New Estimates of Multifactor Productivity Growth for the Canadian Provinces

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ABSTRACT

This article presents new estimates of multifactor productivity for the Canadian provinces for the 1997-2007 period. In contrast to earlier estimates, these estimates incorporate both changes in labour and capital composition or quality. Reflecting differences in labour productivity and capital productivity, multifactor productivity growth varies greatly by province. Newfoundland enjoyed the strongest multifactor productivity growth and Alberta the weakest.

THE OBJECTIVE OF THIS ARTICLE is to present new estimates of multifactor productivity (MFP) or total factor productivity[2] for the Canadian provinces. In contrast to previous estimates of MFP (e.g. CSLS, 2008), these estimates for the first time take account of changes in labour composition or quality and changes in capital composition or quality. The estimates have been prepared by Statistics Canada for the Centre for the Study of Living Standards (CSLS), which received financial support from Alberta Finance and Enterprise in producing this report. The estimates are posted on the CSLS website (www.csls.ca/data/mfp.asp) for free public access.

This report is divided into three main sections. The first section provides a brief overview of the methodologies and data sources used by Statistics Canada to construct the provincial multifactor productivity database. The third section presents the new estimates of labour productivity, capital productivity, multifactor productivity, labour composition or quality, and sources of growth by province. The third and final section concludes.

Methodologies and Data Sources for the Provincial Multifactor Productivity Database

Statistics Canada has detailed the methodologies and data sources used in the preparation of its estimates of multifactor productivity at the national level in the publication *User Guide for Statistics Canada's Annual Multifactor Productivity Program* (Baldwin, Gu, and Yan, 2007). The methodologies and data sources used to generate the provincial multifactor productivity estimates

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2 The terms multifactor productivity and total factor productivity are used as synonyms in this article.

largely follow those used for the national estimates. There are, however, notable differences.

In this section, we first review the growth accounting framework on which MFP measurement is built in Canada. We then provide an overview of the data available from the national MFP program and the Provincial Multifactor Productivity database. We then outline the exact methodologies and data sources used in producing the provincial estimates, with particular emphasis on how they differ from those used to produce MFP estimates at the national level.

Growth Accounting Framework

Multifactor productivity growth measures have been developed as summary statistics to measure improvements in the efficiency of the production process. They do so by comparing actual growth rates in output with the increase in output that would have been expected solely from an increase in inputs.

The growth accounting system provides the framework for measurement of MFP. It allows the decomposition of output growth into the portion that comes from increases in labour input and capital input and a residual (MFP) that captures changes in output that are not directly related to the increasing use of inputs.

The growth accounting framework is based on the extensive literature identifying human capital, physical capital and technological progress as the three fundamental determinants of economic growth. In Canada, the framework used in the MFP program decomposes output growth into five distinct components.

Two components refer to human capital, or labour inputs:

1 Output growth related to changes in hours worked (H)

2 Output growth related to changes in the average skill composition (or quality) of hours worked (QL)

Two components refer to physical capital, or capital inputs:

3 Output growth related to changes in the amount of capital per hour worked, or capital intensity (KI)

4 Output growth related to changes in the average composition (or quality) of capital (QK)

The final component is a residual component, and is often interpreted as a proxy of technological progress:

5 Residual output growth, also called multifactor productivity growth (MFP)

With the exception of hours worked, which is assumed to have a one-to-one relationship with output growth (but a negative relationship with capital intensity), each of the other three factors (excluding MFP) must be weighted by its importance in the economy. In practice, the cost share of labour (L_s) and capital (K_s) are used to weigh the components.[3] In simple mathematical terms, output growth can thus be decomposed as such:

1) $$\Delta GDP = \Delta H + (\Delta QL \times L_S) + (\Delta KI \times K_S) + (\Delta QK \times K_S) + \Delta MFP$$

Significant challenges arise in the measurement of each of these components, both from a theoretical and practical standpoint. Because MFP is measured as a residual component of output growth, it embodies the measurement issues facing each component. These challenges and their significance for the interpretation of growth accounting results will be discussed later in the

3 The labour share is measured as the share of GDP taking the form of labour compensation, while the capital share is measured as a residual of the labour share. The labour share in Canada hovers around 0.6, with the capital share around 0.4. For more information on the composition of and trends in the labour share in Canada, see Sharpe, Arsenault and Harrison (2008). It should also be noted that there are different 'types' of labour (in terms of education or experience) and capital (in terms of depreciation and asset life, and hence the speed at which they provide services). The weights that are generally used to aggregate changes in a type of factor (labour or capital) are the relative shares of each type of factor in the total compensation received by that factor.

section detailing the methodology and data sources used in MFP measurement in Canada.

