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CENTRE FOR THE STUDY OF LIVING STANDARDS

UNBUNDLING CANADA'S WEAK PRODUCTIVITY PERFORMANCE: THE WAY FORWARD

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Unbundling Canada's Weak Productivity Performance: The Way Forward

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Abstract

This report aims to accomplish three objectives: provide an assessment of Canada's productivity performance; provide a synthesis of the productivity studies conducted by the Centre for the Study of Living Standards (CSLS) and the McKinsey Global Institute; and develop a framework for unbundling slow productivity growth in Canada and the widening productivity gap with the United States.

Unbundling Canada's Weak Productivity Performance: The Way Forward

Executive Summary

The objective of the paper is to assist Industry Canada in putting in place a research program to understand better the role of government marketplace framework policies and other industry-specific factors in the productivity performance of Canadian industries relative to their US counterparts. It is well recognized that analytical work seeking a better understanding of the determinants of industry-specific productivity performance is crucial for the development of effective marketplace framework policy reforms. A successful policy-research program requires research priorities to be set, investigation strategies to be thought out and elaborated, and collaborative arrangements with outside stakeholders to be established.

This report aims to accomplish three objectives: provide an assessment of Canada's productivity performance; provide a synthesis of the productivity studies conducted by the Centre for the Study of Living Standards (CSLS) and the McKinsey Global Institute; and develop a framework for unbundling slow productivity growth in Canada and the widening productivity gap with the United States.

Canada's labour productivity growth has been weak in recent years, both from an historical and international perspective. Labour productivity growth in Canada between 2000 and 2007 averaged 1.0 per cent per year, well below the annual average growth of 1.5 per cent recorded between 1973 and 2000 and below the 4.0 per cent per year recorded during the golden era of 1947-1973. Canada's performance also stands in stark contrast to that of the United States, where labour productivity grew by 2.5 per cent per year over the 2000-2007 period. Canada's post-2000 productivity performance was weak not only relative to the United States and to earlier periods, but also relative to other OECD countries. Indeed, the Conference Board/GGDC (Groningen Growth and Development Centre) total economy database places Canada 21 out of 30 OECD countries in terms of labour productivity growth over the 2000-2007 period and 27 in the 1973-2000 period.

In 2008, Canada's business sector output per hour stood at only 73.5 per cent the US level, down from 82.5 per cent in 2000. The lackluster productivity performance of Canada relative to the United States was fuelled by weak multifactor productivity (MFP) growth in Canada relative to the United States. An industry decomposition suggests that while the mining and oil and gas sector in Canada pulled down aggregate labour productivity growth because of its negative labour productivity growth since 2000, this effect was outweighed by the effect of reallocating labour from lower productivity level industries to the higher productivity level mining and oil and gas industry. The key change from previous periods was the decline in the importance of the manufacturing sector, with labour productivity growth in this industry since 2000 lower than in previous periods and 2000-2007 (from 2.9 per cent in 1973-2000 to 1.1 per cent in 2000-2007), in

addition to the negative effect of the decline in hours worked in this above-average productivity level industry.

New data on provincial MFP also provide interesting insights. Over the 1997-2007 period, both labour productivity and MFP growth were lowest in Alberta. The poor performance of Alberta was fuelled by its large mining and oil and gas sector, but was not restricted to this sector. In contrast, Newfoundland and Labrador experienced the largest increase in labour productivity and MFP of all provinces over the period. The mining and oil and gas sector was also at the centre of the story, but unlike in Alberta it boosted rather than deflated labour productivity and MFP growth in the province.

In recent years the CSLS has undertaken a number of studies on various aspects of productivity. These studies can be classified into a number of areas: measurement issues, policy, productivity drivers, industry studies, and studies related to productivity and well-being.

A number of common themes can be traced through the research undertaken at the CSLS. Fundamentally, almost all CSLS research is based on an empirical, rather than a theoretical, approach. Whereas academic research often sets out to test a theory, CSLS research more often seeks out patterns by comparing trends in productivity over time or across provinces, industries, or countries. A second distinguishing feature of the CSLS approach is that most research is oriented towards providing practical policy recommendations. Finally, CSLS research generally tries to situate productivity within the broader context of living standards and economic and social well-being. At the core of the mission of the CSLS is the notion that productivity is an important driver of economic and social well-being, but that it is only one of many drivers. Many policies to improve productivity may have undesirable effects on well-being, and CSLS research often highlights such tradeoffs.

The McKinsey Global Institute (MGI) was founded with the objective of analyzing international productivity levels from both economic and management perspectives. In 2008 MGI released a study focusing on Canada entitled *Breaking Away from the Pack: Enhancing Canada's Global Competitiveness*. This study sought to stimulate discussion on what Canada and its companies could do to improve their ability to innovate and thus become more competitive globally. McKinsey identified three key elements of innovation: flexible and dynamic capital markets; collaboration between the public and private sectors; and cultural encouragement of innovation. In each of these areas they made recommendations to improve innovation, including by restructuring capital markets, enabling greater collaboration between stakeholders, and providing more encouragement to successful entrepreneurs.

In the productivity area, the ground left to be covered by research is extremely large. Given the breadth in possible research areas, results can best be obtained with a clearly defined research agenda. For such an agenda to develop, an overarching question or framework is needed. This question should not only set the objective of the research agenda, but also help to prioritize research projects needed to achieve this objective. In

terms of an overarching research question on productivity in Canada we propose the following:

> What explains Canada's slow productivity growth relative to the United States since 1980 and the ensuing widening of the productivity gap?

The framework is articulated in five phases. First, the overarching research question is posed. This then leads to the research diagnostic phase where steps are taken to identify the salient characteristics or key stylized facts of the situation. The research diagnostic phase includes five components: mismeasurement linked to data issues; decompositions, that is the disaggregation of aggregate labour productivity growth along various dimensions including within industry/reallocation effects, by industry, and by province or region; the identification of the proximate sources of labour productivity growth through growth accounting, an assessment of the drivers of productivity growth; and an assessment of the macro and micro economic framework policies influencing productivity growth.

The key findings from the diagnostic phase then lead to the identification of key knowledge gaps to be addressed through research. The CSLS identified nine important knowledge gaps:

- Relative to the United States, Canada has a smaller share of managers with university education, particularly business training at both the undergraduate and graduate levels. This situation has been suggested as a factor contributing to lower relative productivity levels in this country.
- In Canada, a few industries display long-term negative productivity growth. In modern economies, there are few if any examples of technical regress. This means that in the industries that experience negative labour productivity growth according to the official statistics, mismeasurement issues are likely to be at play and may affect the relative ranking of Canada's productivity performance.
- A key stylized fact that emerged from the diagnosis of Canada's labour productivity gap with the United States is the much lower level of ICT investment and capital stock per worker in Canada relative to the United States. The reasons for this situation represent a major knowledge gap in our understanding of the differences in productivity drivers between the two countries.
- The gap in business expenditure on R&D intensity (BERD) accounts for the entire gap in total economy or gross (expenditure on R&D intensity (GERD) between Canada and the United States. Given the importance of BERD for productivity growth, explaining this gap is of particular importance.
- Canada has a significantly smaller proportion of university graduates than the United States, but a larger proportion of post-secondary graduates. A key knowledge gap is the difference in the overall quality and quantity of human capital possessed by a typical university graduate compared to a typical community college graduate and how it may impact the Canada/US productivity gap.

- In 2008, of 27 countries studied, Canada ranked seventh in the restrictiveness of anti-competitive regulation in the retail distribution industry. Moreover, Canada had the fifth most restrictive regulation in four professional services: accounting, legal, architecture, and engineering. A knowledge gap is the potential productivity gains that would obtain from deregulation of these sectors.
- Canada is less urbanized than the United States. Given that agglomeration and scale economies can have a positive impact of productivity growth, Canada's lower urbanization level relative to the United States could play a significant role in the productivity gap between the two countries.
- Canada has the second highest rate of higher education R&D/GDP (HERD) ratio in among OECD countries, with only Sweden higher. Canada's HERD intensity has increased significantly in recent years as the federal government has increased funding to universities. A key rationale for this increased support for higher education R&D has been to boost Canada's productivity performance. But the linkages between HERD and business sector productivity are poorly understood, making this an important knowledge gap.
- The decoupling of labour productivity growth in Canada and the United States in the early 2000s coincided with significant shocks to the Canadian economy which, it has been posited, have imposed significant adjustment costs on firms and thus reduced labour and multifactor productivity growth in Canada. The importance of this factor for the widening of the Canada-US productivity gap is unknown – it is still a knowledge gap.

Then comes the phase where research strategies are developed and methodologies chosen to investigate the knowledge gaps. Various methodologies and datasets can be used: literature surveys; econometric analysis; micro-data sets; case studies; key informant interviews; plant visits; new surveys or survey questions; and collaborative research arrangements. The final phase of the framework is the policy recommendation phase where the results of the research projects are used or filtered to identify and develop policy initiatives to improve or foster productivity growth.

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Unbundling Canada's Weak Productivity Performance: The Way Forward[1]

The objective of the paper is to assist Industry Canada in putting in place a research program to understand better the role of government marketplace framework policies and other industry-specific factors in the productivity performance of Canadian industries relative to their US counterparts. It is well recognized that analytical work seeking a better understanding of the determinants of industry-specific productivity performance is crucial for the development of effective marketplace framework policy reforms. A successful policy-research program requires research priorities to be set, investigation strategies to be thought out and elaborated, and collaborative arrangements with outside stakeholders to be established.

This report is divided into three major parts. The first section provides an assessment of Canada's productivity performance from a number of perspectives. The second section provides a synthesis of the productivity studies conducted by the Centre for the Study of Living Standards and the McKinsey Global Institute. The third section, the most important, develops a framework for unbundling slow productivity growth in Canada and the widening productivity gap with the United States. It provides a diagnostic of this situation, identifies nine knowledge gaps and outlines research strategies and methodologies to address these gaps.

I. Canada's Recent Productivity Performance in Perspective[2]

Productivity is by far the most important driver of living standards for Canadians. This is because real income can only increase in the long run if more real output is produced.[3] While increased productivity growth is generally associated with higher wages, it also brings to life a new world of possibilities for Canadians. Higher productivity means that Canadians will be able to meet the fiscal pressures associated with an aging population. It means the possibility of more health care funding. It means that workers will have the option of benefiting from increased leisure. In short, productivity growth is vital to the economic success of Canadians.[4] From this

[1] This paper was presented at the Expert Panel on Canada's Productivity Performance held at Industry Canada on April 24, 2009. The authors would like to thank Someshwar Rao and Jianmin Tang of Industry Canada for comments, and Jean-Francois Arsenault and Peter Harrison for research assistance. Email: andrew.sharpe@csls.ca

[2] This section draws on Arsenault and Sharpe (2008).

[3] Terms of trade can also lead to an increase in real incomes, as has been the case in Canada in recent years due in large part to the sharp increase in commodity prices (MacDonald, 2008). Yet, given the uncertain outlook for commodity prices, the future contribution of terms of trade to income in Canada is not obvious and, unlike productivity gains, terms of trade have the potential to contribute negatively to real income as seen in 2008 with falling commodity prices.

[4] See Sharpe (2007) for a discussion of the importance of productivity.

perspective, Canada's weak productivity performance since 2000 represents a massive shortfall.[5]

In order to assess the importance of government policies on productivity growth, it is important to have an understanding of the trends in productivity growth and the factors behind these trends. Such knowledge provides the context for discussion of the impact on productivity growth of economic policy.

A. Labour Productivity Trends

Business sector real output per hour, which is the official measure of labour productivity produced by both Statistics Canada and the US Bureau of Labor Statistics, grew on average 1.0 per cent in Canada over the peak-to-peak 2000-2007 period (Chart 1).[6] In 2008, output per hour growth fell 1.1 per cent, with output declining 0.3 per cent while hours worked increased by 0.8 per cent. Canada's performance stands in stark contrast to that of the United States, which recorded labour productivity growth of 2.5 per cent per year over the 2000-2007 period and 2.7 per cent in 2008.

Canada's post-2000 productivity performance has been weak by historical standards. It was significantly weaker than between 1996 and 2000 (2.9 per cent). Labour productivity growth was also below the annual average growth of 1.5 per cent recorded between 1973 and 2000 and below the 4.0 per cent per year recorded during the golden era of 1947-1973 (Chart 2). Canada's post-2000 productivity performance was weak not only relative to the United States and to earlier periods, but also relative to other OECD countries. Indeed, the Conference Board/GGDC total economy database places Canada 21st out of 30 OECD countries in terms of labour productivity growth over the 2000-2007 period (Chart 3) and 27th in the 1973-2000 period.

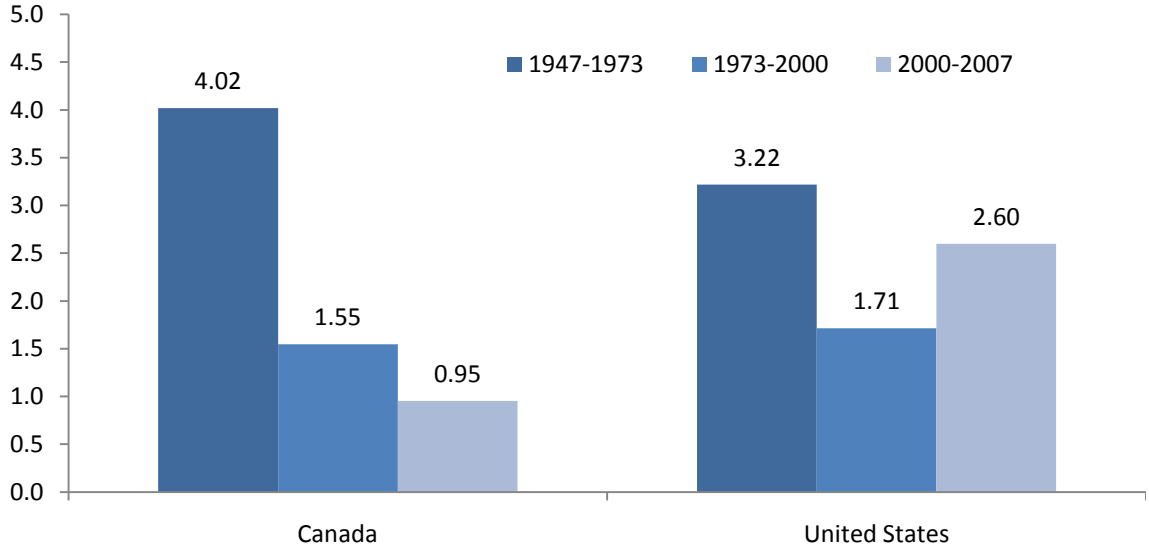
[5] See Arsenault and Sharpe (2008:15-17) for a discussion of what the Canadian economic landscape would have been in 2007 under two alternative scenarios of productivity growth relative to actual developments. In the first scenario, it is assumed that labour productivity since 2000 grows at the same rate as that experienced in the United States over the 2000-2007 period. The second scenario assumes that labour productivity grew at the historical trend established over the 1973-2000 period in Canada. The impacts on GDP, annual hours worked, GDP per capita and GDP per hour are provided.

