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Special Issue

Labour, Productivity, and Efficiency

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SPECIAL ISSUE
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Introduction

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Decimalization in Great Britain

David Bergeron, Curator

Today, all countries use the decimal system, which divides their unit of account—whether it is the dollar, the euro, or the peso—into units of 10 and 100. Russia pioneered decimalization in 1710, when Peter the Great set the rouble equal to 100 kopecks. The United States adopted the system for its dollar in 1792, and Canada followed suit in 1857, abandoning British pounds, shillings, and pence in favour of dollars and cents to facilitate trade with the United States.

Great Britain was among the last nations to change its currency, continuing to rely, as it had for centuries, on the sterling system. In the mid-nineteenth century, however, decimalization was proposed as a means of simplifying accounting procedures, particularly foreign exchanges. It was hoped that the switch could be effected with little disruption to the current coinage. New coins—florins, cents, and mils—would be minted whose values could be measured in the sterling system and would all become fractions of the pound. Requiring existing coinage to fit conversion formulas was complex, however. The value of the copper coinage, in particular, required complicated calculations that many feared would pose problems for those who used them most, the labouring poor.

Input from several stakeholders led to some modifications of the proposed system. The size of the copper coins would be reduced, and only one new denomination would be created, a silver florin. With a value of two shillings (one-tenth of a pound), the florin more closely resembled foreign decimal coins, such as the American half-dollar and the Spanish four-reals coin, than did the British half-crown. To give the coin a chance, minting of the half-crown was discontinued. Mixed opinions forced the delay of the switch to decimalization, however, as well as the reinstatement of the half-crown in 1874.

The coin pictured on the cover is an example of the first silver florin, minted in 1849. About the size of a Canadian two-dollar coin, it was created as an experimental piece to test the general acceptance of decimalization, and was commonly known as the Godless florin, because the inscription DEI GRATIA (D.G.) was missing in the legend. Because of its aesthetic appeal, the florin continues to be highly desired by collectors.

Although Great Britain's adoption of the decimal system was postponed until late into the twentieth century, florins continued to be minted in the reigns of Edward VII, George V, George VI, and Elizabeth II. In 1969, the florin, which had long since ceased to be made of silver, was replaced with the 10-pence piece, and in 1971 Great Britain adopted the decimal system.

The Victorian florin on the cover is part of the National Currency Collection of the Bank of Canada.

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Labour, Productivity, and Efficiency

Sharon Kozicki, Guest Editor

The articles in this special issue examine structural factors that are important for long-run economic growth in Canada. In an accounting sense, real output growth can be divided between labour input growth and labour productivity growth. At the same time, an efficient financial system is important for the development and longer-run growth of the economy. The first article investigates the implications of demographic changes, such as those associated with an aging society, for labour input growth in Canada. Canada's productivity performance since the mid-1990s and the factors that may have contributed to the shortfall of average productivity growth rates in Canada relative to the United States are the subject of the second article. The third article examines efficiency in the Canadian banking industry.

Russell Barnett reports on the methodology used by Bank staff to create a measure of trend labour input in "Trend Labour Supply in Canada: Implications of Demographic Shifts and the Increasing Labour Force Attachment of Women." While demographic change has been an ongoing process in Canada, labour market implications of an aging population will become more acute in coming years. This article discusses the anticipated slowing in the growth of trend labour input over the coming decades with the aging of the baby boomers, declining fertility rates, and a stabilization of the labour force attachment of women. As the availability of labour shrinks, employers and governments will be looking for ways to address barriers to labour force participation, and firms will have an increasing incentive to find ways of improving labour productivity.

Richard Dion examines the evolution of Canadian productivity since the mid-1990s in "Interpreting Canada's Productivity Performance in the Past Decade: Lessons from Recent Research." During this period, trend productivity growth in Canada remained modest, whereas the U.S. witnessed a strong resurgence. Among the factors identified as potential root causes of Canada's lower productivity performance are a lower investment in information and communications technology, reallocation and adjustment costs associated with large relative price movements, and a weak demand for innovation.

Jason Allen and Walter Engert report on recent research at the Bank of Canada on various aspects of efficiency in the Canadian banking industry in "Efficiency and Competition in Canadian Banking." The research summarized suggests that, overall, Canadian banks appear to be relatively efficient producers of financial services, and they do not exercise monopoly or collusive-oligopoly power. The authors note the value of continuing to investigate opportunities to improve efficiency and competition in financial services in Canada.

Trend Labour Supply in Canada: Implications of Demographic Shifts and the Increasing Labour Force Attachment of Women

Russell Barnett, Research Department

- *Over the past 25 years, labour input growth has been driven by growth of the working-age population and a steady rise in the aggregate employment rate stemming from an increase in the labour market attachment of women.*
- *Looking ahead, growth of the working-age population is projected to slow substantially over the coming decades, owing to the cumulative impact of past declines in the national fertility rate.*
- *Our analysis suggests that the increased proportion of older individuals in the working-age population, whose average employment rates are lower than those of prime-age workers, is beginning to exert downward pressure on the aggregate trend employment rate.*
- *The aging of the baby boomers is projected to put downward pressure on labour input growth. Without an offsetting increase in labour productivity, this will imply lower potential output growth over the coming decades.*

Canada, like many industrialized countries, is approaching a demographic transition that will affect many aspects of the Canadian economic landscape, including the labour market. Over the next two years, the leading edge of the baby boomers (those born between 1946 and 1964) will reach 62 years of age, the average age of retirement in Canada. The baby boom generation has had a substantial impact on the demographic composition of the Canadian population over the past 60 years, and according to population projections this will continue to be the case over the next 40 years. Baby boomers' entry into the labour market in the 1960s and 1970s led to a significant increase in the percentage of those 15 to 64 years of age relative to the total population in Canada, as well as in the United States (Chart 1). The share of this age group subsequently stabilized in both countries but, according to United Nations projections, is expected to begin reversing itself in the next few years. This reversal is expected to be relatively larger in Canada than in the United States and suggests that in the future there will be fewer workers to meet the demand for goods and services from the total population. This development will put downward pressure on labour input growth[1] and, without an offsetting increase in labour productivity, will imply lower potential output growth over the coming decades.