Labour productivity growth, or change in output per hour worked, is a partial measure of productivity growth. It represents the portion of output growth not accounted for by changes in hours worked ($\Delta GDP - \Delta H$). Using formula (1), we can see that changes in output per hour worked can be expressed as the sum of the remaining four weighted components: labour quality, capital intensity, capital quality and MFP. Evidently, growth accounting is not only a way to obtain estimates of MFP, but also a diagnosis tool to assess the importance of different factors to growth across time and space. As such, it is useful not only in the context of MFP analysis, but also as a way to shed new light on estimates of labour productivity.

This dual role is important to note because economists differ in their interpretation of multifactor productivity and the importance to give this concept relative to labour productivity. Some see multifactor productivity as more important than labour and capital productivity as it represents gains in efficiency in the use of both of these factors of production. To this group multifactor productivity is the fundamental productivity concept. Others see multifactor productivity as less fundamental and view it more as one of the sources of labour productivity growth. Since it is labour productivity growth that drives real wage and income growth, this group sees labour productivity as the fundamental productivity concept. This group also points out that multifactor productivity estimates are much more affected than labour productivity estimates by data limitations and by the underlying assumptions used to generate the estimates. In both cases, however, growth accounting is considered to hold some analytical value.

An Overview of the Provincial Multifactor Productivity Database

Three levels of industry aggregation exist within the System of National Accounts. The Small (S) level of aggregation represents two-digits NAICS (North American Industry Classification System) industries (up to 25 industry aggregation), the Medium (M) level three-digits NAICS industries (up to 63 industry aggregation) and the Link (L) level four-digits NAICS industries (up to 121 industry aggregation). At the national level, the Multifactor Productivity program develops estimates of MFP and its component at the S-level for the 1961-2007 period and at the M- and L-levels for the 1961-2005 period.[4]

The provincial multifactor productivity database constructed by Statistics Canada for this project covers the ten provinces over the period 1997 to 2007. The database includes indexes of multifactor productivity (MFP), gross domestic product (GDP), capital input (*K*), and labour input (*L*) for the market sector and for 15 industries (the S-level of industry aggregation).[5] Excluded from the database, from the industry dimension, are the non-market sector industries, which include health care, education, and public administration, and from the geographic

4 The national and provincial MFP programs exclude some industry aggregation due to data limitations. MFP estimates for Canada are updated annually at the S-level with a seven-month lag, and at the M- and L-level with a 36-month lag. An annual index of MFP in the business sector is available publically for the 1997-2007 period at http://www40.statcan.gc.ca/l01/cst01/econ86a-eng.htm?sdi=multifactor. Estimates of MFP by industry, and for a longer time series, are available through CANSIM for a fee (Table 383-0021 for the S-level and Table 383-0022 for the M- and L- level).

5 The 15 industries are agriculture, forestry, fishing and hunting (AFFH); mining and oil and gas extraction; utilities, construction, manufacturing, wholesale trade, retail trade, transportation and warehousing, information and cultural industries; finance, insurance, real estate and rental and leasing (FIRE); administrative and support, waste management and remediation services (ASWMR); arts, entertainment and recreation; and other services (except public administration).

dimension, the three territories.[6] The database also includes indexes of total hours and labour composition, which are used to calculate the labour input index, and indexes of capital stock and capital composition, which are used to calculate the capital services index.

From these basic data, the Centre for the Study of Living Standards developed a series of additional tables, including growth accounting summaries for each province and indexes of MFP levels across provinces with the ten-province aggregate as a base. These summary tables are included in the database posted on the CSLS website.

Detailed Methodology

The data requirements for the national and provincial MFP databases are onerous. In general, the methodologies and data sources used to generate the provincial MFP estimates largely follow those used for the national estimates. Statistics Canada has detailed the methodologies and data sources used in the preparation of its estimates of multifactor productivity at the national level in the publication *User Guide for Statistics Canada's Annual Multifactor Productivity Program* (Baldwin, Gu, and Yan, 2007). This section will review these methodologies, and highlight differences between the provincial and national estimates.[7]

MFP estimates can be developed based on either a value added measure of output (in which case inputs are capital and labour) or a gross output measure (in which case inputs are labour, capital, and intermediate inputs, that is energy, materials and services). Because provincial estimates are available only on a value added basis, we focus primarily on the measurement of these estimates.

This section follows a structure similar to the one presented earlier in the section on growth accounting. First, we discuss the measurement of output. Second, we discuss the measurement of labour inputs, that is hours worked and their skills composition. Third, we review the methodology used to measure capital inputs, that is the capital stock and its composition.