[6] Aggregate labour productivity can be measured at the total economy and business sector level. Each measure has strengths and weaknesses. Indeed, the business sector measure suffers from less severe measurement issues than the total economy measure as it excludes industries such as education and health where output is generally not marketed. On the other hand, total economy measures are consistent with GDP per capita and are advantageous for international comparability since, unlike the business sector measures, the definition of what industries are included in the total economy does not differ across countries. See Smith (2004) for a detailed discussion of issues related to the appropriate measurement of aggregate labour productivity.

Chart 1: Real Output per Hour Growth, Business Sector, Canada and the United States, Average Annual Rates of Change, Per Cent, 1973-2008

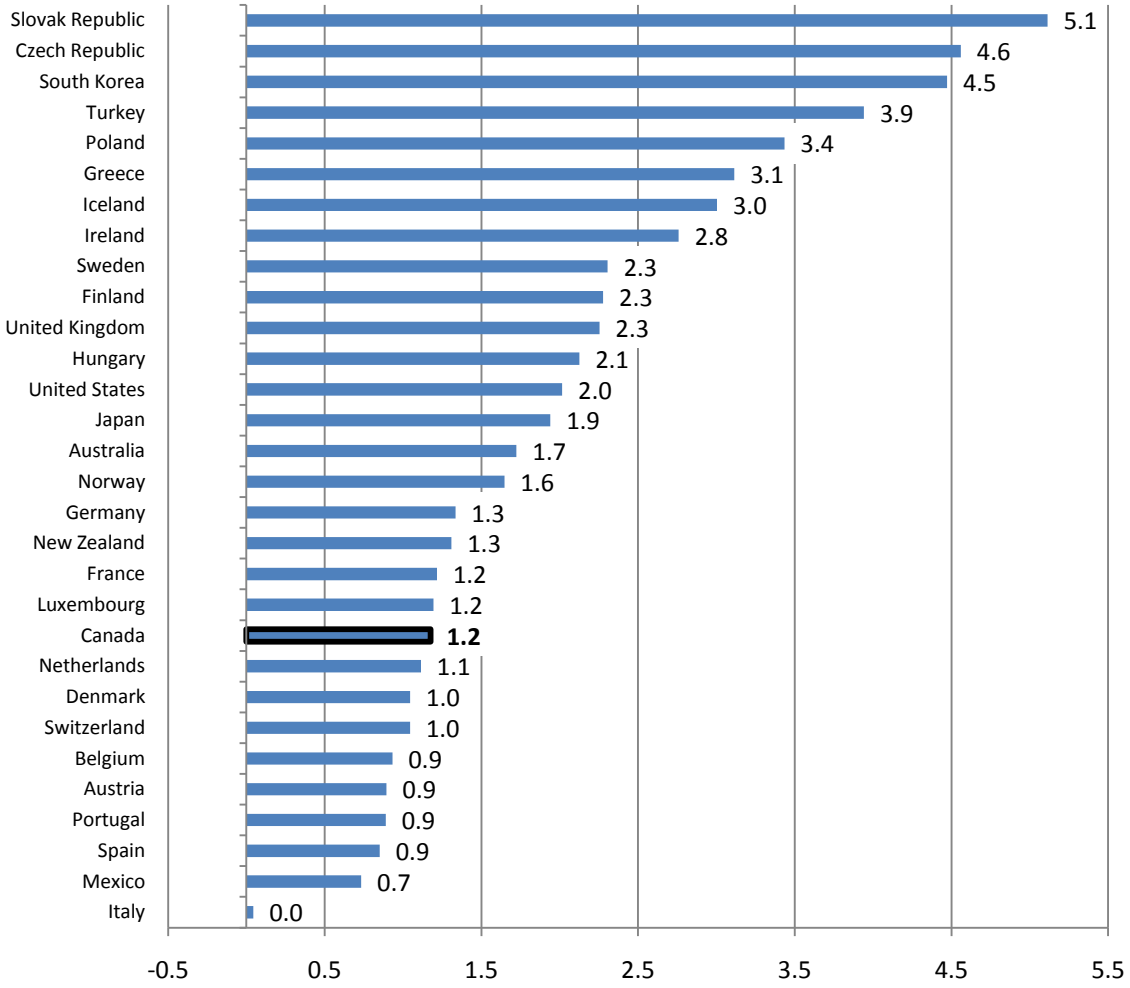
Sources: CSLS Canada-US Productivity database. www.csls.ca.Canada.

Chart 2: Real Output per Hour Growth, Business Sector, Canada and the United States, Average Annual Rates, Per Cent, 1947-2007



Sources: GDP in chained dollars and total hours worked from the Productivity and Costs Program of the Bureau of Labor Statistics for the United States, and annual averages of quarterly estimates from the Productivity Program Database of Statistics Canada for Canada.

Chart 3: GDP per Hour Worked Growth in OECD Countries, 2000-2007 (Compound Annual Rate of Growth, Per Cent)



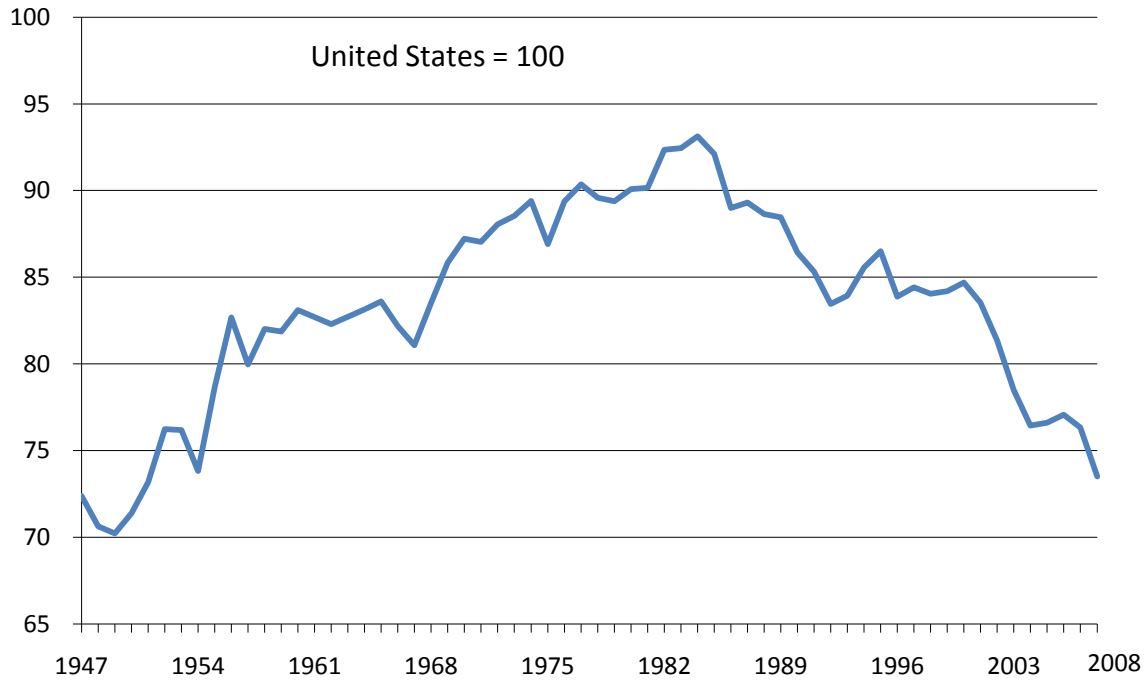
Source: Groningen Growth and Development Centre: www.ggdc.net.

Labour productivity growth is the difference between real output growth and labour input growth. Trends in output growth in the business sector in Canada and the United States have been almost identical between 2000 and 2007, with annual output growth averaging 2.5 and 2.6 per cent respectively. In both countries, average annual output growth between 2000 and 2007 was only about half that of the 1996-2000 period and was slightly below that of the 1973-1996 period.

Business sector total hours worked in Canada increased at an average annual rate of 1.5 per cent between 2000 and 2007, identical to the trend observed between 1973 and 2000. In contrast, in the United States, business sector hours worked did not grow on average over the 2000-2007 period, largely reflecting the sharp recession of the early 2000s south of the border. With output growing at a similar pace in both countries, it was the large difference in labour input growth since 2000 that led to a divergence in labour productivity growth between Canada and the United States.

While Canada's trend productivity growth rate seems to have declined in recent years, its closest neighbour appears to have shifted to higher trend productivity growth.[7] The strong performance during the 1996-2000 period suggested that Canada might follow the path opened by the United States and experience a revival of its labour productivity growth (Chart 1). This, however, did not materialize and the dichotomy in the labour productivity performance of Canada and the United States, particularly since 2000, led to a further widening of the Canada-US productivity gap. In 2008, Canada's business sector output per hour stood at only 73.5 per cent the US level, down from 82.5 per cent in 2000 (Chart 4).

Chart 4: Real Output per Hour Worked, Business Sector, Canada as a Percentage of the US Level, 1947-2008



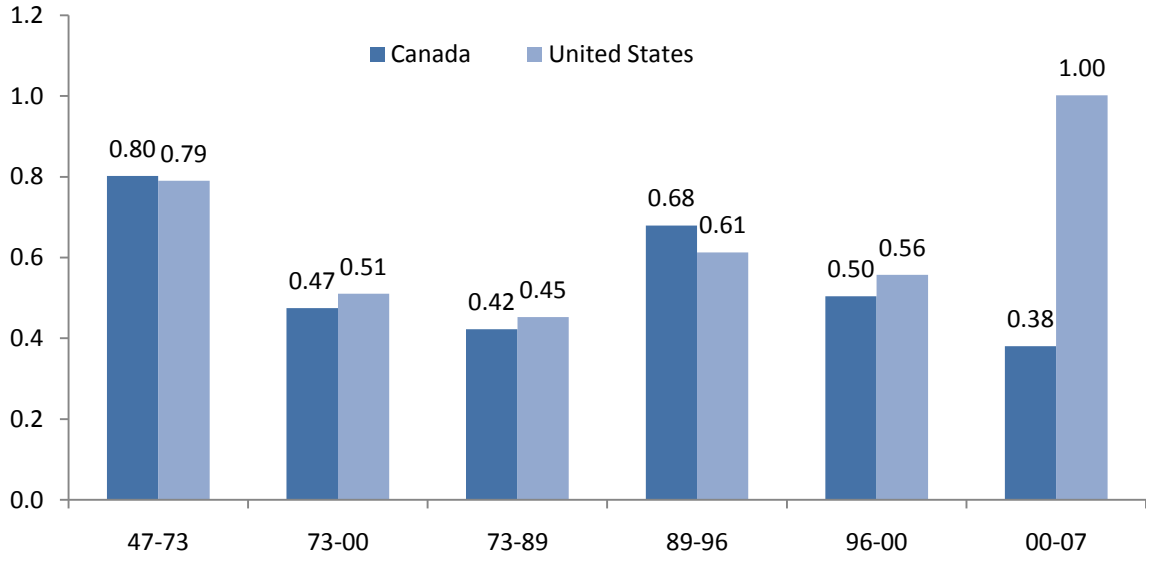
Sources: CSLS Aggregate Income and Productivity Database (http://www.csls.ca/data/ipt1.asp), Table 7a.

Diverging productivity trends in Canada and the United States are even more puzzling given the similarity of output growth trends. This is probably best exemplified by the behaviour of productivity elasticity, that is the proportion of output growth arising from productivity growth. Productivity elasticities in Canada and the United States have closely tracked each other in the two long-term periods 1947-1973 and 1973-2000, as well as for the three recent sub-periods of 1973-1989, 1989-1996 and 1996-2000 (Chart

[7] Skoczylas and Tissot (2005) identify time breaks in productivity growth in OECD countries. Using capacity utilization rates in the manufacturing sector as a proxy to remove cyclicality in business sector productivity, they found that while the United States trend productivity growth increased to 3.00 per cent in the late 1990s (from its 1.25 per cent trend started in the mid 1970s), Canada's trend productivity growth remained at 1.25 per cent, a trend observed since the mid 1970s. Using a HP filter to remove cyclicality gave slightly different results for Canada, with trend productivity growth increasing to 2 per cent in the late 1990s but falling sharply to naught in early 2000s.

5). Since 2000, however, Canada's productivity elasticity has been relatively low, with only 38 per cent of output growth explained by increased labour productivity, slightly below levels of earlier periods. In contrast, the productivity elasticity in the United States was unity, much higher than historical levels. The gap in labour productivity growth rates is thus not only the result of unusual developments in Canada, as evidenced by the decline in productivity elasticity and below average productivity growth since 2000, but also largely a consequence of the atypical behaviour of the US economy, as evidenced by its high productivity elasticity since 2000.

Chart 5: Productivity Elasticity, Business Sector, Canada and the United States, 1947-2007



Sources: GDP in chained dollars and total hours worked from the Productivity and Costs Program of the Bureau of Labor Statistics for the United States, and annual averages of quarterly estimates from the Productivity Program Database of Statistics Canada for Canada.

B. Unbundling Weak Productivity Growth in Canada Since 2000

There exists no consensus on the reasons for the weak productivity performance of the Canadian economy since 2000. While many studies have attempted to identify the effect on productivity in Canada of a host of microeconomic and macroeconomic factors, far fewer studies have focused specifically on the recent productivity performance of Canada.[8] In this section, we provide a growth accounting decomposition of labour productivity growth in Canada in the 1973-2000 and 2000-2007 periods.[9] We also provide a detailed analysis of the role of sector shifts on aggregate productivity growth and discuss productivity growth by industry and province. The following analysis assumes that future statistical revisions will not significantly alter the current productivity

[8] See Dion and Fay (2008) for a review of the recent technical literature on productivity with a focus on Canada. Articles discussing potential reasons for the post-2000 productivity weakness in Canada include Rao, Sharpe and Smith (2005), Gomez (2005), Dion (2007) and Cross (2007) and Arsenault and Sharpe (2008).

[9] The 1973-2000 period is used as a historical benchmark as it is cyclically neutral: initial and end years both were cyclical peaks. It appears that 2007 will be a cyclical output peak so that the 2000-2007 period is also cyclically neutral.

estimates. This is an important caveat as revisions can significantly alter productivity growth as was the case in the late 1990s.[10]

1. A Growth Accounting Perspective

A first step in the identification of the proximate causes of Canada's dismal productivity performance since 2000 is to decompose productivity growth into its main components. Such an exercise provides important insights into the factors affecting labour productivity. Using the neoclassical growth accounting framework and official estimates from Statistics Canada, we decomposed Canada's business sector labour productivity growth into its main accounting components (Summary Table 1). The key findings are as follows:

- Labour productivity growth between 1973 and 2000 averaged 1.66 per cent per year. The contribution of labour composition, or labour quality, was 0.36 points. The contribution of capital services intensity, which includes both capital stock and capital composition, was 1.15 points. Multifactor productivity (MFP) growth contributed only 0.15 points.

- Over the 2000-2007 period, labour productivity growth was 1.06 per cent, down by 0.60 percentage points compared to 1973-2000.

- Growth in labour composition decreased, with its contribution to labour productivity falling slightly by 0.05 percentage points per year (from 0.36 to 0.31 points) between periods. More importantly, both capital services intensity growth and MFP growth decreased, and their contribution to productivity growth fell by 0.14 and 0.41 percentage points respectively when compared to the 1973-2000 period.