1. Labour input growth refers to the growth of total hours worked in the economy. This can be further decomposed into the growth of the working-age population, the change in the labour force employment rate, and the change in the average length of the workweek.

Since 1980, the growth in labour input has accounted for just over half of the growth of real gross domestic product (GDP) in Canada.[2] Most of this rise in labour input can be attributed to increases in the size of the working-age population and to an upward trend in the aggregate employment rate stemming from the strong increase in the labour force attachment of women. These two factors have been partly offset by a declining trend in average weekly hours worked. Both the employment rate and average weekly hours worked exhibit considerable variation over the business cycle. Therefore, to project future trends in labour input, it is essential to identify its underlying trend and the key variables that have determined its evolution over time.

Since 1980, trend labour input growth has been driven by the growth of the working-age population and a steady rise in the trend employment rate stemming from an increase in women's labour market attachment.

The Bank of Canada's main interest in identifying trend labour input is as an input into the calculation of potential output. Defined as the level of economic activity that the economy can produce on a sustained basis without adding to inflationary pressures, potential output has traditionally been constructed by combining an assumed path for trend labour input with an assumption for trend labour productivity. In turn, this measure is used to judge the current and projected amount of excess demand or supply in the economy, which is an input into monetary policy decisions.

The purpose of this article is to explain the methodology used by Bank staff to create its measure of trend labour input and to examine the likely impact on its profile over the next two decades, when Canada will be experiencing a dramatic demographic transition. The methodology used to construct our estimates over history is described first, followed by a presentation of a model-based projection. Possible risks surrounding the base-case projection are then discussed. Finally, conclusions will be drawn.

Modelling and Constructing Trend Labour Input

Labour input, which is defined as total hours worked, is a function of three components: the size of the working-age population, the aggregate labour force employment rate, and the average number of weekly hours worked per employee. A trend estimate for each of these three components is required to construct a measure of trend labour input.

Working-age population

Since movements in the size of the working-age population occur slowly over time and do not appear to exhibit cyclical movements, it is assumed that trend population is simply equal to the actual size of the working-age population at each point in time. Growth of the working-age population has declined substantially since the early 1960s (Chart 2). After averaging growth of 2.4 per cent from 1961 to 1979, the 20-year period in which the full cohort of baby boomers first entered the labour market, growth of the working-age population subsequently fell and has only averaged 1.4 per cent since 1980, a full percentage point lower than the earlier period.

The other two components, the employment rate and average weekly hours worked, are modelled individually, using statistical models that attempt to separate the cyclical and trend factors affecting their respective movements over time. The employment rate and average weekly hours worked both exhibit procyclical behaviour, and it is important to control for these cyclical movements when attempting to identify their respective trends. In the remainder of this section, the methodologies used to estimate the trend employment rate and trend average weekly hours worked will be reviewed, the reasons for choosing the methodology will be explained, the estimation results reviewed, and the implications for our estimate of trend labour input discussed.

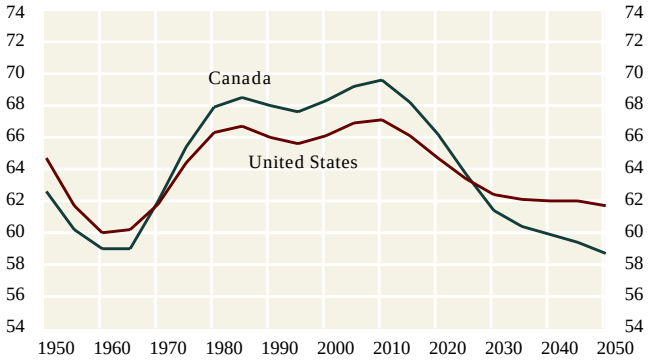
Labour force employment rate

The labour force employment rate has fluctuated substantially over the past three decades, rising during economic expansions and falling during downturns (Chart 3). Movements in the employment rate over the past 30 years have exhibited not only cyclical fluctuations, but an upward trend as well. The employment

2. In an accounting sense, real output growth can be divided between labour productivity growth and labour input growth.

Chart 1

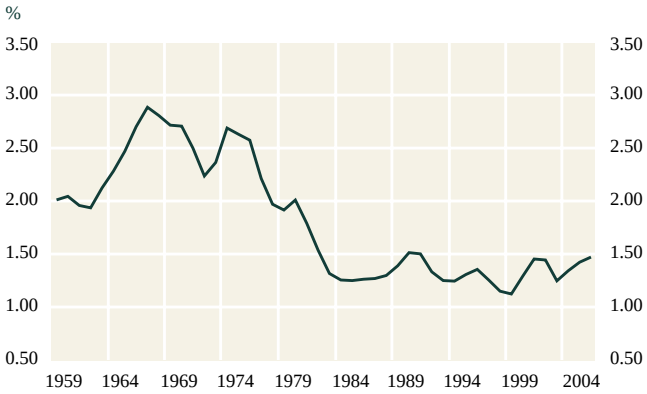
Percentage of Total Population 15 to 64 years of age