Output

At the national level, Statistics Canada's MFP program provides data on chained-Fisher quantity indices for the period 1961-2007 at the S-level and 1961-2005 at the M- and L-levels. Annual estimates are derived from annual Input-Output (IO) tables up to 2005. For the following years, estimates of real GDP are projections obtained from the Industry Accounts Division of Statistics Canada. All estimates are calculated at basic prices.[8]

National GDP estimates obtained from the IO tables are based on make-and-use tables in current prices and in Laspeyres prices (using prices in period t-1). The IO tables in Paasche prices (using prices in period t+1) are not used in the MFP program to ensure that estimates are comparable with those produced in the United States.[9] A make matrix provides data on the

6 The business sector components of the health sector (e.g. doctors' offices) and the education sector (e.g. private schools) are therefore excluded from the market sector.

7 In this section, we compare national estimates with a ten-province aggregate obtained using methodologies consistent with those used for the new provincial MFP database. The reader should be aware that some of the differences between these estimates stem not from methodological differences, but from differences in coverage. Indeed, the ten-province aggregate excludes the three Territories and is for the market sector, not the business sector. This section draws heavily on Baldwin, Gu and Yan (2007), Baldwin and Gu (2007) and Gu et al (2002).

8 The difference between value added at market prices and basic prices is taxes on products less subsidies on products.

9 This methodology for estimating GDP at the national level was adopted by the Canadian Productivity Accounts to ensure that the method for deflating output of the wholesale and retail trade industries is comparable to the one used in the United States by the Bureau of Economic Analysis.

value of a given commodity made by a given industry in the reference year. A use matrix provides data on the value of a given commodity used as an input in a given industry in the reference year. Value added for a given industry can be obtained by subtracting the sum of the value of all its inputs (from the use matrix) from the value of its output (from the make matrix). Estimates of nominal value added are derived directly from the make-and-use table in current prices, while real GDP in the form of a chained-Fisher index is derived from the current-price and Laspeyre-prices indices.

These output estimates are for the business sector, not total economy. This construction involves splitting the chained-Fisher GDP index for all economic activities between the business and non-business sectors. The share of the business sector in total economic activities is estimated as the portion of GDP in chained-Laspeyres dollars going to the business sector for the period covered by IO tables (1997-2005). For subsequent years, the share is extrapolated using the growth of hours worked in the non-business sector, with the assumption of no productivity growth in the non-business sector.

Two methodological differences exist between the national and provincial estimates of output in the respective MFP programs. The most important difference is that for the provincial estimates, the chained-Fisher index of GDP is derived from the IO tables in both Laspeyres and Paasche prices, rather than from the IO tables in Laspeyres prices only. This methodological difference translates into some differences in output growth at the industry level. The second difference is the treatment of the health and education industries which are completely excluded from the business sector aggregate at the provincial level, while the business sector portion of these industries is included at the national level. However, these two methodological differences have little effect on the aggregate output growth rate in Canada over the period 1997-2007.

Capital input

Capital input measures the flow of services provided by the capital stock, hence the term 'capital services'. It can be divided into two components: the level of the capital stock and the composition of the capital stock. In practice, capital services are measured directly as the weighted sum of capital stock across assets using the user costs of each asset as weights (Baldwin and Gu, 2007).

The difference between capital stock and capital services stems from the fact that not all forms of capital assets (or stock) provide the same services, just as not all hours worked provide the same labour services. Short-lived assets, such as a car or a computer, must provide all of their services in just a few years, that is before they become obsolete and completely depreciate. On the other hand, office buildings provide services over decades. So, in a year, a dollar's worth of computers provides relatively more services than a dollar's worth of buildings. Because of differences in capital services between assets, capital input can increase not only because investment increases the amount of the capital stock, but also if investment shifts toward assets—such as equipment—that provide relatively more services per dollar of capital stock. In practice, the effect of capital composition has been a shift towards short-lived assets, measured as the difference between capital stock and capital services.

The measurement of capital services is theoretically straightforward. As noted earlier, capital services can be estimated as the weighted sum of capital stock across assets using their user costs as weights. In practice, however, the methodology used to estimate the user cost of different types of assets is a thorny issue. While the price of the capital good is available (the acquisition price of capital goods is observable), the price of the services that the capital good should command is not usually observed and needs to be inferred.

The user cost of capital can be thought of as the price that a well functioning market would produce for an asset that is being rented by an owner to a user of that asset. That price would comprise a term reflecting the opportunity cost of capital, a term reflecting the depreciation of the asset, and a term reflecting capital gains or losses from holding the asset. This formulation requires data on the rate of return, depreciation, capital gains from holding assets, tax rates on capital, and the price of the asset.[10]

Analysts who calculate rental prices of capital services face several choices: with regard to the expected rate of return; depreciation rates; expected capital gains; expectations; and finally whether to include tax parameters in the formula or not. Needless to say, each of these choices requires justification, either from a practical or theoretical perspective. Baldwin and Gu (2007) review each of these in detail.

