Alberta because of well-paying employment opportunities for youth. In Newfoundland and Labrador post-secondary enrolment increased to close to the national level.

Sixth, while labour productivity growth in the oil and gas sector was strongly negative over the 2000s, it fell more rapidly in the first half of the decade. Since 2007, the productivity level in the non-conventional sub-sector has increased at a high rate. This bodes well for the future contribution of the sector to aggregate productivity growth as the importance of the oil sands in the overall sector is expected to rise.

To conclude, the oil and gas boom has not been the main cause of the slowdown in labour productivity growth in Canada since 2000. However, it has contributed to this development both directly though the large fall in labour productivity in the sector (although offset by positive reallocation effects), and more importantly, through its effects on the exchange rate and the competiveness of the Canadian manufacturing sector.

Of course, as stressed at the beginning of this article, increases in living standards do not only come from productivity growth, but also from improved terms of trade. The dampening of living standards growth though slower productivity growth arising from the oil boom has been largely offset by this development. Real GDI, which incorporates terms of trade effects, grew 0.4 percentage points faster than real GDP (2.3 per cent versus 1.9 per cent per year) in Canada from 2000 to 2012. In 2012, gross domestic income was 4.7% higher than it would have been without improvement of the terms of trade. From this perspective, the oil boom has contributed significantly to Canadian prosperity.

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