Source: United Nations World Population Prospects

Chart 2

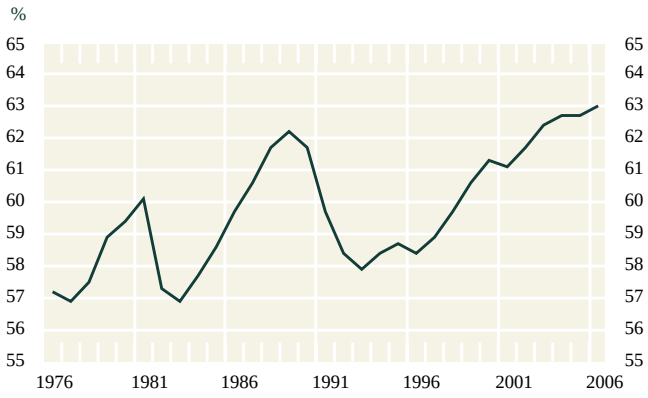
Working-Age Population Growth



Source: Statistics Canada

Chart 3

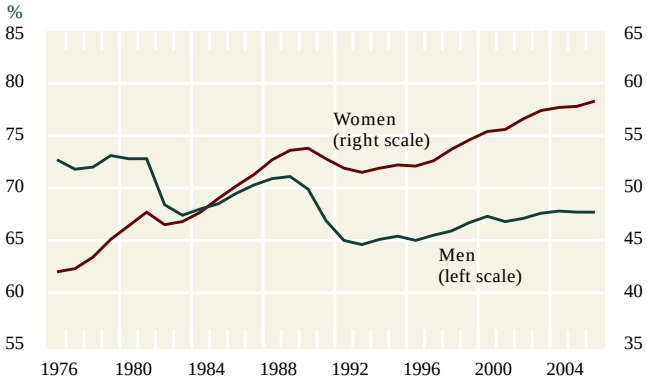
Aggregate Labour Force Employment Rate



Source: Statistics Canada

Chart 4

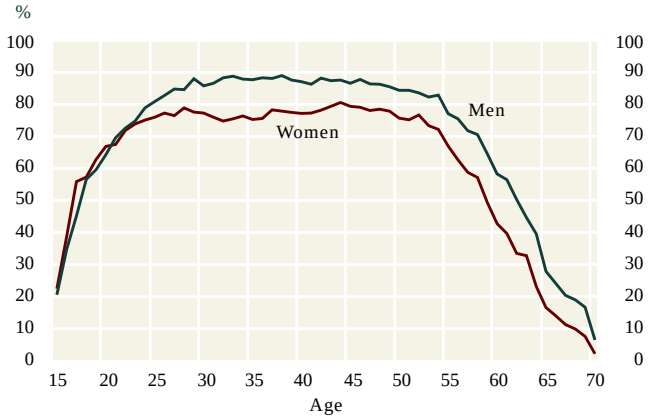
Labour Force Employment Rates for Men and Women



Source: Statistics Canada

Chart 5

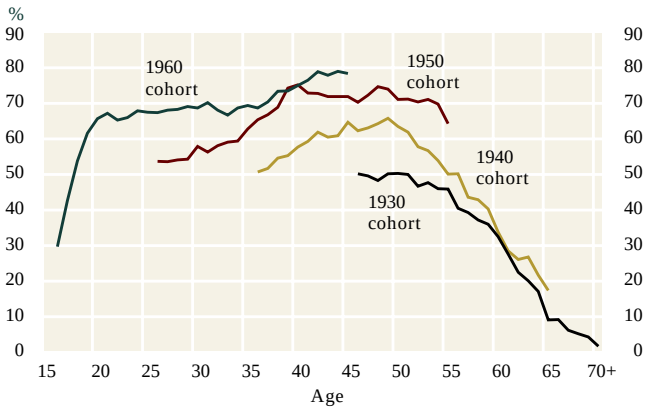
Age-Specific Employment Rates, 2006



Source: Statistics Canada

Chart 6

Birth-Cohort-Specific Employment Rates for Women, by Age, 1976–2006



Source: Statistics Canada

rate has risen by 5.8 percentage points since 1976, reaching a 31-year high of 63.0 per cent in 2006. This upward trend in the aggregate employment rate is mostly explained by the upward trend in the employment rates of women. Over the 1976–2006 period, the employment rate of men showed a mild downward trend, whereas that of women showed a strong upward trend (Chart 4).

Three factors are centrally important to modelling and projecting the trend aggregate employment rate: the shifts in the composition of the working-age population, the inverted-U-shaped lifetime employment rate profile, and the increasing labour force attachment of women over time. The first two factors interact with one another. If the composition of the population was constant over time, or if employment rates were the same at different ages, these two factors would be irrelevant. However, Canada has seen the demographic composition of its population change significantly over the past 30 years as the baby boomers have entered the labour force and moved through their working lives, and as life expectancies at birth have continued to improve. At the same time, labour force employment rates are not constant across age, as illustrated by the distinct inverted-U-shaped pattern across age (Chart 5). This pattern reflects the tendency of employment rates to be low, on average, in the early working years (15–24), when a sizable group of these individuals are still enrolled in educational institutions; to increase and stabilize in the prime working age (25–54); and, finally, to decline as people make the transition out of the labour market and into retirement. The pattern also suggests that the shifting distribution of the population has had, and will continue to have, a direct impact on the aggregate employment rate.

We observe several distinct upward shifts in the entire lifetime employment rate profiles of successive birth cohorts of women.

The third important factor is the significant increase in the labour force employment rate of women over the past half-century, which has led to a marked increase in the aggregate employment rate. While the profiles of the lifetime employment rates of men and women tend to have the same inverted-U shape across time, there have been several distinct upward shifts in the entire lifetime profiles of successive birth cohorts of women.[3] As illustrated in Chart 6, for a given age, the lifetime employment rate profile for women born in 1960 and 1950 lies above those of women born in 1940 and 1930. This upward shift in the lifetime employment rate profiles of successive birth cohorts likely reflects each generation of women's stronger labour force attachment than that of their mothers (Ip 1998). When attempting to explain the historical movements in the employment rate, it is therefore important to ensure that the model chosen is able to account, either explicitly or implicitly, for this phenomenon.