Some aspects of the estimation procedure for capital services in Canada merit mention. First, unlike outside researchers, Statistics Canada benefits from detailed capital stock data by asset type. As such, its estimation of capital services is based on a bottom-up approach. This approach involves the estimation of capital stock by asset type, the aggregation of capital stock of various asset types within each industry to estimate industry capital services, and the aggregation of capital services across industries to derive capital services in the business sector and in the aggregate industry sectors. This approach for estimating aggregate capital input takes into account the difference in the rate of return across industries (as well as tax differences in tax parameters) and does not require the assumption of perfect mobility of capital inputs across industries.

Second, the rate of return used in the user cost formulae is measured endogenously rather than exogenously from observed market rates. The main advantage of using an endogenous rate of return, based on estimates from the System of National Accounts, is the provision of a fully integrated set of accounts.[11]

Finally, the user costs of assets with negative user costs — which are generally due to short-term fluctuations in returns and are not in keeping with the spirit of measuring long-term capital costs — are set to equal the average user costs of the assets across all industries for those assets, and are then adjusted for inter-industry differences in the user cost of capital.

The concept of capital input used in the provincial MFP database is similar to that adopted for the national MFP estimates. Similar to the national estimates, capital input in the provincial MFP database measures the flow of services provided by the capital stock. Yet, the methodologies for estimating capital input differ slightly between the two databases. For the provincial MFP estimates, land and inventories are excluded from capital input estimates due to data limitations, and the effect of tax parameters is not taken into account in the estimation of user costs of capital. The differences in methodologies have little effect on the capital input estimates at the aggregate business sector, but have

10 In Canada, the following variable are included in the user cost formula for asset *k* at time *t* (C_{kt}): the corporate income tax rate at time t, the present value of depreciation deductions for tax purposes on a dollar's investment in asset type k over the lifetime of the investment at time t; the rate of the investment tax credit for asset type k at time t; the market price for asset type k at time t; the real rate of return at time t; the depreciation rate of asset type k at time t; the expected capital gains; and the effective rate of property taxes at time t;.

11 See Baldwin and Gu (2007) for a full discussion of the benefits and problems related to endogenous and exogenous rates of return. The effect of using either rate of returns affects primarily the contribution of capital composition to output growth. In general, the effect on annual MFP growth rates is relatively small.

some effect at the industry level, most notably in the business services industry.

Both nationally and provincially, the database source for estimating capital input is the investment data by asset type maintained by the Investment and Capital Stock Division of Statistics Canada. To ensure the consistency of industry coverage between the investment data and GDP estimates, an estimate for investment in rental buildings is added to the finance, insurance and real estate industry (FIRE).

Labour input

As was noted earlier, labour input includes both the number of hours worked and the quality (or composition) of those hours. In the context of its Productivity Accounts, Statistics Canada already produces labour statistics covering the 1997-2007 period (including hours, jobs and labour compensation) for Canada and the provinces, for both the business and non-business sectors at the L-level of industry aggregation. The national and provincial data are consistent and are built from estimates obtained through the Labour Force Survey and the Survey of Employment, Payrolls and Hours (particularly for industry estimates). The Public Institutions Division's (PID) estimates of public sector employment are also used to estimate hours worked in the non-business sector.

Labour composition captures changes in the 'quality' of workers. In practice, hours worked are weighted by the share of labour compensation of a given group relative to other groups, with the relative weights assumed to reflect productivity differences. The variables used to differentiate labour quality in Canada are education (four education level), experience (proxied with seven age groups) and the class of workers (paid employees versus self-employed workers). In other words, 56 different types of workers are identified. The hours worked of each group is then weighted by its share of labour compensation to obtain an aggregate measure of labour services. Labour services will increase if there is a compositional shift in hours worked favouring high productivity workers (as proxied by relative labour compensation) and/or if there is an increase in the number of hours worked. Labour composition can then be computed as the difference between growth in hours worked and growth in labour services.

The measure of labour composition in Canada does not differentiate workers based on gender. Differences in hourly labour compensation between genders are assumed to be related to factors other than productivity differences (which are captured through education, experience and the class of worker), for example workplace discrimination. Moreover, unlike for capital input, changes in the industry composition of labour are not accounted for, mainly because little or no additional information seems to be embedded in the industry breakdown once education and experience are accounted for.

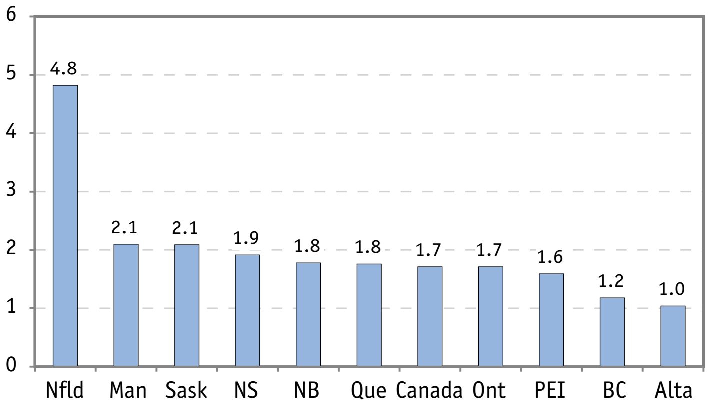
The concept of labour input in the provincial MFP database is the same as the one adopted for the national MFP estimates.[12] The methodologies and data sources for constructing labour inputs are identical in the two databases. For both national and provincial estimates, labour input is estimated as the weighted sum of hours worked across different types of workers using labour compensation as weights. There is little difference at the aggregate market/business sector, and the differences at the industry level due to differences in geographical coverage are minor.