- The decrease in capital services intensity growth was due almost exclusively to slower capital composition growth. Indeed, the shift towards Information and Communications Technology (ICT) capital has slowed markedly since 2000, driving the slowdown in the contribution of capital composition.

- Weak growth in capital services intensity in Canada since 2000 when compared to the 1973-2000 period is somewhat puzzling as the ratio of the price of capital to labour fell on average 3.0 per cent per year between 2000 and 2007. In comparison, the ratio of the price of capital goods to labour decreased only 2.0 per cent per year between 1973 and 2000.

[10] In Canada, for example, over the 1997-2000 period revisions added 1.8 points per year between initial and final labour productivity growth estimates (Kaci and Maynard, 2005). In the United States, labour productivity growth for the same three years was revised downward by an average of 0.4 percentage points per year between initial and final estimates. In other words, while the initial statistics suggested a large Canada-US labour productivity growth gap in the late 1990s, the final estimates instead showed that labour productivity growth was actually faster in Canada . The magnitude of the Canadian revisions, however, was in large part due to one-time events: the capitalization of software expenditures and the introduction of new surveys. Moreover, as short-term revisions take place over a four-year cycle, current estimates of labour productivity for the early 2000s can be deemed reliable.

- This growth accounting exercise suggests that the lacklustre productivity performance of Canada since 2000 relative to the 1973-2000 period cannot be attributed to a single factor, but is rather the result of slower growth in both capital services intensity and MFP, with the latter accounting for the lion's share of the decline.

Summary Table 1: Sources of Labour Productivity Growth in the Canadian Business Sector, 1973-2000 and 2000-2007

	1973-2000	2000-2007	Post-2000
	A	B	B - A
Average Annual Rate of Growth			
Output	3.35	2.59	-0.76
Total hours	1.66	1.51	-0.15
Labour composition	0.60	0.54	-0.06
Capital services	4.65	3.90	-0.75
Capital stock	2.86	2.49	-0.36
Capital composition	1.75	1.35	-0.39
ICT capital services	19.56	10.17	-9.38
Non-ICT capital services	3.54	3.24	-0.31
Capital services intensity	2.94	2.35	-0.59
ICT cap. serv. Intensity	17.60	8.53	-9.08
Non-ICT cap. serv. Intensity	1.85	1.70	-0.16
Average Annual Percentage Point Contributions to Labour Productivity Growth			
Labour productivity	1.66	1.06	-0.60
Labour composition	0.36	0.31	-0.05
Capital services intensity	1.15	1.01	-0.14
Capital stock intensity	0.70	0.68	-0.02
Capital composition intensity	0.43	0.32	-0.11
ICT cap. serv. Intensity	0.46	0.34	-0.13
Non-ICT cap. serv. Intensity	0.67	0.66	-0.01
Multifactor productivity	0.15	-0.26	-0.41
Average Annual Percent Contributions to Labour Productivity Growth			
Labour productivity	100.0	100.0	100.0
Labour composition	21.7	29.6	7.8
Capital services intensity	68.9	95.2	22.8
Capital stock intensity	42.2	64.3	3.5
Capital composition intensity	25.9	30.3	18.2
ICT cap. serv. Intensity	27.8	31.7	20.9
Non-ICT cap. serv. Intensity	40.5	62.5	1.8
Multifactor productivity	8.9	-24.5	67.5

Source: CSLS Calculations based on the Canadian Productivity Accounts from Statistics Canada, CANSIM Table 383-0021.

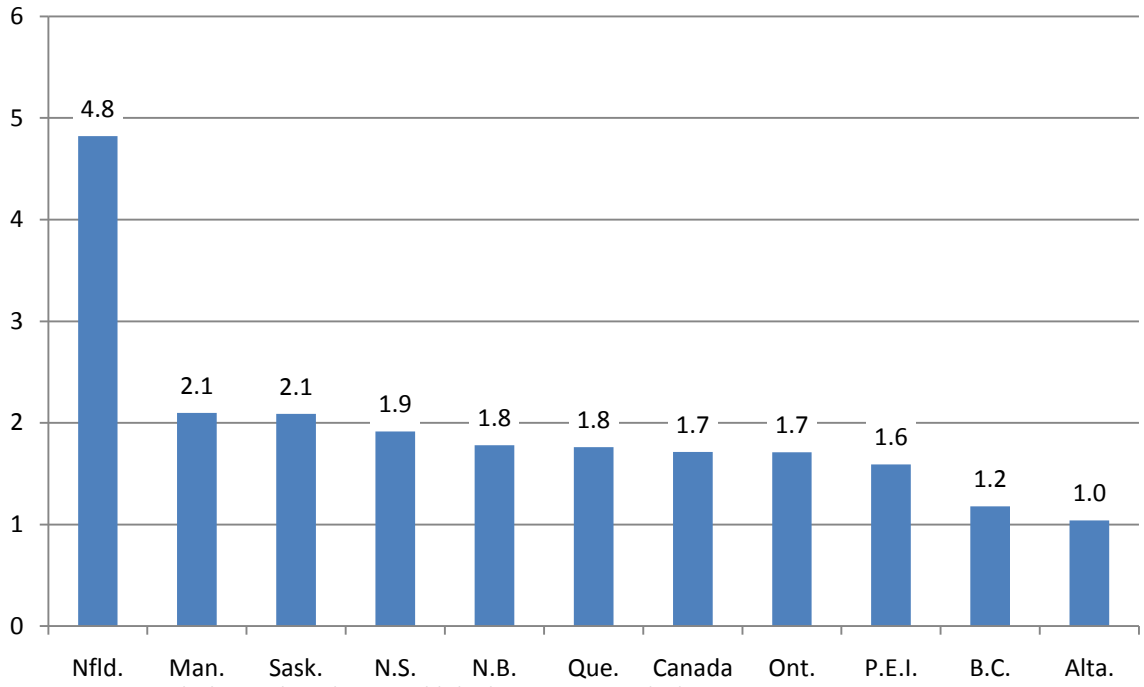
2. A Provincial Perspective

This section of the report provides an overview of the main results from the new provincial multifactor productivity estimates produced by Statistics Canada for the CSLS and the Alberta government.

i. Labour productivity

At the Canada level output per hour in the market sector advanced at a 1.71 average annual rate between 1997 and 2007. The first three years of the period (1997-2000) saw much more rapid productivity growth than the period since 2000: 3.21 per cent per year versus 1.08 per cent. This report will focus on the whole period, not the two sub-periods.

Chart 6: Labour Productivity Growth by Province, 1997-2007
Average Annual Rate of Growth



Source: CSLS calculations based on unpublished Statistics Canada data.

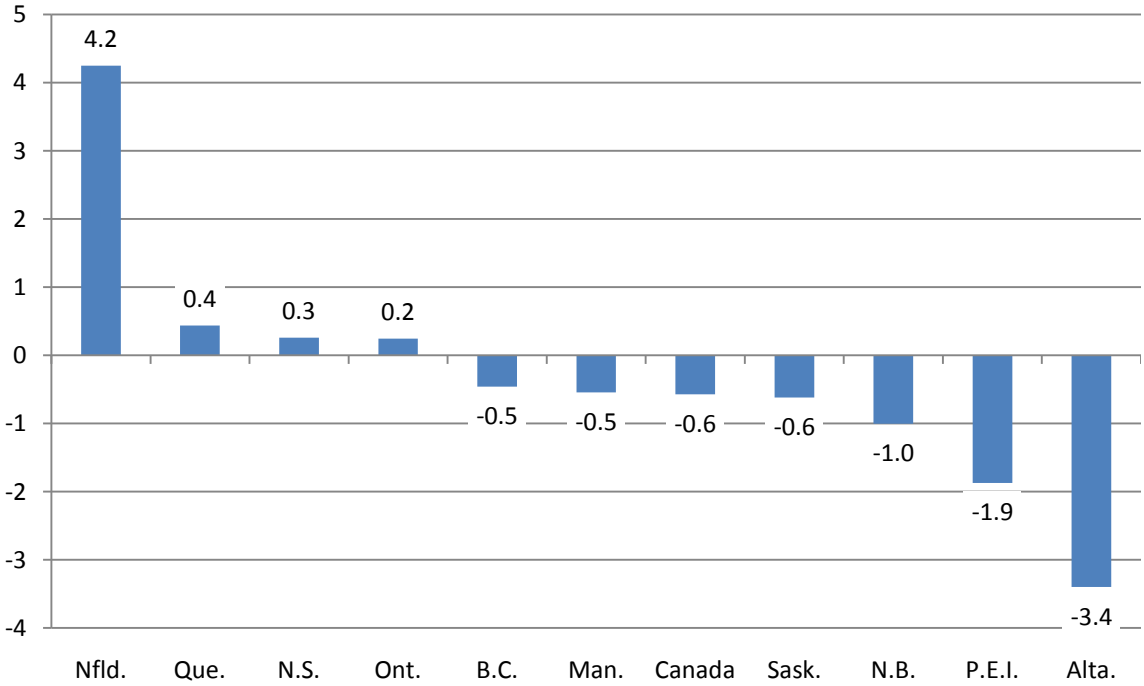
There was significant variation in market sector labour productivity growth by province. Newfoundland[11] was the province with by far the most rapid labour productivity growth. At 4.82 per cent per year from 1997 to 2007, Newfoundland's rate of advance was nearly three times the national average and more than double that of the province with the second fastest labour productivity growth, Manitoba (2.10 per cent). At the other end of the spectrum, Alberta had the weakest productivity growth at 1.04 per cent per year, followed closely by British Columbia at 1.18 per cent.

[11] The term Newfoundland is used to refer the province of Newfoundland and Labrador throughout this report.

ii. Capital Productivity

At the Canada level, capital productivity per hour in the market sector fell at a 0.57 per cent average annual rate between 1997 and 2007. The first three years of the period (1997-2000) saw positive capital productivity growth (1.15 per cent per year), while the period since 2000 has experienced falling capital productivity (-1.30 per cent per year). Again, this report will focus on the whole period, not the two sub-periods.

Chart 7: Capital Productivity Growth by Province, 1997-2007
Average Annual Rate of Growth



Source: CSLS calculations based on unpublished Statistics Canada data.

There was even more variation in market sector capital productivity growth by province than labour productivity. Newfoundland again was the province with by far the most rapid capital productivity growth (4.25 per cent per year). No other province was close. Quebec was second with capital productivity growth at a meager 0.44 per cent. At the other end of the spectrum, Alberta had the worse capital productivity performance, with real GDP per unit of capital services falling at a 3.40 per cent average annual rate.

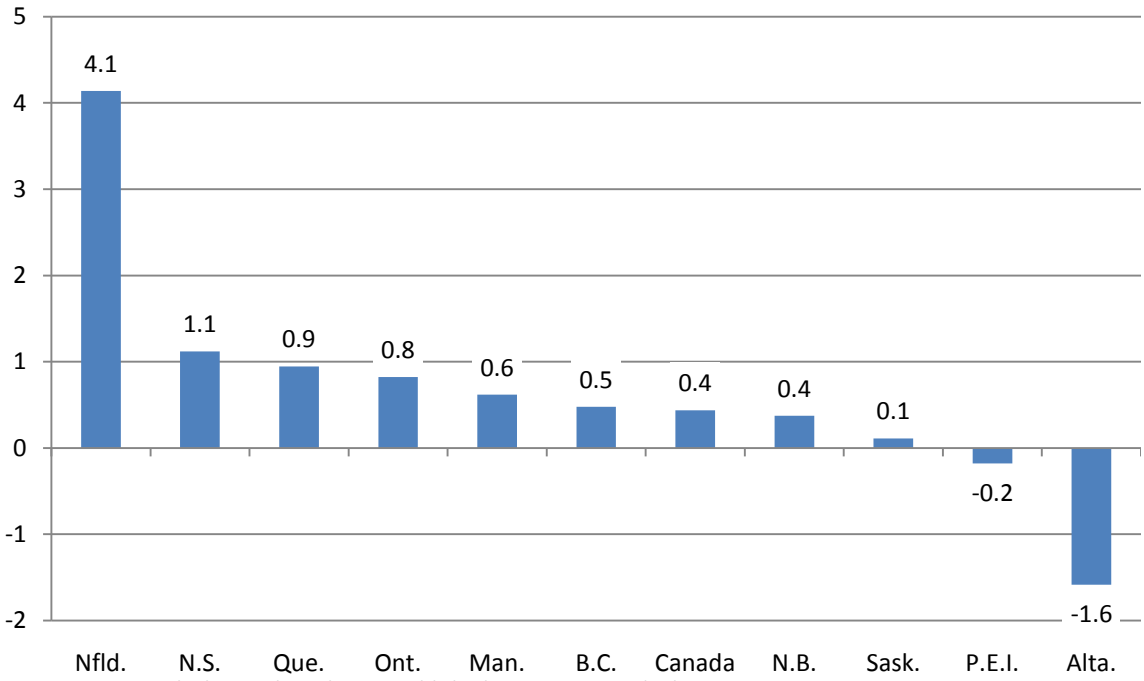
iii. Multifactor Productivity

At the Canada level, multifactor productivity per hour in the market sector rose at a 0.44 average annual rate between 1997 and 2007. The first three years of the period (1997-2000) saw much stronger multifactor productivity growth (2.02 per cent per year), while the period since 2000 has experienced falling multifactor productivity (-0.24 per cent per year). Again, this report will focus on the whole period, not the two sub-periods.

There was more variation in market sector multifactor productivity growth across province than labour productivity, but less than capital productivity growth.

Newfoundland again was the province with by far the most rapid multifactor productivity growth, an impressive 4.14 per cent per year. No other province was close. Nova Scotia was second with multifactor productivity growth at 1.12 per cent, and Quebec third at 0.94 per cent. Alberta had by far the worse multifactor productivity performance, with real GDP per unit of combined labour and capital falling at a 1.58 per cent average annual rate. The only other province to experience negative multifactor productivity growth was Prince Edward Island (-0.18 per cent).

Chart 8: Multifactor Productivity Growth by Province, 1997-2007
Average Annual Rate of Growth



Source: CSLS calculations based on unpublished Statistics Canada data.

3. An Industry Perspective

The provincial multifactor productivity estimates also provide interesting insights at the industry level. In this section we focus on the industry-level results, with particular attention given to Alberta given its particularly poor productivity performance over the 1997-2007 period.