The labour force employment rate model

With these considerations in mind, we chose to model the employment rate using a cohort-based analysis, as described in Barnett et al. (2004). We chose a cohort model because it allows cyclical and structural factors to be taken into account while also measuring differences in the employment rate behaviour of individuals that relate directly to the year in which they were born, referred to as a cohort effect (Paquet, Sargent, and James 2000). The cohort effect will allow us to account for the upward shifts previously described. Our data set consists of single-year age (15–70 and over) and sex-specific annual employment rates from Statistics Canada's Labour Force Survey (LFS) over the 1976–2006 period. From this data set we are able to construct a total of 86 birth cohorts for men and women born in the years 1906 (the oldest cohort observed, i.e., 70 years old in 1976) through to 1991 (the youngest cohort observed, i.e., 15 years old in 2006).[4]

3. "Cohort" refers to people born in the *same year.* Individuals switch in and out of age groups from one year to the next, but they always remain members of the same birth cohort. This definition is identical to that used in Paquet, Sargent, and James (2000) and Barnett et al. (2004) and is similar to that of Beaudry and Lemieux (1999), who define their cohorts by an individual's year of entry into the labour force.

4. This methodology is quite similar to the work recently produced by the Board of Governors of the U.S. Federal Reserve (see Aaronson et al. 2006). The main difference between the two methodologies is that their analysis used five-year age groups to proxy individual birth cohorts when estimating their cohort model for the United States, whereas our data set consists of single-year birth cohorts.

The labour force employment rate (*LFER*) is modelled as a function of a cyclical labour demand variable, measured as the job-offer rate (*jor*),[5] and several structural factors, including: 11 age-related dummy variable ($age_{k,j,t}$),[6] the ratio of net wealth (adjusted for market prices) to nominal GDP (*wealth*), the real after-tax interest rate (*r*), a measure of employment insurance (*E.I.*) disincentives[7] (*eiindex*), and a birth-year cohort effect for women (α_j, where *j* denotes a cohort's birth year).[8] The model is estimated as a system of equations in the following log-linear form:

$$\overline{LFER}_{j,t} = \alpha_j + \Psi \times LFER_{j,t-1} + \beta_k \times age_{k,j,t} + \vartheta_l \times wealth_t \times age_{l,j,t} + \zeta_l \times jor_t \times age_{l,j,t} + \gamma_l \times r_t \times age_{l,j,t} + \delta_l \times eiindex_t \times age_{l,j,t},$$

where: $j = 1911, 1912, \ldots, 1986$; $k = 1, 2, \ldots, 11$; $l = 1, 2, \ldots, 12$; $t = 1977, 1978, \ldots, 2006$; $\overline{LFER}_{j,t} = -\log\left(\frac{100}{LFER_{j,t}} - 1\right)$.

The model is estimated over the 1977–2006 period for all cohorts with at least five observations. The model also includes a lagged dependent variable to account for the direct impact that an individual's previous labour market experience will likely have on their decision to engage in labour market activities today. With the exception of the birth-cohort effect and the lagged dependent variable, all the explanatory variables interact with 12 age-related dummy variable ($age_{l,j,t}$)[9] to allow for their varied impacts over an individual's life cycle. The employment rates are estimated for each birth cohort and then aggregated using their respective shares of the working-age population, which will ensure that we capture any impact on the aggregate employment rate caused by shifts in the composition of the workforce.

Results

Before attempting to isolate the trend employment rate, we perform a dynamic simulation with the model, including both the demand and supply components, to examine the model's empirical performance. The results show that the model is able to do a reasonably good job of tracking the general upward trend, as well as the business cycle movements, in the labour force employment rate (Chart 7).[10] In general, movements in labour demand as measured by the job-offer rate appear to drive the majority of the large swings in the employment rate. The upward trend, on the other hand, is mainly explained by an upward trend in the female cohort effect discussed earlier.

Between 1990 and 1996, the aggregate employment rate declined by 3.2 percentage points, with the employment rates of men and women falling by 4.9 and 1.7 percentage points, respectively. Our model attributes most of this drop to a steep decline in labour demand, which had a particularly strong impact on men. The model also estimates that increases in net wealth were putting downward pressure on the employment rate over this period, but that this pressure was entirely offset by a decline in the E.I. index, which was pushing up the employment rates of both men and women. As well, the shifting demographic composition of the labour force had a small negative impact on the aggregate employment rate over this period. Finally, the negative impact coming from the decline in labour demand was partially offset by the cohort effect of women which, all else being equal, would have raised the aggregate employment rate by 1.3 percentage points over this period.

From 1996 to 2001, the aggregate employment rate rebounded from its 1996 trough, increasing by 2.7 percentage points, and therefore offsetting most of the decline observed over the previous six years. The model attributes the increase in the employment rate over this period to three main factors. First, the female

5. From 1976 to 2002, the job-offer rate is defined as the ratio of the help-wanted index to the size of the working-age population. From 2003 to 2006, the job-offer rate was extended, using the percentage of firms who reported having a shortage of skilled or unskilled labour in the Business Conditions Survey published by Statistics Canada. The job-offer rate was used as the measure of cyclical labour demand for a couple of reasons. First, it would be inappropriate to include as a measure of labour demand a variable, such as GDP growth, that is endogenously driven by employment. Second, as noted in Fortin and Fortin (1999), Archambault and Fortin (1997) find that the help-wanted index is a good instrument of labour demand, since it is highly correlated with the probability of finding a job but appears to be insensitive to labour-supply shocks.

6. Where *k* denotes in which of the following age groups a cohort *j* is at time *t*: 15–17, 18–19, 20–24, 25–29, 45–54, 55–59, 60–62, 63–64, 65–66, 67–69, and 70 and over. The age dummies are measured relative to workers 30 to 44 years of age.

7. For a more detailed description, see Sargent (1995).

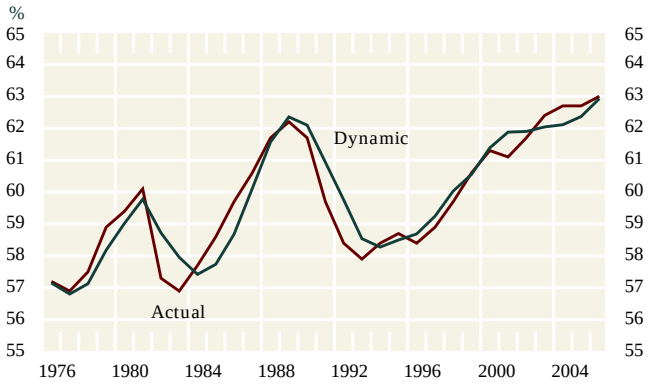
8. For men, differences in effect across cohorts were not statistically significant and were therefore excluded.