A Summary of Methodological Differences

The different methodologies in the measurement of output, labour and capital between the national and provincial MFP estimates are

12 For a detailed discussion of the methodologies and data sources used to estimates labour input, see Gu *et al.* (2002).

Chart 1
Labour Productivity Growth by Province, 1997-2007
Average annual rate of growth, per cent



Source: CSLS calculations based on unpublished Statistics Canada data.

numerous. The key differences that were noted are:

- The health and education industries are completely excluded from the market sector aggregate at the provincial level while the business sector portion of these industries is included in the national level estimate of business sector.
- The estimate for Canada based on the provincial program is an aggregation of the ten provinces, and thus excludes the three territories.
- Output in the provincial program is derived from the IO tables in both Laspeyres and Paasche prices, rather than from the IO tables in Laspeyres prices only.
- Land and inventories are excluded from capital input estimates at the provincial level.
- The effect of tax parameters is not taken into account in the estimation of user costs of capital at the provincial level.

For some industries, the sum of these methodological differences translates into significant differences in growth rates.[13] In general, however, the estimates remain fairly consistent between the provincial and national program. At the market / business sector level, the difference is only 0.1 percentage points per year.

Results from the New Provincial Multifactor Productivity Database

This section of the report provides an overview of the main results from the new provincial productivity estimates produced by Statistics Canada. It first provides a discussion of labour and capital productivity, followed by an introduction to the new provincial measures of labour composition, capital composition and multifactor productivity. The section closes with a provincial perspective on the sources of growth.

Labour productivity

Table 1 and Chart 1 provide estimates of labour productivity for the market sector for the provinces. At the Canada level output per hour in the market sector advanced at a 1.71 average annual rate between 1997 and 2007.[14]

There was significant variation in market sector labour productivity growth by province. Newfoundland[15] 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 that 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, fol-

13 See Sharpe and Arsenault (2009) for a detailed discussion of these differences.

14 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 article will focus on the whole period, not the two sub-periods.

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

Table 1
Productivity Measures by Province, 1997-2007
Average annual rate of growth, per cent

	Labour Productivity	Capital Productivity	Labour Composition	Capital Composition	Multifactor Productivity
Canada – Based on Provincial Estimates*	1.68	-0.68	0.58	1.58	0.32
Canada – Based on National Estimates**	1.71	-0.57	0.52	1.20	0.44
Newfoundland	4.82	4.25	0.60	0.89	4.14
Prince Edward Island	1.59	-1.87	0.59	2.34	-0.18
Nova Scotia	1.92	0.26	0.24	0.51	1.12
New Brunswick	1.78	-1.00	0.44	0.73	0.37
Quebec	1.76	0.44	0.46	1.18	0.94
Ontario	1.71	0.24	0.52	1.07	0.82
Manitoba	2.10	-0.54	0.61	1.38	0.62
Saskatchewan	2.09	-0.62	0.90	1.98	0.11
Alberta	1.04	-3.40	0.49	1.29	-1.58
British Columbia	1.18	-0.46	0.12	0.97	0.48

* Aggregation of the ten provinces, market sector.
** National estimates, business sector.

lowed closely by British Columbia at 1.18 per cent.[16]

Capital Productivity

At the Canada level, capital productivity in the market sector fell at a 0.57 per cent average annual rate between 1997 and 2007 (Table 1). The first three years of the period (1997-2000) saw positive capital productivity growth (1.15 per cent per year), while capital productivity has fallen in the period since 2000 (-1.30 per cent per year). Again, this report will focus on the whole period, not the two sub-periods.