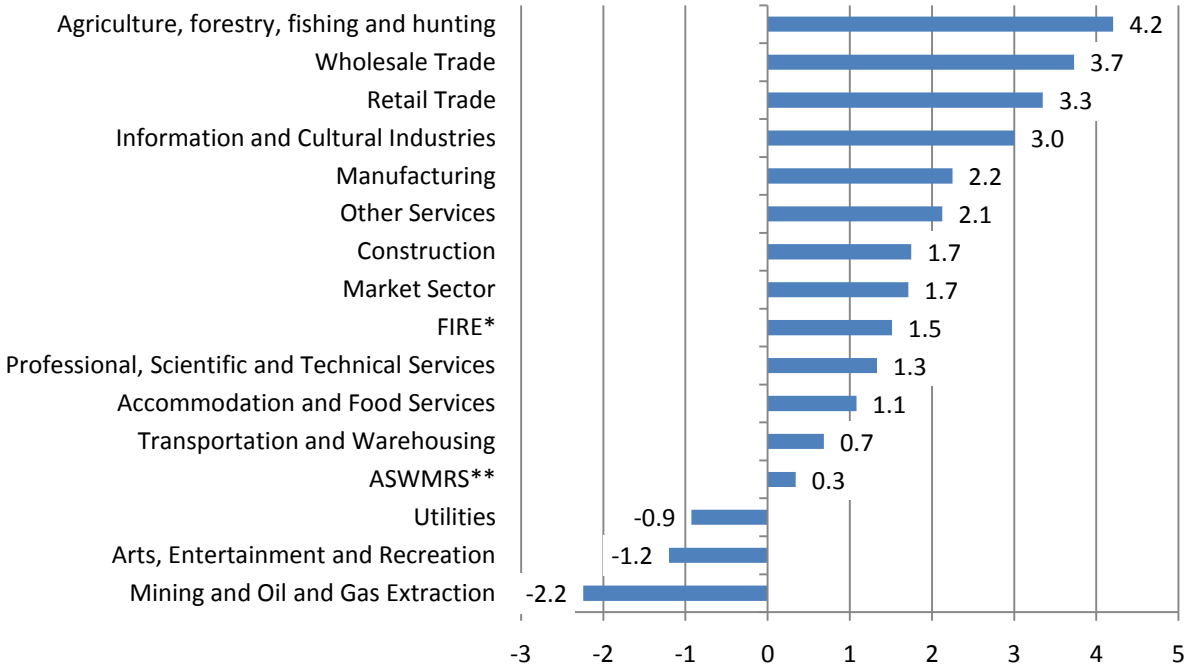
i. Labour productivity

For Canada, the sector experiencing the most rapid labour productivity growth over the 1997-2007 period was agriculture, forestry, fishing and hunting (4.2 per cent per year), followed by wholesale trade (3.7 per cent), retail trade (3.3 per cent) and information and cultural industries (3.0 per cent). At the other end of the spectrum, mining and oil and gas extraction had the worse labour productivity performance, with output per hour falling 2.2 per cent per year. Other sectors with negative labour

productivity growth were arts, entertainment and recreation (-1.2 per cent) and utilities (-0.9 per cent).

The three industries with the fastest labour productivity growth at the national level were also the three industries with the fastest growth in Alberta: 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). Equally, the three industries with the worst productivity performance at the national level were the three industries in Alberta that also experienced the worst performance: 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).

Chart 9: Labour Productivity Growth by Industry in Canada, 1997-2007
Average Annual Rate of Growth



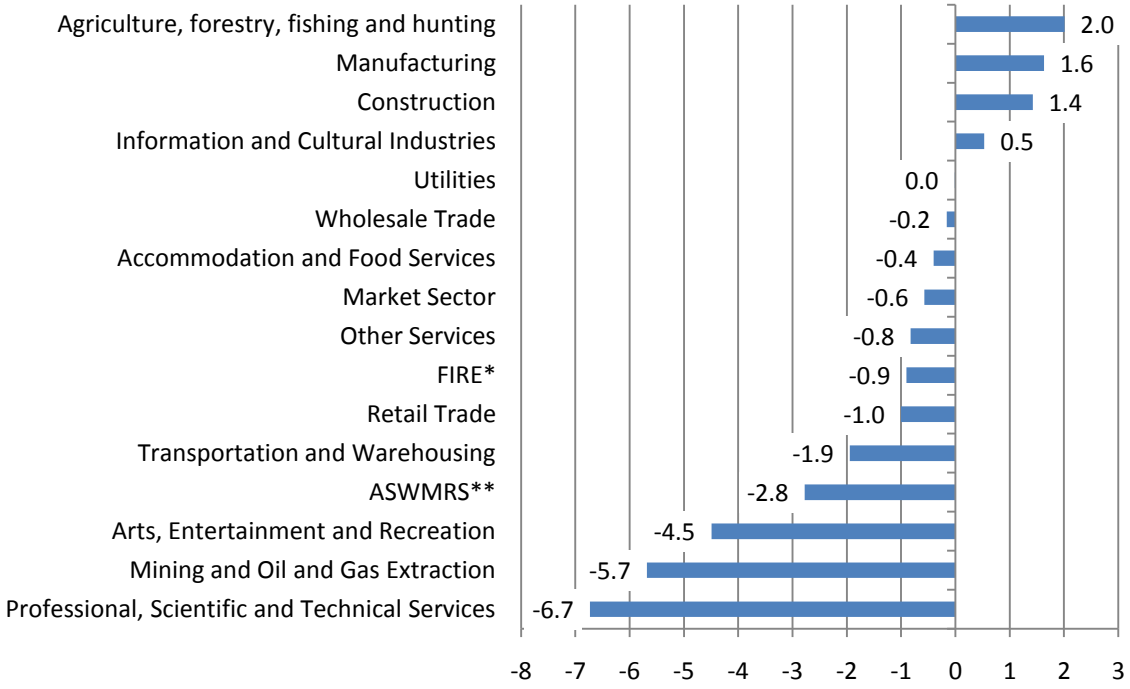
Source: CSLS calculations based on unpublished Statistics Canada data.
* FIRE: Finance, Insurance, Real Estate and Renting and Leasing
**ASWMRS: Administrative and Support, Waste Management and Remediation Services

ii. Capital Productivity

For Canada, the sector experiencing the most rapid capital productivity growth over the 1997-2007 period was agriculture, forestry, fishing and hunting (2.01 per cent per year), followed by manufacturing (1.63 per cent) and construction (1.42 per cent). At the other end of the spectrum, professional, scientific and technical services had the worse capital productivity performance, with output per unit of capital services falling 6.73 per cent per year. The second worse capital productivity performance was recorded by mining and oil and gas extraction (-5.68 per cent), followed by arts, entertainment and recreation (-4.49 per cent).

Two of the three industries with the fastest labour productivity growth at the national level were also among the top three industries with the fastest growth in Alberta: construction, with an amazing 12.29 per cent average annual rate of capital productivity increase, and agriculture, forestry, fishing and hunting (2.28 per cent per year). The industry with the third fastest capital productivity growth in Alberta was retail trade (2.22 per cent). The three industries with the worst capital productivity performance at the national level were the three industries in Alberta that also experienced the worse performance: professional, scientific and technical services (-8.63 per cent per year), followed by mining and oil and gas extraction (-8.30 per cent per year), and arts, entertainment and recreation (-7.74 per cent).

Chart 10: Capital Productivity Growth by Industry in Canada, 1997-2007
Average Annual Rate of Growth



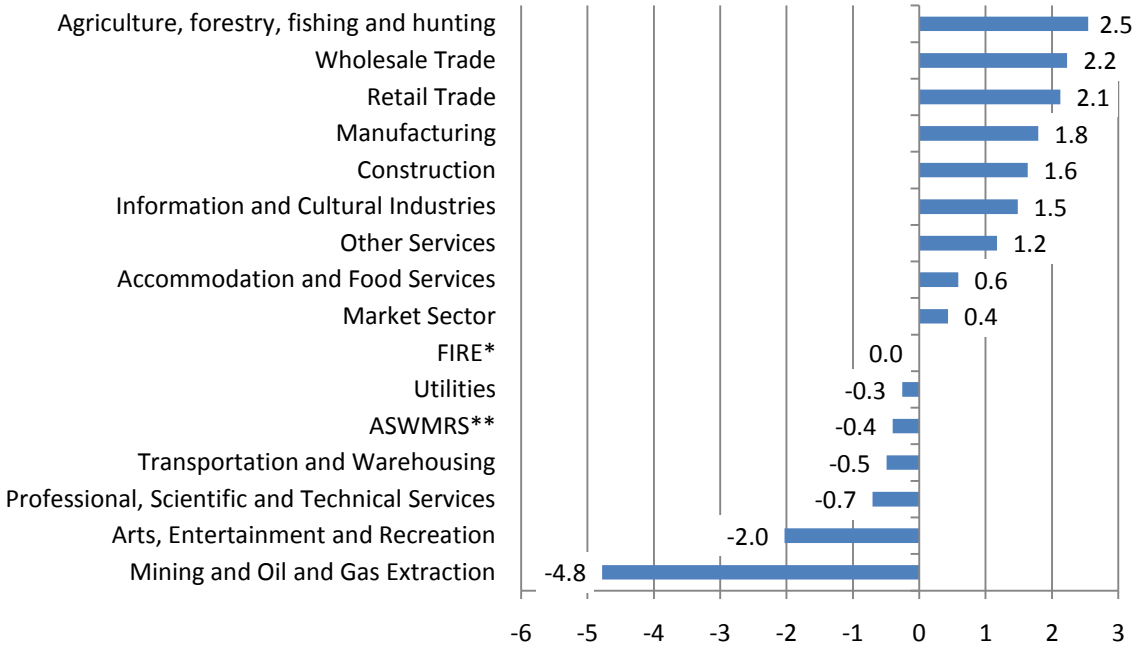
Source: CSLS calculations based on unpublished Statistics Canada data.
* FIRE: Finance, Insurance, Real Estate and Renting and Leasing
**ASWMRS: Administrative and Support, Waste Management and Remediation Services

iii. Multifactor Productivity

The data also allow one to compare multifactor productivity growth at the sector level for Canada and the provinces. For Canada, the sector experiencing the most rapid multifactor productivity growth over the 1997-2007 period was agriculture, forestry, fishing and hunting (2.5 per cent per year), followed by wholesale trade (2.2 per cent) and retail trade (2.1 per cent) At the other end of the spectrum, the worse multifactor productivity performance was recorded by mining and oil and gas extraction (-4.8 per cent per year), followed by arts, entertainment and recreation (-2.0 per cent), and professional, scientific and technical services (-0.7 per cent).

Two of the three industries with the fastest multifactor productivity growth at the national level were also among the top three industries with the fastest growth in Alberta: agriculture, forestry, fishing and hunting (3.42 per cent per cent per year) and retail trade (4.44 per cent). The industry with the fastest multifactor productivity growth in Alberta was construction (4.58 per cent) Again, two of the three industries with the worst multifactor productivity performance at the national level were among the three industries that experienced the worst performance in Alberta: mining and oil and gas extraction (-7.40 per cent per year), and arts, entertainment and recreation (-3.66). The industry with the third worst multifactor productivity performance in Alberta was utilities (-2.4 per cent).

Chart 11: Multifactor Productivity Growth by Industry in Canada, 1997-2007
Average Annual Rate of Growth



Source: CSLS calculations based on unpublished Statistics Canada data.
* FIRE: Finance, Insurance, Real Estate and Renting and Leasing
**ASWMRS: Administrative and Support, Waste Management and Remediation Services

4. Reallocation Versus Within-Industry Perspective

The CSLS also completed an industry decomposition of labour productivity growth. The CSLS calculated the within-sector effect, the reallocation level effect, the reallocation growth effect (also known as the Baumol effect or the interaction effect), the total reallocation effect (the sum of the productivity level and growth effects) and the total sector contribution related to aggregate (business sector) labour productivity growth for 12 sectors for the 1961-2007 period and six cyclically neutral (peak-to-peak) sub-periods (1961-1973, 1973-2000, 1973-1981, 1981-1989, 1989-2000, and 2000-2007). Summary Table 2 provides estimates of the total contributions to aggregate labour productivity growth from these effects in both absolute and relative terms for the seven periods. Summary Table 3 provides a sectoral decomposition of these effects for the 2000-2007 period. More detailed estimates of the sectoral contributions to aggregate

labour productivity growth from the different effects for each of the seven periods are also available. The focus of the discussion in this section will be on the Summary Table 2 and Summary Table 3.

For the business sector as a whole, the average annual rate of labour productivity growth in the 2000-2007 period was 1.10 per cent per year (Summary Table 2). As noted earlier in this paper, this is below the growth rate experienced in all earlier periods under analysis. Of this growth rate, 1.13 percentage points or 102.3 per cent was due to the within-sector effect, that is, productivity growth within the 12 sectors; 0.12 percentage points or 10.6 per cent was due to the reallocation level effect, and -0.14 percentage points or 12.8 per cent was due to the reallocation growth effect. The total reallocation effect is the sum of the reallocation level and growth effects and was -0.03 percentage points or -2.3 per cent.

The total reallocation effect can be positive, that is a boost or fillip to aggregate productivity growth (1961-1973 and 1973-1981) or negative, that is a drag on productivity growth (1961-1973, 1973-2000, 1981-1989, 1989-2000, and 2000-2007). Its importance relative to the aggregate labour productivity growth depends on the absolute size of the effect (in percentage points) as well as the absolute level of aggregate labour productivity growth (the greater the productivity growth, the smaller the relative importance and vice versa, ceteris paribus). The positive contribution of the total reallocation effect, in both absolute and relative terms, was greatest in positive terms on 1961-73 and 1973-1981 and the negative contribution was largest in 1981-1989 and 1989-2000.

Results on the sectoral decomposition of the contributions of the reallocation effects to aggregate labour productivity growth in the 2000-2007 period were also completed. There were offsetting developments within this period. In terms of the productivity level reallocation effect, there were significant positive effects experienced by the mining and oil and gas extraction sector (0.26 percentage points per year) and finance, insurance, real estate and rental and leasing (0.08 points) because of the above average labour productivity level and increasing hours share of these sectors. Significant negative level reallocation effects occurred in manufacturing (-0.15 points) because of the sector's above average productivity level and falling hours share and in other services (except public administration) (-0.09 points) because of this sector's below average productivity level and increasing hours share.

In terms of the productivity growth reallocation effect, all sectors had minimal effects except mining and oil and gas extraction (-0.09 points), due to the very large fall in labour productivity in this sector and the increase in the hours share.

Because of the small size of the sectoral productivity growth reallocation effects, the total reallocation effect was close to the productivity level reallocation effect for all sectors, except for mining and oil and gas extraction.

Summary Table 2: Decomposition of Aggregate Labour Productivity Growth into Within-Sector and Reallocation Effects, 1961-2007

	Average Annual Growth Rate	Contribution to Labour Productivity Growth								Churn Measure			
		Within-Sector Effect[1]		Reallocation Level Effect[2]		Reallocation Growth Effect[3]		Total Reallocation Effect		Share of Hours Worked		Reallocation Level Effect	
	Per Cent	Points	Per Cent	Points	Per Cent	Points	Per Cent	Points	Per Cent	Total	Average Annual	Total	Average Annual
1961-2007	2.01	2.13	105.9	0.28	13.9	-0.40	-19.76	-0.12	-5.91	51.7	1.1	0.31	0.01
1961-1973	3.44	3.08	89.7	0.48	14.1	-0.13	-3.80	0.35	10.30	17.6	1.5	0.66	0.05
1973-2000	1.62	1.83	113.0	0.06	3.8	-0.27	-16.74	-0.21	-12.97	32.0	1.2	0.21	0.01
1973-1981	1.71	1.37	80.3	0.56	32.5	-0.22	-12.82	0.34	19.73	14.4	1.8	0.74	0.09
1981-1989	1.31	1.53	117.1	-0.13	-10.0	-0.09	-7.12	-0.22	-17.15	7.8	1.0	0.25	0.03
1989-2000	1.79	2.03	113.3	-0.10	-5.6	-0.14	-7.69	-0.24	-13.32	13.2	1.2	0.31	0.03
2000-2007	1.10	1.13	102.3	0.12	10.6	-0.14	-12.82	-0.03	-2.27	9.6	1.4	0.71	0.10

Source: CSLS calculations based on Statistics Canada's Canadian Productivity Accounts KLEMS database.