9. Where *l* denotes in which of the following age groups a cohort *j* is at time *t*: 15–17, 18–19, 20–24, 25–29, 30–44, 45–54, 55–59, 60–62, 63–64, 65–66, 67–69, and 70 and over.

10. The term "dynamic" is used to highlight that the results shown in Chart 7 are obtained with a simulation starting in 1977, using the estimated employment rate of cohort *j* in period *t*–1 to produce the employment rate in period *t*.

Chart 7

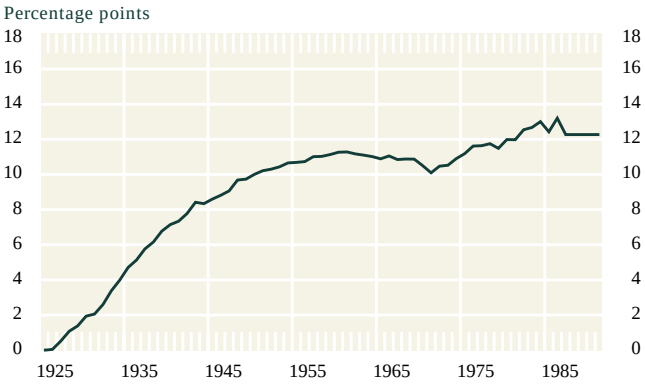
The Employment Rate: Dynamic Simulation Results



Source: Statistics Canada and model estimates

Chart 8

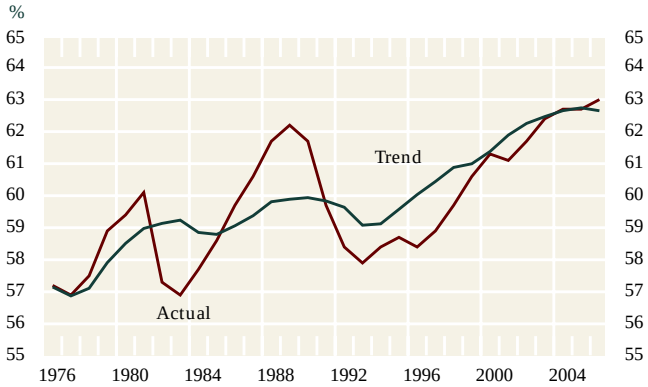
Estimated Cohort Effects for Women (relative to a 1925 cohort)*



* The female cohort effect can be interpreted as the percentage point increase in the entire lifetime employment rate profile of a cohort born in a given year relative to a cohort born in 1925 after controlling for the other factors included in the model.

Chart 9

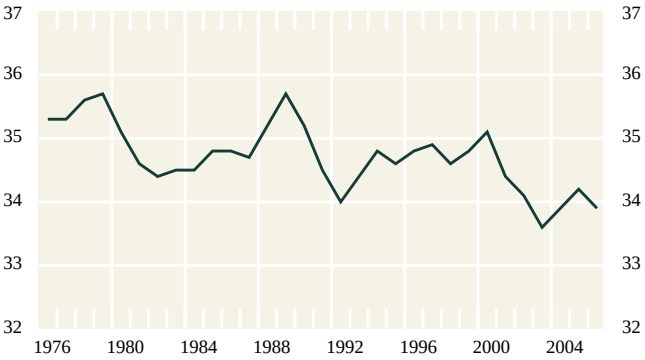
Actual and Trend Employment Rate



Source: Statistics Canada and model estimates

Chart 10

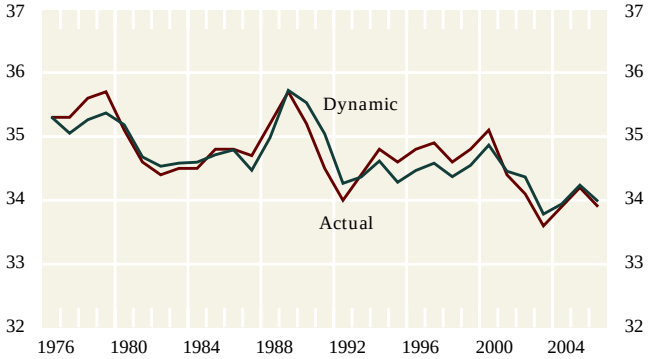
Average Weekly Hours Worked



Source: Statistics Canada

Chart 11

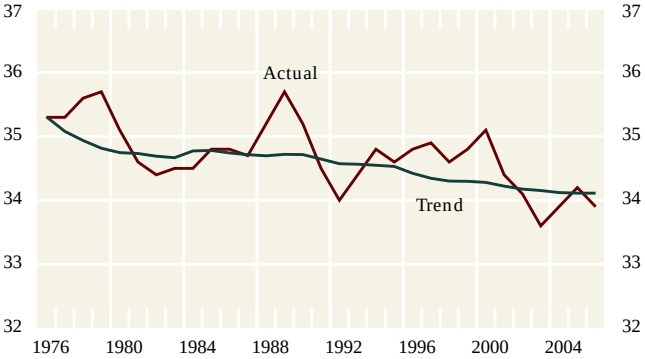
Average Weekly Hours Worked: Dynamic Simulation Results



Source: Statistics Canada and model estimates

Chart 12

Actual and Trend Average Weekly Hours Worked



Source: Statistics Canada and model estimates

cohort effect continued to push up the aggregate employment rate, adding approximately 0.2 and 0.4 percentage points per year to the aggregate and female employment rates, respectively. Second, labour demand increased each year over this period, with the exception of 2001. Third, reforms to the E.I. system in the mid-1990s, which reduced the system's generosity, were also pushing up the employment rate. These positive pressures were only partially offset by the downward pressure from the continued increases in net wealth.