There was even more variation in market sector capital productivity growth by province than labour productivity (Chart 2). 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 meagre 0.44 per cent. At the other end of the spectrum, Alberta had the worst capital productivity performance, with real GDP per unit of capital services falling at a 3.40 per cent average annual rate.[17]

Labour Composition or Quality

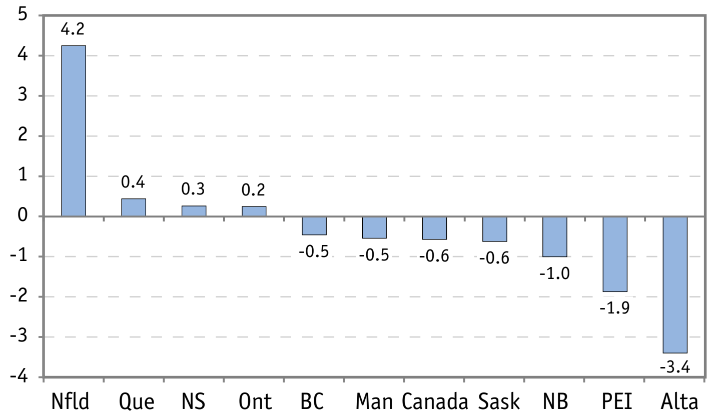
At the Canada level, labour quality in the market sector advanced at a 0.52 per cent average annual rate between 1997 and 2007 (Table 1). The first three years of the period (1997-2000) saw very similar growth to the post-2000 period: 0.56 per cent per year versus 0.50 per cent.

There is much less variation in market sector labour quality growth across provinces than manifested by the three productivity measures (Chart 3). Saskatchewan was the province with the most rapid labour quality growth (0.90 per year), followed by Manitoba (0.61 per cent), and Newfoundland (0.60 per cent). British Columbia experienced the slowest increase in labour quality, a very weak 0.12 per cent per year, followed by Nova Scotia (0.24 per cent).[18]

16 The unabridged version of this article (Sharpe and Arsenault, 2009) provides a comparison of labour productivity growth at the sector level for Canada and the provinces.

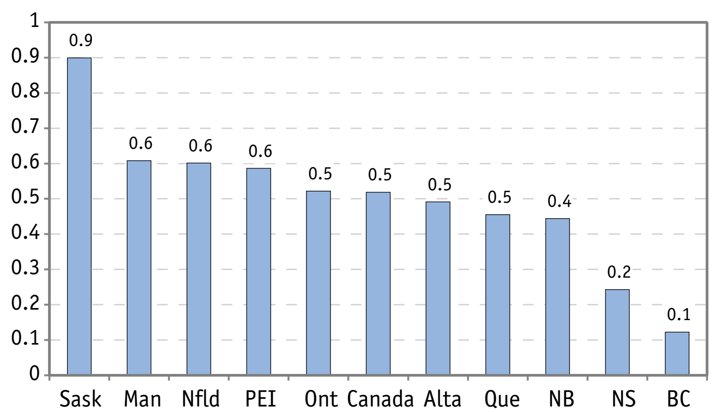
17 The unabridged version of this article (Sharpe and Arsenault, 2009) provides a comparison of capital productivity growth at the sector level for Canada and the provinces.

Chart 2
Capital Productivity Growth by Province, 1997-2007
Average annual rate of growth, per cent



Source: CSLS calculations based on unpublished Statistics Canada data.

Chart 3
Labour Quality Growth by Province, 1997-2007
Average annual rate of growth, per cent



Source: CSLS calculations based on unpublished Statistics Canada data.

Capital Quality or Composition

At the Canada level, capital quality in the market sector advanced at a 1.2 per cent average annual rate between 1997 and 2007 (Table 1). Capital composition growth as twice as fast in the first three years of the period (1997-2000) than in the post-2000 period: 1.86 per cent per year versus 0.93 per cent.

There is significant variation in market sector capital quality growth across provinces (Chart 4). Prince Edward Island and Saskatchewan were the provinces with the most rapid capital quality growth (2.34 and 1.98 per cent per year respectively), followed by Manitoba (1.38 per cent), and Alberta (1.29 per cent). Nova Scotia experienced the slowest increase in capital quality, a relatively weak 0.51 per cent per year, followed by New Brunswick (0.73 per cent).[19]

Multifactor Productivity

At the Canada level, multifactor productivity in the market sector rose at a 0.44 average annual rate between 1997 and 2007 (Table 1).[20] 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 saw falling multifactor productivity (-0.24 per cent per year).

There was more variation in market sector multifactor productivity growth across provinces 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 (Chart 5). No other province was close. Nova Scotia was

18 The unabridged version of this article (Sharpe and Arsenault, 2009) provides a comparison of labour quality growth at the sector level for Canada and the provinces.

19 The unabridged version of this article (Sharpe and Arsenault, 2009) provides a comparison of capital quality growth at the sector level for Canada and the provinces.