Notes:

The aggregate is the business sector. The business sector covers the whole economy less public administration, non-profit institutions and the rental value of owner-occupied dwellings. GDP for the business sector is calculated as the sum of the GDP of the constituent sectors.

Labour productivity is real GDP per hour worked. Real GDP is calculated from Statistics Canada, Canadian Productivity Accounts KLEMS Database, CANSIM Table 383-0021. Current-dollar GDP estimates for 2002 were extended forward to 2007 and backward to 1961 using the growth rates of the corresponding real GDP series from the same table.

The churn measure is the sum of the absolute values changes in share of total hours worked or the sum of the absolute values of the reallocation effect. The average annual churn is the total churn measure divided by the number of years in the period.

1. The contribution of labour productivity growth within the sector to aggregate labour productivity growth.

2. The contribution of changes in the share of hours worked between sectors to aggregate labour productivity growth.

3. The reallocation growth effect is the sum of the product of the absolute change in the share of hours worked and the absolute change in the labour productivity level for each of the i sectors. It measures whether an economy is subject to Baumol's cost disease, i.e. the tendency of factors of production to move into sectors with relatively small absolute increases in productivity.

It is interesting to note that gross reallocation effects (sum of the absolute values of the sectoral productivity level effect), which we also call the churn measure, has been greater on an average annual basis in the most recent period (0.10) than in the six earlier periods (Summary Table 2).

Summary Table 3 provides estimates of the absolute and relative importance by sector of the within-sector effect and the total effect for the 2000-2007 period. Given the 4.17 per cent average annual fall in output per hour in the mining and oil and gas extraction sector between 2000 and 2007, this sector's within-sector effect contributed -0.24 percentage points per year to aggregate labour productivity growth. The above average productivity level of the sector combined with the increased hours share resulted in a 0.26-point productivity level effect. The below average productivity growth of the sector, again combined with the rising hours share, resulted in a -0.09 point productivity growth reallocation effect for a total reallocation effect of 0.17 points. This offset much of the sector's large negative within sector effect to result in a -0.06 point net contribution to aggregate productivity growth.

Summary Table 3: Decomposition of Aggregate Labour Productivity Growth by Sector and Within-Sector and Reallocation Effects, 2000-2007

	Within-Sector Effect	Reallocation Effect			Total Effect	Within-Sector Effect	Reallocation Effect			Total Effect
		Level	Growth	Total			Level	Growth	Total	
	(Percentage Points)					(Per Cent)				
Business Sector	1.10	-	-	-	1.10	100.0	-	-	-	100.0
Agricult., Forest., Fish. and Hunt.	0.12	0.04	-0.02	0.02	0.14	10.5	3.66	-1.52	2.14	12.6
Mining and Oil and Gas Extract.	-0.24	0.26	-0.09	0.17	-0.06	-21.4	24.03	-8.50	15.53	-5.9
Utilities	-0.01	0.02	0.00	0.02	0.01	-1.2	2.24	-0.14	2.10	0.9
Construction	0.11	-0.03	0.00	-0.03	0.08	9.8	-2.83	0.40	-2.44	7.4
Manufacturing	0.27	-0.15	-0.01	-0.16	0.11	24.4	-13.37	-1.12	-14.49	9.9
Wholesale Trade	0.26	0.00	0.00	0.00	0.26	23.4	0.21	-0.37	-0.16	23.3
Retail Trade	0.23	-0.01	0.00	-0.01	0.23	21.2	-0.73	0.08	-0.65	20.6
Transportation and Warehousing	0.03	0.00	0.00	0.00	0.03	2.8	0.02	0.01	0.03	2.8
Information and Cultural Ind.	0.14	-0.01	-0.01	-0.02	0.13	12.9	-0.89	-0.57	-1.46	11.4
FIRE	0.11	0.08	0.00	0.08	0.19	9.6	7.36	0.19	7.54	17.1
Prof., Scient. and Tech. Services	0.03	-0.01	0.00	-0.02	0.01	2.3	-1.27	-0.38	-1.65	0.6
Other Services (exc. Pub. Admin.)	0.09	-0.09	-0.01	-0.10	-0.01	8.1	-7.87	-0.90	-8.77	-0.7

Source: CSLS calculation based on data from Statistics Canada. FIRE stands for Finance, Insurance, Real Estate Rental and Leasing.

Three sectors made large positive within-sector contributions to aggregate labour productivity growth in the 2000-2007 period: manufacturing (0.27 points), wholesale trade (0.26 points), and retail trade (0.23 points). The absolute increases in constant dollar output per hour were the same for the three sectors, but that of the retail and wholesale trade were due to the rapid productivity growth of these two sectors (3.30 per cent and 3.64 per cent per year

respectively), while that of manufacturing reflected mainly its high productivity level (productivity growth in this sector was only 1.11 per cent). The overall contribution of the two trade sectors to aggregate productivity growth, in both absolute and relative terms, was close to the within sector contribution due to small reallocation effects. In contrast, the overall contribution of manufacturing to aggregate productivity growth was only 0.11 points, because of this sector's negative reallocation effect (-0.16), primarily due to a large negative productivity level effect arising from the very large fall in the sector's hours share (3.32 points). It is interesting to note that the two trade sectors accounted for 0.49 points or 44 per cent of aggregate labour productivity growth in 2000-2007, but accounted for only 19.9 per cent of total hours worked.

II. Review of the Findings of CSLS and McKinsey Productivity Studies

In recent years the Centre for the Study of Living Standards (CSLS) has undertaken a number of studies on various aspects of the productivity issue. These studies can be classified into a number of areas: measurement issues, policy, productivity drivers, industry studies, and studies related to productivity and well-being. This section of the report synthesizes the findings of recent CSLS productivity research.

A. CSLS Studies

1. Measurement Issues

While all CSLS research must address measurement issues to some extent, the CSLS has frequently devoted reports to measurement issues of particular interest. Smith (2004) conducted a thorough investigation into measurement issues associated with the aggregate labour productivity in Canada and the United States. He concluded that total economy trends in aggregate labour productivity should be monitored in addition to the more traditional focus on the business sector. He also noted that the comparability of non-business productivity growth in both countries is suspect, citing the very high rate of labour productivity growth in the Canadian non-business sector. Another effort at the CSLS has been the development of estimates of multifactor productivity for Canadian provinces. Thanks to the financial support of the Government of Alberta and working in cooperation with Statistics Canada, the CSLS has released estimates of multifactor productivity for all Canadian provinces on a basis consistent with national estimates from the Productivity Program (Sharpe, 2008).

Sharpe (2007c) identified data sources for international productivity comparisons and evaluated the strengths, weaknesses and limits of these datasets and their underlying methodologies at the aggregate and industry levels for various analytical purposes. The report highlighted the productivity database of the Groningen Growth and Development Centre as particularly useful, because it was well-designed, easy to use, and available free of charge.

In 2008, Harrison, Arsenault, and Sharpe attempted to explain a significant measurement problem: why have real wages lagged labour productivity growth in Canada? The most direct mechanism by which labour productivity affects living standards is through real wages, that is, wages adjusted to reflect the cost of living. Between 1980 and 2005, the median real earnings of Canadians workers stagnated, while labour productivity rose 37 per cent. The report identified four factors of roughly equal importance: rising earning inequalities; falling terms of trade for labour; a decrease in labour's share of GDP; and measurement issues.

2. Policy

Productivity research at the CSLS frequently addresses questions of policy. Some research is prepared with the explicit objective of providing policy advice, while other research leads to conclusions that have important implications for public policy. In the first category, the CSLS has worked independently, and with partners such as the Chief Actuary of the Canada Pension Plan, the Institute for Research on Public Policy, the British Columbia Progress Board

and the Atlantic Canada Opportunities Agency. In 2006, Sharpe investigated the future of productivity growth in Canada and its implications for the Canada Pension Plan. He looked at the effect of different productivity growth assumptions on the financial projections of the CPP.

In 2007, in a contribution to the Institute for Research in Public Policy volume *A Canadian Priorities Agenda: Policy Choices to Improve Economic and Social Well-Being.* Sharpe (2007b) made the case that productivity is Canada's economic destiny and that Canada's dismal productivity performance, both from a historical and international perspective, therefore represents our biggest economic challenge. He put forward three policies to improve Canada's productivity performance: foster the diffusion of best-practice technologies; remove the provincial sales tax on purchases of machinery and equipment; and promote interprovincial movement of workers by improving labour market information, removing professional barriers to labour mobility, and establishing a tax credit for interprovincial job search. He found that the short-term costs of these policies would be greatly outweighed by their long-term benefits.

In the first of a series of reports for the British Columbia Progress Board, Sharpe and Arsenault (2008c) identified five productivity drivers that merit additional investigation in British Columbia: education and literacy, public and private investment, research and innovation, resource reallocation, and trade and migration. Following up on that report, Sharpe, Arsenault, and Harrison (2008) examined investment in British Columbia more closely. They found that investment in British Columbia had lagged the country as a whole and recommended that the Government of British Columbia adopt a number of policy changes including the harmonization of the provincial sales tax with the federal Goods and Services Tax.

In 2009, Sharpe and Harrison investigated the causes of the labour productivity gap between Atlantic Canada and Canada as a whole. They found that the significant gap between Canada and the Maritimes in particular could be narrowed with reduced tax distortions and improved regulation. They also identified significant scope to improve the efficiency of provincial governments.

3. Productivity Drivers

The CSLS has devoted significant effort to advancing knowledge in Canada about the factors that drive productivity growth. In recent years the research agenda of the CSLS in this area can be categorized into studies that take a broad approach and those that focus on a specific driver like information and communications technology, interprovincial migration, and competitive intensity.

In a review of research originally conducted by the McKinsey Global Institute, Kellison (2004) examined three broad productivity drivers in an attempt to shed light on the causes of Canada-US productivity differences at the industry level. He concluded that competitive factors may explain the poor productivity performance of the Canadian financial and cultural service industries relative to their US counterparts, and likewise may explain the high productivity levels of some natural resource industries in Canada relative to the United States. He also found that managerial factors, especially the implementation of new technologies and related processes, may be important in explaining the poor productivity growth in Canada relative to the United States in service industries such as retail trade.

Sharpe and Arsenault (2008) investigated the causes of the historically weak productivity growth in Canada between 2000 and 2007 and concluded they were likely associated with over-hiring and the adjustment costs of moving from a labour surplus to a labour shortage economy. They also found that the productivity gap with the United States had widened in this period most likely reflecting developments south of the 49th parallel.

Sharpe (2008) tackled the paradox of market-oriented reform and weak productivity growth in Canada. He concluded that Canada's significant market orientation leaves little scope for further reforms. He proposed that market oriented reforms have also helped to increase labour supply, which while perhaps desirable in itself, would not necessarily improve productivity. Overall, he argued for an approach to improving productivity that focuses on human capital development, higher business investment in machinery and equipment, and the adoption of best-practice technologies, rather than one focusing on further regulatory reform.

The CSLS has undertaken a significant amount of research on information and communications technology (ICT), which is generally acknowledged as an important driver of productivity. In 2005 Sharpe attempted to explain why Canadian firms investment less in ICT than their US counterparts. He identified key factors affecting the gap as industrial structure, the size distribution of employment, and ICT measurement. Other factors included higher ICT costs relative to labour costs and potentially the lower quality of management in Canada. In 2006 Sharpe (2006a) investigated the impact of ICT on productivity. The key conclusion was that ICT had been the driving force behind the acceleration of productivity growth in Canada and the United States since 1996. The research from 2005 and 2006 was subsequently confirmed and expanded to Canadian provinces in 2008 (Sharpe and Arsenault, 2008b and Sharpe and Arsenault, 2008a).

Other drivers of productivity growth that have recently been studied by the CSLS include interprovincial migration and competitive intensity. Interprovincial migration has played an increasing role in Canada's economy in the middle years of the 2000s. In 2007, Sharpe, Arsenault, and Ershov estimated the number of workers moving in and out of each province and the total output gains due to interprovincial migration. In 2008 Sharpe and Currie surveyed economic literature and empirical evidence on the linkages between open and competitive markets (competitive intensity) and innovation and productivity growth. They found that the weight of the evidence indicated that competitive intensity has a strong positive effect on innovation and productivity. They concluded that Canada should pay closer attention to the competitive implications of public policy than has been the case in the past.

4. Industry Studies

CSLS has often studied productivity at the industry level. Such studies have investigated productivity trends and issues in the service industries; construction; forest products; selected natural resources industries; oil and gas extraction; the mining industries, including coal mining, gold mining, diamond mining; public administration; and healthcare.

In 2004, Rao, Sharpe and Tang explored trends in the productivity in the Canadian service sector over time and relative to the United States. Noting that the sector had performed well, they concluded that there had been a marked acceleration in productivity growth in recent

years. They also noted that faster multifactor productivity growth and human capital growth were helping Canadian service industries close the gap with their US counterparts.

Motivated by a divergence between the observations of practitioners and official estimates, Harrison (2007) investigated whether official estimates of productivity growth in the construction sector were understating the rate of growth of productivity. He concluded that the use of input-cost indexes to estimate real output growth was the most likely source of measurement error, and could account for some, but certainly not all, of the relatively slow growth of productivity in construction relative to the economy as a whole.

In 2009, Harrison and Sharpe analyzed the productivity performance of the forest products sector in Canada. They concluded that the sector has performed well in terms of productivity growth in comparison to the average of all industries. However, much of this productivity improvement had come from cuts in inputs (labour and capital) that exceeded cuts in real output. They noted that this pattern could only be sustained temporarily since there will eventually be no more labour or capital to cut.

The CSLS (2004) explored productivity in nine selected natural resource industries. Key findings were that natural resource industries contribute disproportionately to aggregate productivity growth in Canada, with labour productivity levels twice as high as the total economy on average, and labour productivity growth one and a half times as rapid as total economy labour productivity growth; capital deepening was a key driver of labour productivity growth in natural resource industries, and high levels of capital intensity explained the high levels of labour productivity; technological advance was another important driver of labour productivity growth, and had also increased the importance of human capital; the earth sciences industries made a significant contribution to productivity growth in the natural resource industries by providing innovative exploration and development services; and price trends played a large role in the productivity performance of many natural resource industries by determining the quality of deposit that is profitable to be exploited.

The oil and gas sector has been an important driver of growth for the Canadian economy in recent years, especially in Alberta, Saskatchewan, and Newfoundland and Labrador. In 2008, Bradley and Sharpe found that the productivity performance oil and gas extraction had been very poor. They concluded that the most robust explanation seemed to be that higher output prices had suppressed productivity growth through increased exploitation of low-productivity marginal deposits.