Finally, since 2001, the aggregate employment rate has risen a further 1.8 percentage points, to reach its highest annual level in 31 years. The female cohort pushed up the employment rate of older workers (55+) as well as contributing to the rise in the aggregate employment rate. Further strengthening in labour demand also contributed to the increase in the employment rate, particularly in 2005 and 2006. Income effects continued to push the employment rate down, although by a much smaller amount than in the previous two periods, owing to the bursting of the stock market bubble in 2000–01 and declines in real after-tax interest rates. Lastly, the changing composition of the working-age population has also put mild downward pressure on the aggregate employment rate.

The observed levelling off in the cohort effect means that most of the positive boost to the aggregate employment rate coming from the female cohort effect will be exhausted within the next 15 years.

Of particular interest is the shape and size of the cohort effect for women. Our estimates suggest that it trended upwards for cohorts born over the 1920s to the 1950s and began to level off for cohorts born after 1955 (Chart 8). The shape of the female cohort effect likely reflects several factors, including: changing views of women's role in society, reductions in workplace discrimination, higher levels of educational attainment, and greater availability of contraception and child-care services. The observed levelling off in the cohort effect means that most of the positive boost to the aggregate employment rate coming from the female cohort effect will be exhausted within the next 15 years.

Calculating the trend employment rate

Our trend estimate of the aggregate employment rate is constructed over history by performing a dynamic simulation of the model, with the cyclical labour demand variable set equal to its assumed trend value and the remaining explanatory variables set at their actual values. Our trend estimate of the employment rate has been increasing for most of the past three decades (Chart 9), largely because of the female cohort effect. According to our estimates, the employment rate was just above its trend in 2006.

Labour force average weekly hours worked

We now turn our attention to the last component of trend labour input, the amount of time that individuals spend at work, on average, during a typical week. Aggregate labour force average weekly hours worked has been on a downward trend over the past 30 years (Chart 10). Unlike the employment rate, the raw data do not suggest that there have been any discernible cohort effects for either men or women with respect to average hours worked. Examining the data by disaggregated age groups, on the other hand, shows that youth, defined as those 15 to 24 year of age, are the only age group to show a significant downward trend in the number of average hours worked. For the remaining age groups, the average hours worked have remained relatively stable over the past 30 years.

Modelling average weekly hours worked

We chose to model average weekly hours worked by age and sex using a fixed-effects[11] model, based on Hazel (2006). This framework makes it possible to control for differences in average hours worked relating exclusively to age. Examining the disaggregated age groups, for example, we notice that older workers (55 and over) worked approximately two fewer hours, on average, than prime-age workers (25–54). This disparity could reflect several factors, such as: older workers assigning greater value to leisure time, a greater number of missed work days for health reasons, or simply that older workers typically have more seniority and additional vacation days. Regardless of why older workers have lower average hours worked, the advantage of our framework is that it allows us to control for these differences, after accounting for other cyclical and structural factors. The data set used to

11. Fixed effects refers to a panel-data estimation procedure that assumes that differences across the dependent variables can be captured by differences in the constant terms, once we have controlled for all the other observable variables.

estimate the average weekly hours worked consists of single-year age- (15–70 and over) and sex-specific annual average hours worked at all jobs from the LFS over the 1976–2006 period. Average weekly hours worked (*HAW*) are modelled as a function of lagged hours, the job-offer rate (*jor*), the real after-tax interest rate (*r*), the annual LFS seasonal adjustment factor on hours worked (*seasonal*), and the sex-specific full-time school enrolment rates (*school*).[12]

$$\overline{HAW}_{j,t} = \alpha_j + \psi_l \times HAW_{j,t-1} \times age_{l,j,t} + \xi_l$$

$$\times jor_t \times age_{l,j,t} + \vartheta_l \times seasonal_t \times age_{l,j,t}$$

$$+ \gamma_l \times r_t \times age_{l,j,t} + \delta \times school_t \times age_{15-24,j,t},$$

where: j = 15, 16,…, 70 and over; l = 1, 2,…, 5; t = 1977, 1978,…, 2006.

All the explanatory variables interact with five age dummies ($age_{l,j,t}$)[13], with the exception of the school enrolment rate, which is only included for the 15 to 24-year-old age group. Average hours worked are estimated for each age (denoted by *j*) and sex, and then aggregated using their respective shares of the employed population.

Results

The dynamic simulation results indicate that the model is able to track the majority of the movements in aggregate average hours worked (Chart 11). Two key factors appear to explain the decline in average hours worked in the early part of the sample. First, average weekly hours worked by youth (males and females) shows a downward trend until the mid-1990s. The model attributes this mainly to an upward trend in the school enrolment rates which, from 1980 to 1997, increased by 16.9 and 21.2 percentage points for men and women, respectively. The negative effect from this trend has eased somewhat in recent years, since school enrolment rates of females have remained fairly stable since 1997, while those of males have given back some of their earlier increase. Second, women's share of employment rose substantially between 1976 and 1992, increasing from 37.1 to 45.3 per cent of total employment. Because women work fewer paid hours on average than their male counterparts, this shift in the composition of employment put downward pressure on aggregate average weekly hours worked. Since 1992, this composition effect has continued to put downward pressure on average hours worked, but to a much smaller degree than in the past. Between 1992 and 2006, the employment share of women continued to rise, increasing by 0.1 per cent per year, on average, compared with 0.5 per cent in the earlier period. As noted previously, average weekly hours worked for most of the other age groups have remained relatively stable over the past 30 years.