20 The CSLS productivity database has until now provided estimates of multifactor productivity growth for Canada and the provinces based on hours worked and capital stock estimates that were not adjusted for quality or composition. Not surprisingly, these estimates show considerably stronger total factor productivity growth than the estimates in this article. For example, total economy total factor productivity growth grew 1.3 per cent per year between 1997 and 2006, in contrast to the 0.6 per cent per year over the same period for the market sector measure found in this article.

second with multifactor productivity growth at 1.12 per cent, and Quebec third at 0.94 per cent. Alberta had by far the worst 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).[21]

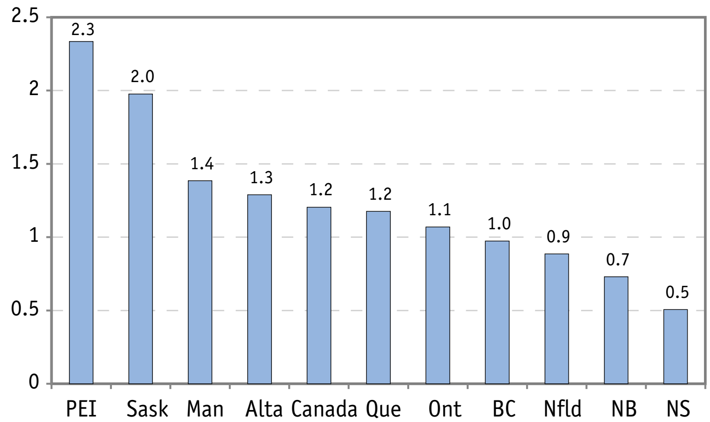
Sources of Labour Productivity Growth by Province

Table 2 provides estimates in both percentage point contributions and percentages of the sources of labour productivity growth for the market sector for Canada and the provinces for the 1997-2007 period. As noted earlier, labour productivity growth can be decomposed into a labour composition or quality effect, a capital services intensity effect (in turn broken down into capital stock and capital composition effect), and multifactor productivity growth, the residual.

As was noted by way of illustration earlier in the report, at the Canada level the 1.7 per cent average annual rate of labour productivity growth for the market sector for the 1997-2007 period can be decomposed into a 0.3 percentage point (17.5 per cent) contribution from labour quality, a 1.0 percentage point contribution from capital services intensity (57.6 per cent) and a 0.4 percentage point contribution from multifactor productivity growth (25.5 per cent).

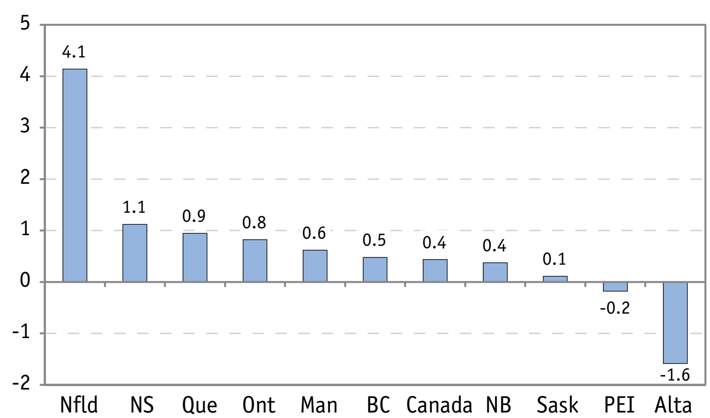
The relative importance of the sources of labour productivity growth at the provincial level deviated significantly in many instances from that observed at the national level. As the provincial labour productivity growth rate is used for the calculation of per cent contribution to labour productivity growth, differences in this rate can affect the relative importance of the sources of growth. Equally, differences in the absolute or percentage point contributions from the three sources of productivity growth affect the relative importance of these sources. For example, the percentage point contribution of labour quality to labour productivity growth ranged from a low of zero in British Columbia to a high of 0.4 points in Saskatchewan, while the

Chart 4
Capital Quality Growth by Province, 1997-2007
Average annual rate of growth, per cent



Source: CSLS calculations based on unpublished Statistics Canada data.

Chart 5
Multifactor Productivity Growth by Province, 1997-2007
Average annual rate of growth, per cent



Source: CSLS calculations based on unpublished Statistics Canada data.

21 The unabridged version of this article (Sharpe and Arsenault, 2009) provides a comparison of multifactor productivity growth at the sector level for Canada and the provinces.