Mining has also been a prominent sector in recent years, and the CSLS has prepared four reports that address mining productivity. Smith (2004a) found the emergence of the high value added diamond mining industry in the late 1990s and early 2000s to have been a boon to mining productivity in Canada. Smith (2004b) also examined productivity trends in the gold mining industry. He found that the industry's strong performance over the past four decades had been the result of real price movements, with lower prices squeezing out marginal operations and leading to faster productivity growth. The coal mining industry was the subject of another study by Smith (2004c). Like gold mining, coal mining in Canada has also seen rapid productivity improvement over the past four decades, and like gold, Smith concluded that real price movements had had an important impact on productivity growth. The most recent work by the

CSLS on mining productivity examined the sector as a whole rather than a particular mineral industry. Bradley and Sharpe (2008b) found that overall productivity growth in 2000-2007 in the mining industry has been very poor and that the most likely explanation was that higher output prices had suppressed productivity growth through increased exploitation of low-productivity marginal resource deposits.

Healthcare is a sector of the economy that has grown significantly as a share of GDP and has been the subject of considerable public attention. In 2007, Sharpe, Bradley, and Messinger noted that it was widely recognized that official estimates of productivity may seriously understate the true contribution of healthcare to real output and the well-being of Canadians. They argued that more resources were needed to further investigate the alternative approaches to measuring healthcare productivity and to develop better output measures that adjust for outcomes directly related to health care spending.

Most recently, Harrison and Sharpe (2009a) attempted to build a deeper understanding of the concept of productivity in the public service and its drivers. They found significant deficiencies with the way Statistics Canada measured public administration productivity and that important lessons could be learned from developments in other countries.

5. Productivity and Well-Being

The CSLS generally tries to incorporate a broad perspective into its research that addresses issue beyond productivity, including living standards and well-being. On occasion, the CSLS has explicitly addressed the linkages between productivity and well-being. Guilbaud and Sharpe (2003) used several sources of international data on labour productivity, poverty, and income inequality to find that across the developing countries—for which data were available—productivity growth played a substantial role in reducing poverty. They also concluded that this effect was stronger in countries with relatively low income inequality and that productivity growth better accounted for changes in poverty than the more commonly used economic growth.

6. Common Themes

A number of common themes can be traced through the research undertaken at the CSLS. Fundamentally, almost all CSLS research is based on an empirical, rather than a theoretical, approach. Data are gathered and analyzed to provide insights without the use of a more rigid theoretical framework that is often used in academic research. Whereas academic research often sets out to test a theory, CSLS research more often seeks out patterns by comparing trends in productivity over time or across provinces, industries, or countries.

A second distinguishing feature of the CSLS approach is that most research is oriented towards providing practical policy recommendations. Sometimes this objective is explicit, as was the case in the studies prepared for the British Columbia Progress Board, but often the research informs public policy indirectly, as is often the case in the research on productivity drivers like information and communications technology.

Finally, CSLS research generally tries to situate productivity within the broader context of living standards and economic and social well-being. At the core of the mission of the CSLS

is the notion that productivity is an important driver of economic and social well-being, but that it is only one of many drivers. Many policies to improve productivity may have undesirable effects on well-being, and CSLS research often highlights such tradeoffs.

B. McKinsey Productivity Studies

The McKinsey Global Institute (MGI) is a think tank based in Washington, DC founded in 1990 with the objective of analyzing international productivity levels from both economic and management perspectives. MGI uses microeconomic analysis on a sector-by-sector level to study the effects that industry decisions ultimately have on national productivity. For the most part the productivity drivers identified by MGI can be grouped into three broad areas: competitive factors (concentration, trade protection, deregulation, minimum wages, work rules, and zoning laws); managerial factors (best practice, human capital, capital intensity, and information technology); and demand factors (average income, cyclical factors, and consumer preferences).

The CSLS (Kellison, 2004) has examined these factors in an attempt to shed light on the causes of Canada-US productivity differences at the industry level. Competitive factors may explain the poor productivity performance of the Canadian financial and cultural service industries relative to their US counterparts, and likewise may explain the high productivity levels of some natural resource industries in Canada relative to the United States. Managerial factors, especially the implementation of new technologies and related processes, may be important in explaining the poor productivity growth in Canada relative to the United States in service industries such as retail trade. Given the similarities between Canada and the United States, the findings of the MGI studies cannot be indiscriminately applied to Canada-US productivity differences at the industry level. However, the MGI studies do put forward a number of useful working hypotheses for analyzing these differences.

In 2008 the McKinsey and Company released a study focusing on Canada entitled *Breaking Away from the Pack: Enhancing Canada's Global Competitiveness*. This study sought to stimulate discussion on what Canada and its companies could do to improve their ability to innovate and thus become more competitive globally. Identifying productivity and terms of trade improvements as key to building a sustainable competitive advantage, they analyzed four export sectors with a high degree of global exposure: electronics, aerospace, oil sands, and financial services. McKinsey identified three key elements of innovation: flexible and dynamic capital markets; collaboration between the public and private sectors; and cultural encouragement of innovation. In each of these areas they made recommendations to improve innovation, including by restructuring capital markets, enabling greater collaboration between stakeholders, and providing more encouragement to successful entrepreneurs.

In each of the three key elements of enhanced competitiveness, McKinsey outlined government- and business-led initiatives. In the area of capital markets, recommended government-led initiatives were revising policies influencing foreign investment in Canada; promoting Canada as an attractive location for investment; and supporting the restructuring of the Canadian venture capital industry. Business-led initiatives recommended by McKinsey were to create a greater variety of commercial lending products customized to meet the needs of growing businesses and developing a world-class venture capital sector.

In terms of collaboration between the public and private sectors, McKinsey called for governments to promote collaboration to attract more foreign investment among organizations with interest in growing Canadian business; the streamlining of processes enabling public-private collaborations and the creation of new co-investment models; and collaboration with private institutions to support the development of two or three world-class clusters in Canada. For business, McKinsey argued for the development of global partnerships along sector value chains; the initiation of collaboration programs among peers to support the diffusion of innovations in industries that require high upfront investment but have delayed returns; and the encouragement of industry associations to take a lead role in facilitating interactions, knowledge transfer, and investment within sectors.

Finally, in the area of competitive culture, McKinsey recommended that governments bring international experience into Canada through targeted immigration; expand support for second career retraining and mobility programs; improve Canadian school systems by learning from countries with higher-performing students; attract the best graduates to teaching; and reassess intellectual property (IP) ownership rights, particularly for academics. They recommended that companies create international experiences for emerging business leaders; support the development of specialized skills by funding targeted research in universities; and build strong internal processes to support the development of new ideas.

III. A Framework for a Research Agenda to Unbundle Weak Productivity Growth in Canada

Research on productivity and its determinants in Canada and across the OECD has intensified in recent years. Many statistical offices in OECD countries have developed better measures of industry-level productivity, and significant effort was spent developing an enhanced framework for productivity measurement in the new System of National Accounts 2008 (SNA08), which will gradually replace SNA93. Databases compiling comparable productivity estimates for large sets of countries were also developed (GGDC, OECD KLEMS), and a plethora of cross country studies on productivity level and productivity growth differences were published.

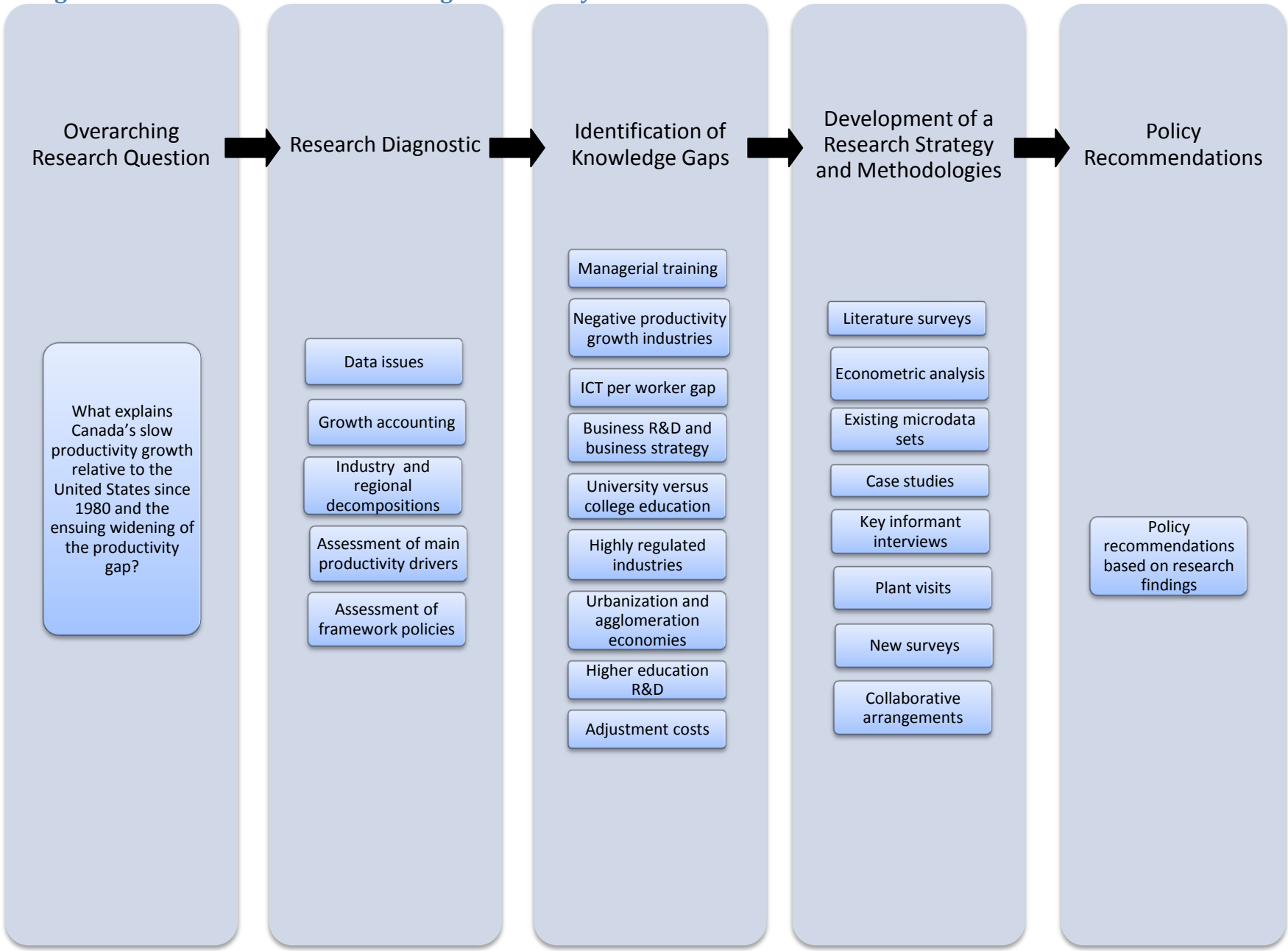
In Canada, much research has focused on the short-lived productivity resurgence of the late 1990s and the ensuing years of poor productivity performance, both from an historical and international perspective. Potential culprits for Canada's poor productivity performance were identified, but few definitive answers were found. In this section, we discuss the potential framework for a productivity research agenda in Canada to shed light on weak productivity growth and our widening productivity gap with the United States.

Potential research questions encompass macro- and microeconomics, quantitative and qualitative differences in time and in space, policy-oriented and policy-irrelevant questions. In the productivity area, the ground left to be covered is, obviously, extremely large. Given the large amount of possible research areas, results can best be obtained with a clearly defined research agenda. For such an agenda to develop, an overarching question or framework is needed. This question should not only set the objective of the research agenda, but also help to prioritize research projects needed to achieve this objective. In terms of an overarching research question on productivity in Canada we propose the following:

> What explains Canada's slow productivity growth relative to the United States since 1980 and the ensuing widening of the productivity gap?

The framework is articulated at five phases (Figure 1). First, the overarching research question is posed. This then leads to the research diagnostic phase where steps are taken to identify the salient characteristics or key stylized facts of the situation. Following the diagnostic phase is the identification of key knowledge gaps to be addressed through research. Then comes the phase where research strategies are developed and methodologies chosen to investigate the knowledge gaps. The final phase of the framework is the policy recommendation phase where the results of the research projects are used or filtered to identify and develop policy initiatives to improve or foster productivity growth.

Figure 1: A Framework for Unbundling Productivity Growth in Canada



The diagnostic phase employs such tools as growth accounting to identify the proximate sources of growth, and decomposition formulae to identify the role of within-sector and reallocation effects, industry contributions to productivity growth and regional contributions to productivity growth. In addition to the use of these methodological tools, the research diagnostic phase can include an assessment of the fundamental productivity drivers, namely investment, human capital, and technical change or innovation, both from the point of view of the quantity and quality of these drivers, and an assessment of the macro and micro framework policies influencing productivity growth. Finally, potential data measurement problems and issues can be identified.

The results of the research diagnosis lead to the identification of knowledge gaps. For this paper nine specific knowledge gaps related to Canada's slow productivity growth and widening productivity gap with the United States have been identified: less trained managers in Canada; negative productivity growth industries; the ICT investment per worker gap; the role of business strategy in the business R&D gap; the relative contribution of university versus colleges educated workers to productivity growth; highly regulated industries; urbanization and agglomeration economies; higher education R&D: and adjustment costs.

The research projects and strategies to address and investigate the knowledge gaps can employ a number of methodologies and datasets, including literature reviews, econometric techniques, case studies at various levels (country studies, sector/ industry studies, and firm/ plant studies including plant visits), key informant interviews, micro-data sets and new surveys initiated by the research projects.

Finally, the light shed on Canada's productivity gap though results through detailed research can be used to develop policies to reduce, if not close, the productivity gap.

To foster the development of Industry Canada's research agenda on the factors behind the Canada-US productivity gap and the identification and formulation of policies to reduce the gap, this section reviews the current state of knowledge on the gap and identifies potentially high yield avenues of research.

In 2008, the CSLS estimates that business sector output per hour in Canada was only 73 per cent that of the United States, a gap of 27 per cent or percentage points. In 1984, the gap had been only 7 percentage points, and in 2000 about 15 percentage points. This widening of the gap over the last quarter century reflected faster labour productivity growth in the United States relative to Canada (2.2 per cent versus 1.4 per cent in 1984-2008 and 2.7 per cent versus 1.0 per cent 2000-2008).

A. The Diagnostic Phase

As noted above the proposed research diagnostic phase includes five components: mismeasurement linked to data issues; decompositions, that is the disaggregation of aggregate labour productivity growth along various dimensions including within industry/reallocation effects, by industry, and by province or region; the identification of the proximate sources of labour productivity growth through growth accounting, an assessment of the drivers of productivity growth; and an assessment of the macro- and micro-economic framework policies

influencing productivity growth. The key findings from each type of diagnosis are discussed below. The discussion, largely based on the CSLS research reviewed later, focuses on Canada as the CSLS has done much less research on the United States.

1. Measurement Issues

A starting point for any international productivity comparisons is to ensure data comparability. If data are not comparable, differences in measured productivity growth rates or levels between countries may be statistical artifacts and not represent actual differences. Fortunately, Statistics Canada attempts to ensure that its productivity estimates are comparable to those produced by US statistical agencies. It is for this reason that official aggregate productivity statistics for Canada and the United States focus on the business sector, not the total economy, because different assumptions and methodologies are used to estimate real output in the non-business sector in the two countries. This is much less the case for non-business sector industries. International productivity comparisons at the total economy level, have a greater margin of error than studies at the business sector level due to more limited international comparability of non-business sector productivity estimates (Smith, 2004).