Calculating trend average weekly hours worked

Our trend estimate of the average weekly hours worked by age and sex is constructed over history by performing a dynamic simulation of the model, after setting the cyclical variable and the seasonal factors at their assumed trend levels, and the remaining explanatory variables at their actual values. The aggregate series is then calculated by multiplying the age- and sex-specific trend average hours worked series by their respective shares of trend labour force employment.[14] Our trend estimate of average hours worked has been declining since 1976, which, as noted before, can be attributed to the increasing employment share of women and a fall in the average hours of youth, owing to an increasing trend towards school enrolment (Chart 12).

Constructing trend labour input

The estimated trends for the employment rate and average hours worked are now combined with the actual labour force source population to construct our measure of trend labour input. Since 1980, trend labour input is estimated to have grown, on average, by 1.6 per cent (Chart 13). Of this growth, 1.4 percentage points are attributable to growth in the working-age population. The upward trend in the labour force employment rate contributed, on average, 0.3 percentage points over the same period, while the downward trend in average hours worked subtracted about 0.1 percentage points.

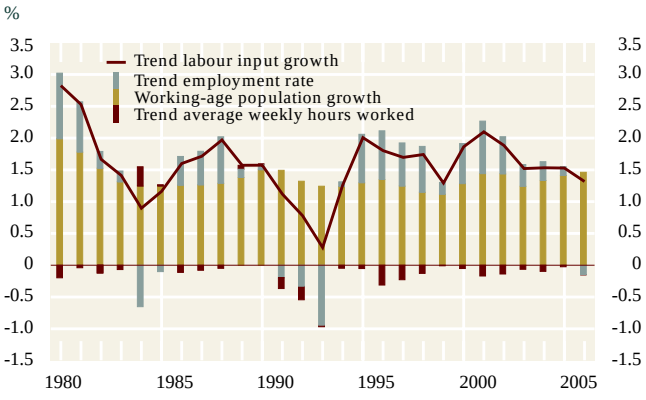
12. The annual LFS seasonal factor for total hours worked (main job) is included to account for movements in the reference week that lead to excessive volatility in the unadjusted hours series.

13. Where *l* denotes the following age groups: 15–24, 25–54, 55–59, 60–64, and 65 and over.

14. Trend labour force employment is calculated using the age and sex-specific trend employment rates estimated in the previous section and the age- and sex-specific population.

Chart 13

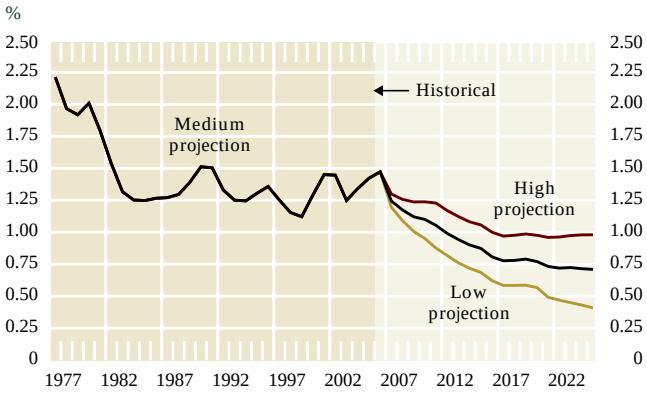
Decomposing the Growth in Trend Labour Input



Source: Statistics Canada and model estimates

Chart 14

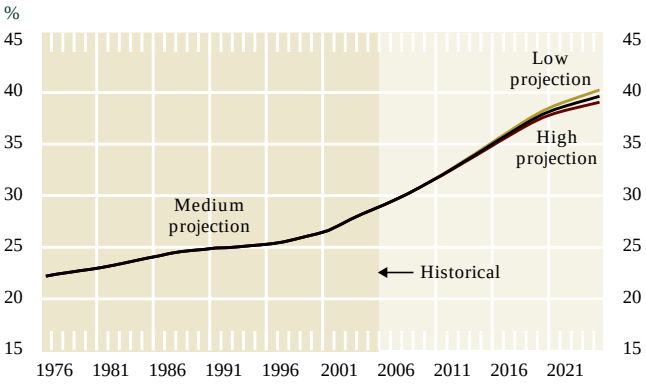
Growth of the Working-Age Population



Source: Statistics Canada (2005)

Chart 15

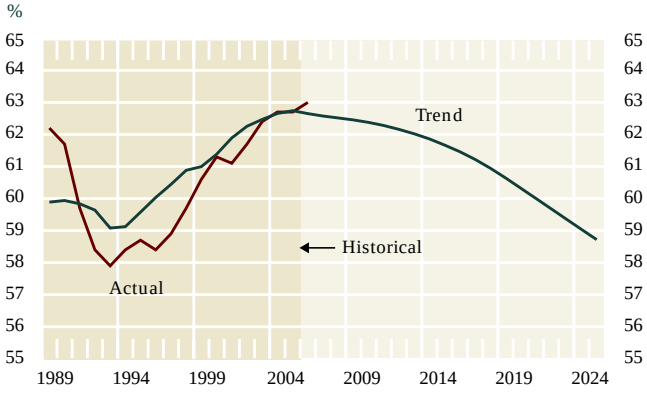
Older Workers' Share of the Working-Age Population



Source: Statistics Canada (2005)