Table 2
Sources of Growth in the Market Sector by Province, 1997-2007

	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.
	Average annual rate of growth										
Output	3.61	6.68	2.95	3.22	3.08	3.33	3.71	2.86	1.98	4.06	3.29
Total Hours	1.87	1.78	1.34	1.28	1.28	1.54	1.97	0.75	-0.10	2.99	2.08
Labour Composition	0.52	0.60	0.59	0.24	0.44	0.46	0.52	0.61	0.90	0.49	0.12
Capital Services	4.21	2.34	4.92	2.95	4.12	2.88	3.46	3.42	2.62	7.72	3.76
Capital Stock	2.97	1.44	2.52	2.43	3.37	1.68	2.36	2.01	0.63	6.35	2.76
Capital Composition	1.20	0.89	2.34	0.51	0.73	1.18	1.07	1.38	1.98	1.29	0.97
Capital Services Intensity	2.30	0.55	3.53	1.65	2.81	1.32	1.46	2.65	2.73	4.59	1.64
	Percentage point contributions to labour productivity growth										
Labour Productivity (Output per hour)	1.71	4.82	1.59	1.92	1.78	1.76	1.71	2.10	2.09	1.04	1.18
Labour Composition	0.30	0.27	0.35	0.15	0.26	0.27	0.32	0.35	0.37	0.23	0.08
Capital Services Intensity	0.97	0.39	1.42	0.64	1.13	0.54	0.56	1.12	1.60	2.43	0.62
Capital Stock	0.68	0.24	0.73	0.53	0.93	0.32	0.38	0.66	0.39	2.00	0.45
Capital Composition	0.28	0.15	0.67	0.11	0.20	0.22	0.17	0.45	1.21	0.41	0.16
Total Factor Productivity	0.44	4.14	-0.18	1.12	0.37	0.94	0.82	0.62	0.11	-1.58	0.48
	Percent contributions to labour productivity growth										
Labour Productivity (Output per hour)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Labour Composition	17.5	5.5	22.0	7.6	14.8	15.1	18.8	16.6	17.8	22.1	6.5
Capital Services Intensity	56.6	8.0	89.2	33.5	63.7	30.7	32.5	53.4	76.5	233.9	52.6
Capital Stock	39.9	4.9	45.8	27.6	52.1	18.0	22.2	31.3	18.5	192.4	38.6
Capital Composition	16.2	3.0	42.4	5.7	11.3	12.6	10.1	21.6	57.7	39.1	13.6
Total Factor Productivity	25.5	85.9	-11.3	58.4	20.9	53.6	48.1	29.4	5.3	-152.5	40.6

Source: Unpublished Statistics Canada Estimates. Growth rates calculated by the CSLS.

per cent contribution ranged from a high of 22.1 per cent in Alberta to a low of 5.5 per cent in Newfoundland. The weak labour productivity growth in Alberta (1.0 per cent) and the very strong growth in Newfoundland (4.8 per cent), combined with the narrow range of labour quality contributions, accounts for this situation.

The contribution of capital services intensity to labour productivity growth varied greatly across provinces. This situation of course reflected differences in capital services intensity growth, and possibly differences in the capital share of income. The largest contribution of capital services intensity was in Alberta (2.4 percentage points) and the smallest in Newfoundland (0.4 points). Given the weak labour productivity growth in Alberta, capital services intensity growth was responsible for 234 per cent of labour productivity growth in this province. In contrast, given the strong labour productivity growth in Newfoundland, capital services intensity growth accounted for only 8.0 per cent of labour productivity growth.

Labour productivity growth not accounted for by labour quality and capital services intensity growth is said to be accounted for by multifactor productivity growth. Given the very large contribution of increased capital services intensity to labour productivity growth in Alberta, it is not surprising to find that multifactor productivity was responsible for -152.5 per cent of labour productivity in this province. In contrast, with the limited importance of capital services intensity growth for labour productivity growth in Newfoundland, multifactor productivity accounted for 85.9 per cent of labour productivity growth.

Conclusion

This article has presented new estimates of labour, capital and multifactor productivity growth by province. These estimates were produced by Statistics Canada for the Centre for the Study of Living Standards, with financial support from Alberta Finance and Enterprise. Estimates of the levels of labour, capital, and multifactor productivity will also be produced and will appear in the unabridged version of this article (Sharpe and Arsenault, 2009). The full database upon which these estimates are based is posted at http://www.csls.ca/data/mfp.asp and can be accessed without charge.

The first major finding of the article is the poor productivity performance of Alberta over the 1997-2007. This province experienced the slowest labour productivity growth (1.0 per cent per year), the worst capital productivity growth (-3.4 per cent) and the worst multifactor productivity growth (-1.6 per cent) of all ten provinces.

The second key finding of the article is the strong productivity performance of Newfoundland over the 1997-2007. This province experienced by far the fastest labour productivity growth (4.8 per cent per year), by far the best capital productivity growth (4.2 per cent) and by far the best multifactor productivity growth (4.1 per cent) of all ten provinces.

A third major finding of the report is the key role played by the mining and oil and gas extraction sector in shaping productivity performance at the provincial level. This role, perhaps surprisingly, can be both positive and negative. Newfoundland experienced by far the most rapid market sector labour productivity growth among the provinces. The very rapid labour productivity growth (15.3 per cent per year) in the mining and oil and gas extraction (primarily the latter) as well as the increased importance of this high productivity level industry in the province's employment, were the drivers of this productivity success. In contrast, Alberta's poor productivity performance is in large part explained by the 4.3 per cent average annual decline in labour productivity in mining and oil and gas extraction, in large part due to the shift in resources from conventional oil and gas production to non-conventional production (i.e. the oil sands). A much greater amount of capital and labour is needed to extract a barrel of oil in the latter sub-industry.

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