2. Decompositions

- Since 1981 negative reallocation effects have been at work in Canada, reducing aggregate labour productivity growth by around 0.2 percentage points per year (Summary Table 2). If there had been no similar negative reallocation effects in the United States, then this factor may account for part of the widening of the productivity gap. Estimates are needed for the United States.

- There has been a very wide divergence in productivity growth across industries in Canada over the last decade. Mining and oil and gas extraction has experienced negative labour, capital, and total factor productivity growth, reducing overall productivity growth. One factor contributing to Canada's weaker overall productivity growth may be a better productivity performance in the US mining and oil and gas extraction industry and the smaller relative size of the industry in the United States. Again, estimates are needed for the United States.

- Productivity growth has also differed greatly by province over the past decade, with Newfoundland recording the strongest growth rates for labour, capital, and total factor productivity, and Alberta the weakest.

3. Growth Accounting

- Growth accounting is usually used to shed light on the sources of growth rates of labour productivity over time. But it can also be used to explain differences in labour productivity levels across countries.

- Multifactor productivity growth has been very weak in Canada in recent years, and hence has been a limited (indeed negative in certain sub-periods) source of labour productivity growth. In contrast, multifactor productivity growth has been much

stronger in the United States and thus accounts for a significant part of the widening of the labour productivity gap.[12]

- Increased ICT intensity is estimated to have contributed 0.3 percentage points per year to labour productivity growth in Canada from 2000 to 2006. Again, in contrast, the contribution was found to be considerably larger in the United States.

- Increased labour composition or quality has been found to make a relatively stable contribution of around 0.3 percentage points per year to labour productivity growth in Canada in recent years. This is comparable to estimates for the United States, implying that a deterioration in relative labour quality cannot account for the diverging productivity growth between the two countries.

4. Productivity Drivers

The key drivers of productivity growth from a production function perspective are human capital, investment, and technical change or innovation. These drivers have both quantitative and qualitative dimensions. In terms of a diagnostic of slower productivity growth in Canada and the rising Canada-US productivity gap, the following points regarding productivity drivers are germane.

- At 45 per cent, Canada has by far the highest proportion of its population aged 25-64 with post-secondary education among OECD countries, above that of the United States (39 per cent) (OECD, 2006). Canada does less well in terms of the proportion of its 25-64 population with a university education at 22 per cent, well below the US proportion of 30 per cent.

- Canada exceeds the United States in terms of both the literacy and numeracy skills of its population (OECD, 2005), and especially in terms of the performance of high school students in standard tests of sciences and mathematics (PISA).[13]

[12] From 1996 to 2006 labour productivity in Canada, measured as real output per hour worked, grew at an average annual rate of 1.8 per cent (Baldwin and Gu, 2007). In contrast, labour productivity growth in the United States averaged 2.8 per cent per year over the same period. Multifactor productivity growth over this period in the United States averaged 1.5 per cent per year, considerably faster than in Canada, 0.6 per cent per year. Moreover, in the period from 2000 to 2006, multifactor productivity growth in the United States was 1.7 per cent per year, while in Canada multifactor productivity actually declined at an average annual rate of 0.1 per cent.

[13] In 2003, Canada's mean prose literacy score on the Adult Literacy and Life Skills Survey (ALLSS) was 280.8 compared to 268.6 for the United States for the population aged 16 to 65 years (OECD, 2005). Canada performed better than the U.S. over the entire distribution (for example the score at the 95th percentile was 358.7 in Canada compared to 346.9 in the United States). Canada also outperformed the United States in document literacy (280.6 versus 269.8) and numeracy (272.3 versus 260.9). In 2006, the OECD Programme for International Student Assessment (PISA) found that Canada's students still (15 years old) outperform their U.S. counterparts in 2006 in both mathematics (527 versus 475) and science (534 versus 489) (OECD, 2007).

- Canada's overall non-residential investment ratio is actually slightly higher than the US ratio (15.5 per cent of GDP versus 14.1 per cent in 2007), but the composition of the investment differs between countries, with a much smaller share of GDP devoted to machinery and equipment (M&E)—8.1 per cent versus 9.6 per cent—and greater share to structures. As M&E investment embodies the latest technological advances to a greater extent than structures investment, the lower share may account for the lower productivity level.

- Canada does particularly poorly relative to the United States in terms of information and communications technology (ICT) investment, with ICT per worker in 2007 in Canada at 62.6 per cent of that in south of the border. As the productivity-enhancing effect of ICT investment is now widely recognized, this situation likely contributes to Canada's lower relative aggregate labour productivity level (Fuss and Waverman, 2005).

- Technological change is determined by the creation of new knowledge, which in turn is related to research and development (R&D). Canada's total R&D intensity (R&D/GDP) is well below that of the United States (1.89 per cent versus 2.68 per cent in 2007). The gap is particularly wide for R&D performed by business (1.03 per cent versus 1.93 per cent), considered by many to be more important for productivity advance than R&D performed by government and higher education.

- Technological change is also driven by the adoption of new technologies as well as their creation. Innovation surveys suggest that Canadian businesses do not differ significantly in their propensity to innovate, defined as the adoption of best practice technologies, compared to EU countries. Unfortunately, innovation surveys are not currently conducted in the United States.

5. Policy Environment

The state of the productivity drivers discussed above is related to the policy environment or framework affecting business sector investment decisions. Framework policies include both macroeconomic policies such as monetary (interest rate and inflation targets) and fiscal policy (deficits and debt) and micro-economic policies including trade policy, foreign investment policy, competition policy, intellectual property policy, regulatory policy, and tax policy. A diagnostic of Canada's slower productivity growth requires an assessment of the status of these framework policies, both from an historical perspective within Canada and relative to our competitors. Some key aspects of the policy environment affecting business in Canada relative to that in the United States are highlighted below.

- The macroeconomic policy environment in Canada in recent years has been more favourable than that in the United States, as evidenced by lower CPI inflation, nominal interest rates, better fiscal balances, and a lower debt/GDP ratio.

- The marginal effective tax rate (METR) on investment has been falling in Canada in recent years and in 2007 at 29.1 per cent was below that in the United States at 36.0 per cent (Chen and Mintz, 2008).

- The degree of overall product market regulation in Canada has been on a downward track over the past decade and was third lowest among OECD countries in 2008. Only the United Kingdom and the United States were lower, and only slightly (Wolfl, et al., 2009).

- Despite the overall high level of competitive intensity in the Canadian economy, certain sectors continue to be shielded from competition. The most egregious example of lack of competition are the agricultural marketing boards, such as the dairy industry marketing board, that tightly control both production and imports.

B. The Identification of Knowledge Gaps and Research Strategies and Methodologies

The research diagnostic of Canada's weak productivity in many ways raises more questions than it supplies answers. This is as it should be. The next phase of the research agenda or framework for unbundling productivity growth builds on these more detailed questions. It develops and tests hypotheses to explain knowledge gaps that emerge from the stylized facts identified in the diagnostic stage through the use of different research methodologies. This section first outlines a number of methodologies that would be potentially useful in addressing knowledge gaps. It then identifies nine knowledge gaps in the productivity area and discuses research strategies to address them, including appropriate methodologies.

1. A Review of Methodologies

i. Literature surveys

The starting point of any research strategy is to situate the issue to be investigated within the context of past research. This means that the researchers must be aware of all relevant work on the issue in order to build on these findings and not "reinvent the wheel." The best way to become informed on a topic is through a literature survey. Such a survey can include articles published in peer-reviewed journals as well as working papers, reports, and government documents. Web-based search tools such as Google Scholar and REPEC are normally used to initiate the search.

ii. Econometric Analysis

Econometric techniques allow one to quantify the effect, in terms of both statistical and economic significance, of a number of independent variables on a dependent variable of interest. Regressions can search for and identify empirical linkages between productivity growth rates and a variety of economic, policy, and institutional indicators. A key question is whether the results are powerful and robust enough to provide useful information on the exogenous factors driving productivity growth.

Econometric analysis has its limitations. As noted by Helper (2000), regressions can have serious problems of generalizability (they predict poorly out of sample), subjectivity (researchers

may stop specification searches when their favourite t-statistic rises over 2) and measurement error (critical values like output and capital are often very poorly measured).

iii. Use of Micro-data Sets

Studies based on micro- or firm-level data have been used to understand productivity drivers. The exploitation of the variance of firm productivity performance, and firm dynamics in general, within an industry can contribute to an understanding of the determinants of productivity growth. John Baldwin and colleagues at Statistics Canada have made extensive use of micro-data, particularly from manufacturing industries, to shed light on productivity determinants. These studies have been particularly useful for quantifying the impact of the reallocation of factor inputs on aggregate productivity growth (e.g. Baldwin and Gu, 2004). Researchers have also exploited the innovation surveys conducted by Statistics Canada to examine the link between productivity and innovation (e.g. Le and Tang, 2003). Household surveys such as the census and the household component of the Workplace and Employer Survey (WES) can provide useful information on the characteristics of the employed work force, such as educational attainment, at the industry level.

iv. Case Studies

Case studies of productivity performance can be done at the establishment, firm, industry or country level. An example of country case studies is Sharpe (2007a and 2007b) which examined the lessons for Canada from the productivity experience of the United States, the United Kingdom, Ireland, Australia, Sweden and Finland. The McKinsey Global Institute has done a number of country case studies on productivity performance in Sweden, Australia, France and Germany the Netherlands, Brazil, Japan, the United States, and India. Lewis (2004) provides a synthesis of these studies. The CSLS has done a number of industry case studies based on a statistical analysis of industry data and key informant interviews.

v. Key informant interviews

Interviews with persons with detailed and comprehensive knowledge in particular areas represent an important avenue to gain understanding of productivity knowledge gaps. These key informant interviews should where appropriate be incorporated into research strategies. They are often conducted as part of the case study approach.

vi. Plant Visits

A particularly useful type of case study is the plant visit. As the industrial environment influences the rate of productivity change, visiting plants directly allows the researcher to observe the production process and talk with management and workers, which can be an instructive way to investigate the sources of productivity change. Indeed, in the late 1990s, the NBER (National Bureau of Economic Research) and the Sloan Foundation developed a project on industrial technology and productivity whose objective was to incorporate learning from plant visits and interviews into economic research. The project resulted in a large number of insightful papers (NBER, 2000). Indeed, the project was called the "Pin Factory" visits in deference to Adam Smith's famous description in the *Wealth of Nations* of the production process in a pin factory. Indeed, as Martin Feldstein notes in his preface to the NBER summary of the project (NBER, 2000:ii) "Smith was able to see how the division of labor increased productivity and

went on to theorize about the gains from increased market size, expanded trade, improve infrastructure and other things on the basis of this visit."

Key insights gleaned from the fieldwork visits included the following points (Helper, 2000).

- The number of production workers in plants is limited so raising the productivity of production workers does relatively little to raise overall productivity. Consequently, the big scope for productivity gains is with non-production workers and this may explain why the information technology revolution has been such an important source of productivity advance in recent years.

- Researchers can ask managers and workers directly about their objectives and constraints, leading to insights into incentives and strategies not evident by looking just at outcomes.

- Fieldwork allows exploration of areas with little pre-existing data or theory, facilitates the use of the most appropriate data, and provides vivid images that promote intuition. Indeed, fieldwork offers a new source of inspiration, one complementary to more conventional methods.

vii. New Surveys

When existing surveys are not available on a particular topic, consideration should be given to the development by researchers of their own survey, to be conducted by the researchers themselves, or contracted out to an organization that specializes in survey work. The obvious advantage of such an exercise is the new insight on the question of interest that is generated. An obstacle to such surveys can be the high cost, particularly large scale surveys which strive for a representative sample to minimize possible bias. One approach that can be cost effective is to have questions developed by the researchers added to existing surveys, such as those conducted by Statistics Canada.

viii. Collaborative Arrangements

In Industry Canada's development of research strategies, consideration should be given to collaborative arrangements with other researchers and research organizations. Such arrangements have many advantages. They can result in the leveraging of additional resources to the research project; the gaining of access to data sets; and the enrichment of the project through the knowledge and expertise of the collaborators as well as their potentially different perspective on the research issue in question. Potential collaborators on Industry Canada productivity research projects include: other federal government departments and agencies (e.g. Statistics Canada, Finance Canada, Bank of Canada, PRI, DFAIT); provincial governments, individual academics, university-based research institutes (e.g. Institute for Policy Analysis at the University of Toronto); non-university-based research institutes (e, g. CSLS, IRPP, Institute for competitiveness and Prosperity, etc.), industry associations (e.g. ITAC), international organizations (e.g. OECD, UNIDO, etc.); government departments or agencies in other countries (e.g. BEA, BLS); economic consulting firms, and individual firms.

2. Knowledge Gaps and Research Strategies

The diagnostic of Canada's slower productivity growth leads to a large number of questions and hypotheses that can be explored and tested with the methodologies surveyed above. This section identifies nine specific knowledge gaps that would comprise the detailed research phase of the unbundling productivity project and outlines innovative research strategies to address the gaps, particularly from a micro perspective.

i. Managerial training and productivity

Relative to the United States, Canada has a smaller share of managers with university education, particularly business training at both the undergraduate and graduate levels. This situation has been suggested as a factor contributing to lower relative productivity levels in this country. Roger Martin, Dean of the Rotman Business School at the University of Toronto, in particular has put forward this hypothesis. It is argued that better educated managers are more likely to be innovative as they are more aware of and interested in advances in the knowledge base than their less educated counterparts. In addition, with their higher level of education, they have greater capacity to adopt and implement new technologies.

This is an important hypothesis to explain the Canada-US labour productivity gap and merits rigorous investigation from a micro perspective. Unfortunately, firm-level data do not provide information on the formal education attainment of employees, including managers. But data on the education attainment (including by field of study) of the labour force by occupation are available from the micro-data census files. Although this household-based micro data does not allow one to match managers with the firm or establishment in which they work, it does allow the identification of the industry. Consequently, the proportion of managers with university education, and in particular with training in business, can be obtained on an industry basis. It is expected that comparable data can be obtained for the United States from the US census.

The research strategy would then be to compare the size of the labour productivity data with the managerial education attainment gap across industries between the two countries. An econometric framework could be developed with the Canada-US labour productivity gaps by industry as the dependent variable and the Canada-US managerial education gaps by industry as the independent variable of interest. The equation would need to be specified to include and control for other variables potentially affecting the relative labour productivity gaps, including capital intensity, capacity utilization, and R&D by industry data on these variables would be needed for the two countries.

ii. Negative labour productivity growth industries

Since technological change, capital accumulation, and educational upgrading are on-going phenomena, the normal expectation is that labour productivity will increase over the medium to long term. In modern economies, there are few if any examples of technical regress. This means that in the industries that experience negative labour productivity growth according to the official statistics, mismeasurement issues are likely to be at play. If one assumes that the true labour productivity growth in these falling productivity industries is at least zero, and recalculates aggregate productivity on this basis, the aggregate growth rate will be raised. One factor that may account for slower productivity growth in Canada relative to the United States

may be the greater importance of negative productivity growth industries in Canada. Indeed, an earlier study by Sharpe, Rao, and Tang (2002) found this to be the case.[14]

The knowledge gap to be addressed is whether the negative productivity growth rates at the industry level are statistical artifacts or real phenomena. The first step in the research is of course to identify at as detailed a level as possible the industries experiencing negative labour productivity growth over at least a full business cycle in both Canada and the United States.[15] Then the methodologies used to estimate productivity growth must be fleshed out. A key question is whether real output is measured independently of input or whether labour input is used as a proxy for output. The latter approach implies zero productivity growth. A second issue is whether the price series used to deflate nominal output to obtain real output are quality adjusted.

The second phase of the research strategy is a detailed analysis of the relevant documentation from the statistical agencies. The third and final phase is key informant interviews with the statisticians who compiled the negative productivity estimates and with persons knowledgeable about the industry and considered capable of shedding light on possible reasons for falling productivity in the industry. Obvious research collaborators in such a research agenda would be Statistics Canada in Canada and the Bureau of Economic Analysis and Bureau of Labor Statistics in the United States.

iii. ICT per worker gap

A key stylized fact that emerged from the diagnosis of Canada's labour productivity gap with the United States is the much lower level of ICT investment and capital stock per worker in Canada relative to the United States. The reasons for this situation represent a major knowledge gap in our understanding of the differences in productivity drivers between the two countries. Research on this issue (e.g. Sharpe, 2005, Fuss and Waverman, 2005) has not yet yielded a definitive explanation.

A research strategy to shed light on the Canada-US ICT investment per worker gap could consist of a number of methodologies or approaches, including database analysis, technology in use surveys, case studies and key informant interviews, and econometric studies.

Based on official data from Statistics Canada and the US Bureau of Economic Analysis, the Centre for the Study of Living Standards has compiled a very large database on ICT investment measures (ICT investment per worker, ICT investment as a share of total investment, ICT investment as a share of GDP) for Canada and the United States at the industry level. This database has not been exploited to its potential. For example, an analysis of the industry

[14] Sharpe, Rao and Tang (2002) found that the importance of the service sector industries that experienced negative productivity growth after 1987 was significantly greater in Canada than in the United States. In 2000, these industries represented 18.5 per cent of total economy real value added in Canada versus 12.2 per cent in the United States, and 27.6 per cent of total economy hours worked in Canada, versus 19.4 per cent of full-time equivalent employment in the United States.

[15] At the two-digit level (16 industries) Sharpe (2009) identified three industries with negative labour productivity growth over the 1997-2007 period in Canada: mining and oil and gas extraction (-2.24 per cent per year); arts, entertainment and recreation (-1.20 per cent); and utilities (-0.93 per cent).

contributions to the gap would provide useful diagnostic information of the relative industry weakness in ICT investment in Canada.

It is believed small and medium-sized firms invest less per worker than large firms. Unfortunately, the ICT investment data collected by Statistics Canada through the Private and Public Investment Intentions Survey in its current form do not allow a breakdown of ICT investment by firm size. This data gap prevents a complete analysis of the nature of ICT investment. A priority of the research agenda on this knowledge gap should be a project to obtain estimates of ICT investment by firm size. Statistics Canada officials have indicated that such a project is feasible, but that it would be costly.

ICT investment is measured in dollars. But ICT use can also be approached from a technology in use perspective that compares the proportion of a certain type of equipment or version of software used between countries. Unfortunately, technology in use surveys have lost ground to innovation surveys. The most recent comparable technology-in-use surveys that covered both Canada and the United States were completed in the 1980s or 1990s and covered few ICT goods. A comprehensive survey of ICT hardware and software use in Canadian and US firms would shed tremendous light of whether the Canadian business sector truly suffer from an ICT gap compared to its US counterparts.

The case study approach represents a complementary lens to address the ICT investment gap, whether at the industry or sector level. It is widely believed that the health care sector in Canada makes much less use of ICT for electronic health records than in the United States. Data on ICT investment per worker in the two countries confirm this. A case study of ICT investment and use for an industry with a large ICT investment gap in both countries could potentially provide much insight on the lower ICT investment in this country. Key informants interviews should be an important component of the study. It would be particularly desirable to include as informants persons from multinational corporations with knowledge of the drivers of ICT spending decisions on both sides of the border.

Finally, econometric modeling can also potentially shed light on the reasons for the ICT investment gap. A recent econometric analysis by Cette and Lopez (2008) found that ICT diffusion gap between the United States and major advanced countries could be largely explained by a smaller share of the population with higher education and a higher level of rigidity in labour and product markets in the latter. Citing data constraints, the authors unfortunately did not include Canada in the study. It is important that the study be replicated with Canadian data to ascertain if the same results obtain.

A potential research collaborators on this knowledge gap is the Information Technology Association of Canada (ITAC), which is very interested in the issue of the Canada-US ICT investment gap.

iv. Business R&D gap and business strategy

As shown in the diagnostic of Canadian productivity drivers, the gap in business R&D intensity (BERD) accounts for all of the gap in total economy R&D intensity (GERD) between Canada and the United States. Thus to explain Canada's mediocre R&D performance, one must explain the weakness in business R&D. In April 2009, the Council of Canadian Academies

(2009) released a major report by an expert group on business innovation in Canada. The report provided a detailed analysis of the reasons for weak BERD in Canada, a major knowledge gap. Based largely on the experience of the senior business leaders on the panel, it concluded that the key factor was the failure on the part of Canadian business to use R&D as part of its business strategy. This conclusion merits more rigorous examination.

It is unlikely that the statistical agencies in the two countries have comparable available large scale firm or establishment surveys that would inform an analysis of differences in business strategy between the two countries. Innovation surveys do ask firms questions on business strategy, but such surveys have not been conducted in the United States (this may change shortly). Consequently, a research strategy to explore the hypothesis that differences in business strategy between Canada and the United States account for Canada's lower BERD intensity would likely have to use a case study approach that incorporated key informant interviews, plant visits, and possibly a small-scale survey developed and administered by the researchers.

Business strategy is a key element of the curriculum of many business schools. Thus researchers based at business schools may potentially interested in collaborating on any research project related to business strategy.

v. University versus college education

As noted in the diagnostic of productivity drivers in Canada, the educational attainment of the adult population, as defined as the proportion of the adult population (25-64) with post-secondary education, is the highest among OECD countries. But Canada does not do as well in terms of university education, with a significantly smaller proportion of university graduates than the United States. A key knowledge gap is the difference in the overall quality and quantity of human capital possessed by a typical university graduate compared to a typical community college graduate.

Some argue that a university graduate has a broader, more general education than the community college graduate. This makes her more flexible and adaptable, with a greater capacity to learn and hence more productive in the long run. Others make the case that the applied and practical education dispensed at community colleges is a better fit with the needs of the labour market than the more theoretical education given at universities. There is currently no definitive research on this issue.

A research strategy to address this knowledge gap could employ a rate of return methodology to calculate the rate of return to the two types of post-secondary education and to derive the implications for productivity from these rates of return, both private and social. The micro-files from the 2006 census, to be released shortly, could be used for these calculations.

vi. Highly Regulated Industries

It is widely recognized that the degree of competitive intensity in an industry affects productivity (Sharpe and Currie, 2008). Industries facing a high degree of competitive intensity generally experience superior productivity performance to those with limited competition. Competitive intensity can be greatly affected by public policies, particularly regulatory frameworks. As noted in the diagnostic, the overall degree of regulation in Canadian product and

labour markets is very low by OECD standards. But there are a number of industries in Canada where the OECD considers regulation to be high and where changes in regulation may have a positive effect on productivity. A knowledge gap is the potential productivity gains that would obtain from deregulation of these sectors.

In 2008, of 27 countries studied, Canada ranked seventh in the restrictiveness of anti-competitive regulation in the retail distribution industry.[16] Moreover, Canada had the fifth most restrictive regulation in four professional services: accounting, legal, architecture, and engineering. Regulation was found to be particularly restrictive of competition in engineering services, where Canada ranked third; in architecture, where Canada ranked fourth; and in accounting, where Canada ranked fifth. Regulation was not as restrictive of competition in legal services, where Canada ranked 12 out of the 27 countries (Conway and Nicoletti, 2006).

In 2007, of 30 countries on which data were available for the energy, transportation, and communications sectors Canada's performance was mixed. Canada's regulation in the electricity sector was the fourth most restrictive. In the gas sector, Canada had the least regulation in restraint of competition of any country. In postal service, Canada had the most anti-competitive regulatory regime. In telecoms regulations, Canada had the ninth most restrictive regulation. The Canadian airline industry ranked 14th most restrictive; 20th in rail; and 26th in road transportation. Parts of the Canadian agricultural sector, such as the dairy industry, are also highly regulated. The OECD does not however provide estimates of the degree of product regulation in agriculture.

A research project that addressed the specific factors that accounted for the high degree of regulation in the highly regulated industries, discussed the putative rationale for and historical development of these measures from both an economics and political economy perspective, and estimated the potential productivity gains from moving to a less restrictive framework could make a useful contribution to an agenda for productivity advancement in this country. A key component of such a research strategy would be case studies of the industries of interest, possible with international benchmark comparisons of productivity indicators.[17] Methodologies that these industry case studies could employ include key informant interviews, plant visits, as well as econometric analysis.

vii. Urbanization and Agglomeration Economies

There is a long-standing school of thought in economics that emphasizes that greater amounts of productive activity concentrated in a particular region or city leads to higher levels of productivity. Harris (2002) notes that there is still debate over the reason that agglomeration and scale economies can have a positive impact of productivity growth but leading hypotheses are knowledge spillovers, ease of communication, and the facilitation of learning. The Institute for Competitiveness and Prosperity (2007) argues that a significant part of the Canada-US prosperity gap does indeed reflect the less urbanized nature of Canada relative to the United States. A Conference Board of Canada study (Sutherland et al., 2008), on the other hand, finds little link

[16] Estimates of product market regulation are drawn from the OECD website: http://www.oecd.org/document/1/0,3343,en_2649_34323_2367297_1_1_1_37421,00.html."

[17] As a example, the number of gallons of milk produced per milking cow in Canada is said to be well below that in the United Stares because of the entry restrictions related to Canada's system of provincial dairy marketing boards.

between urbanization and productivity. These inconclusive results represent a significant knowledge gap in our understanding of the productivity growth process in general and the Canada-US productivity gap in particular.

A research project that attempted to identify the specific linkages between various levels of urban development and productivity and to estimate the empirical importance of these linkages could shed light on this knowledge gap. An important first step in such a project would be a survey of the literature on agglomeration economies. Much of this literature has been done by economic geographers and is not well known to economists. Econometric analysis would likely be the key research methodology used in such a research project, although case studies of the economic development of particular cities should also be considered. A serious data gap for any econometric work is the lack of data on real output and hence labour productivity at the sub-provincial level in Canada and below the state level in the United States, although exploratory estimates of GDP for urban areas in the two countries are available.

viii. Higher education R&D

As noted in the diagnostic, Canada has the second highest rate of higher education R&D/GDP (HERD) ratio in among OECD countries, with only Sweden higher. Canada's HERD intensity has increased significantly in recent years as the federal government has increased funding to universities through the granting councils, the Canada Foundation for Innovation, and the Canada Research Chairs program, among others. A key rationale for this increased support for higher education R&D has been to boost Canada's productivity performance. But the linkages between HERD and business sector productivity are poorly understood, making this an important knowledge gap.

A research project that attempted to identify all possible linkages, and estimate the empirical importance of these linkages, between higher education research activity and business sector productivity performance is suggested to fill our current knowledge gap on the HERD-business sector productivity relationship. These linkages are multifaceted. The most obvious one is the commercialization of university research. A second linkage, which is possibly more important from a long-run productivity perspective, is the hands-on training of high-quality researchers by the universities that R&D activities entail and the subsequent movement of this highly qualified manpower to the business sector where they have the capacity to both create new knowledge and adopt new technologies. A third linkage is the contributions to basic knowledge from university R&D, which in the long run can result in many applications that directly boost productivity, although these benefits are not just captured by Canadian businesses but spill over to the world.

Again, a case study approach may be the most effective means to address this knowledge gap. One could identify specific university research projects that have generated important results and then examine the direct and indirect effects on productivity, in Canada and abroad from both a short- and long-term perspective. Equally, evaluations of specific government funding programs for HERD could focus on the productivity payoffs. Methodologies that these two types of case studies could use include document analysis, key informant interviews, site visits, and surveys.

ix. Adjustment costs

The decoupling of labour productivity growth in Canada and the United States in the early 2000s coincided with significant shocks to the Canadian economy which, it has been posited, have imposed significant adjustment costs to firms and thus reduced labour productivity in Canada, reflected in lower MFP growth rate.[18] These shocks included notably the rapidly rising prices for mining and oil commodities which led to increased activity in these sectors, as well as a rising Canadian dollar which precipitated the downfall of large portions of the manufacturing sector. As the Bank of Canada noted in its April 2008 Monetary Policy Report, slow productivity growth in Canada recently "may reflect factors such as the high adjustment costs associated with reducing employment levels in the manufacturing sector and increased precautionary demand for labour in sectors facing labour shortages" (Bank of Canada, 2008:10). In this case, the key channel through which adjustment costs impact labour productivity is through the sluggish adjustment of labour. The importance of this factor for the widening of the Canada-US productivity gap is unknown – it is still a knowledge gap.

Before any research is undertaken, it will be important to establish how adjustments costs can lead to lower labour productivity growth. In earlier literature, the most oft-quoted linkage between adjustment costs and labour productivity is that occurring in the early stages of the adoption of a new technology (Leung, 2004). In the current context, however, adjustments costs are believed to lower the speed of adjustment of labour utilization by firms, thus translating into lower measured labour productivity. This hypothesis has not been well tested empirically. The literature on labour adjustment has primarily focused on its impact on the unemployment rate (for example Amano, 1995). Moreover, it has focused solely on the speed of adjustment, rather than on both the magnitude of needed adjustment and its speed. An analysis of the former is essential if we are to measure the impact of adjustment costs on labour productivity growth.

Given the absence of convincing literature on this subject, the research strategy would need to encompass both macro and micro perspectives. In other words, it would first be necessary to establish the existence of significant adjustment costs at the macro level before embarking on a detailed analysis at the micro level. The macro-level identification could make use of tools similar to those used to explore the relationship between adjustment costs and the unemployment rate – model-based econometric analysis using macroeconomic data on labour markets. Comparing estimates of adjustment costs for Canada and the United States would provide an indication of whether this research route is worth pursuing further.

[18] As noted in the diagnostic, differences in MFP growth accounted for an increasingly important part of the Canada-US labour productivity gap.

IV. Conclusion

This report aimed to accomplish three objectives: provide an assessment of Canada's productivity performance; provide a synthesis of the productivity studies conducted by the Centre for the Study of Living Standards and the McKinsey Global Institute; and develop a framework for unbundling slow productivity growth in Canada and the widening productivity gap with the United States.

The key conclusion of the paper is that Canada has indeed underperformed in the productivity area in recent years both from an historical perspective and relative to our major competitors, particularly the United States and that the factors behind this deterioration in productivity performance are still poorly understood. A research strategy that focuses on key knowledge gaps related to this poor performance is badly needed. As the federal department responsible for the productivity file, Industry Canada is well positioned to lead such a strategy, in collaboration with other interested organizations, and it strongly encouraged to do so.

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