Chart 16

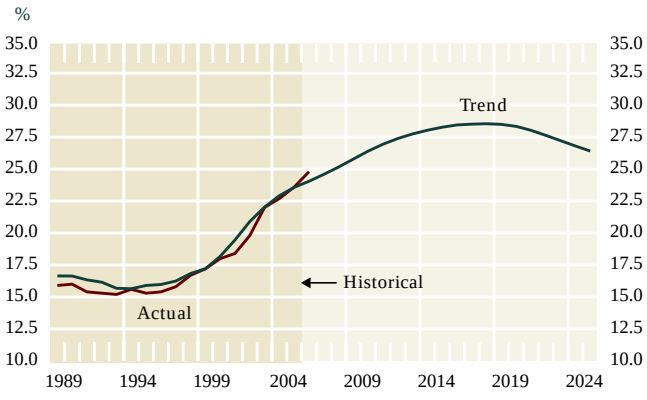
Trend Employment Rate



Source: Statistics Canada and model estimates

Chart 17

Trend Employment Rate of Women 55 and Over



Source: Statistics Canada and model estimates

Prospects for Trend Labour Input

The working-age population

Statistics Canada's medium population projection scenario (discussed below) is used to project the size and composition of the working-age population. The population projection is driven by three key assumptions on the national fertility rate, life expectancy at birth, and the net migration rate. The fertility rate in Canada, like that for most industrialized countries, has been declining since the 1960s. The total fertility rate in Canada was close to 4 children per woman in 1960, but has declined in almost every year since, reaching 1.5 children per woman in 2002 (Statistics Canada 2005). Statistics Canada's medium scenario assumes that the fertility rate will remain near its current level of 1.5 births per woman, well below the replacement rate of 2.1 births per woman. As for the second assumption, life expectancies at birth have significantly improved over the past three decades, rising from 69.3 and 76.3 years in 1970 to 77.2 and 82.2 years in 2002, for men and women, respectively. Statistics Canada's medium scenario assumes that this trend will continue over the next three decades, with male and female life expectancies at birth reaching 81.9 and 86.0 years in 2031, respectively. Finally, the most difficult component to project is net migration, since it is strongly influenced by a country's national immigration policies. In the medium scenario, Statistics Canada projects the number of immigrants to Canada by assuming a fixed immigration rate of 7.0 per 1,000, which allows the level of immigration to grow in line with total population growth. Emigration is also projected, using a fixed emigration rate of 1.5 per 1,000, based on average emigration rates by age, sex, and province observed over the past five years (Statistics Canada 2005). These assumptions are combined to construct a population projection which suggests that growth in the working-age population will slow significantly in the next few decades.

Estimates of the size and composition of the population should be fairly reliable, at least in the near term, since they are essentially embedded in the current structure of the population. That does not mean, however, that the projections are flawless, since they still depend on the assumptions described above. For this reason, Statistics Canada constructs a range of scenarios that consider two alternative assumptions, one high and one low, for each of the key factors (specifically the fertility rate, life expectancy at birth, and the immigration rate). A total of 27 scenarios can be constructed using different combinations of these alternative assumptions. Three scenarios are presented in Table 1, labelled as low, medium, and high scenarios. The medium scenario is our base-case profile, whereas the high (low) scenario combines all the highest (lowest) assumptions.[15] All three scenarios project the size of the working-age population and the age distribution.[16]

Table 1

Assumptions for Statistics Canada's Population Projections

	Assumptions		
	Low	Medium	High
Fertility	1.3 children per woman	1.5 children per woman	1.7 children per woman
Life expectancy			
Men (in 2031)	81.1 years	81.9 years	82.6 years
Women (in 2031)	85.3 years	86.0 years	86.6 years
Immigration rate	5.5 per 1,000	7.0 per 1,000	8.5 per 1,000
Emigration rate	1.5 per 1,000	1.5 per 1,000	1.5 per 1,000

In all three scenarios, growth of the working-age population is expected to slow considerably over the next decade, falling from 1.5 per cent in 2006 to 1.0, 0.7, and 0.4 per cent by 2025 in the high, medium, and low scenarios, respectively (Chart 14). Since the growth in trend labour input is mainly driven by population growth, this decline will have an important effect on our projection.

Labour force employment rate

The second component of trend labour input, the trend aggregate labour force employment rate, is also expected to change substantially over the next three decades. The trend employment rate is constructed using the cohort model discussed above, after setting some long-run assumptions for the structural variables. Specifically, the cohort effect of females is estimated to have stabilized for cohorts born after 1955; the ratio of net wealth to nominal GDP is expected to stabilize

15. If the alternative assumptions selected are believed to adequately capture the uncertainty surrounding these factors, then the high and low scenarios can be viewed as the high and low confidence bands surrounding the base-case scenario.

16. For more details, see Statistics Canada (2005).

at its average value observed over the 1997–2006 period; and the real after-tax interest rate is expected to return to a stable long-run value.

Outside the model, an equally important development embedded in all three population scenarios is the projected shift in the composition of the working-age population. The average age of this population is projected to increase significantly over the next 20 years as the share of older workers (55 and over) is projected to rise in all three scenarios (Chart 15). While there has been an upward trend in the share of older workers for some time, the pace of the increase is expected to pick up considerably over the next decade. While the share of older workers increased by seven percentage points over the past three decades, rising from roughly 22 per cent in 1976 to around 29 per cent in 2006, the aging of the baby boomers is projected in all three scenarios to lead to a seven percentage point increase in only 11 or 12 years. This development is expected to have a significant impact on the aggregate trend employment rate over the next 20 years.

The aggregate employment rate is projected to reverse the trend observed over the past 30 years and is expected to decline over the next two decades as older workers become an increasingly larger share of the working-age population.

At the aggregate level, the employment rate is projected to reverse the trend observed over the past 30 years and is expected to decline over the next two decades as older workers, whose employment rates are on average lower than those of prime-age workers, become an increasingly larger share of the working-age population (Chart 16). This downward trend occurs despite the projection that the employment rates of women 55 and over will continue to rise over the next 10 years as cohorts with stronger attachment to the labour force than their predecessors enter this age group (Chart 17).

Labour force average weekly hours worked

Third, the projection for trend labour force average weekly hours worked is constructed in much the same way as the employment rate, but with the fixed-effects hours model discussed above. The profiles for the explanatory variables included in both models are identical to the assumptions used for the trend employment rate. The other variable, the school enrolment rate, is projected to remain at its current level. Like the employment rate, aggregate average weekly hours worked is also affected by the age distribution of the population. The impact from the aging of the population on average weekly hours worked is quite small, however, and is expected to cause a mild downward trend over the projection horizon as older workers, who work fewer hours on average, become a greater share of the employed (Chart 18).

Growth of trend labour input

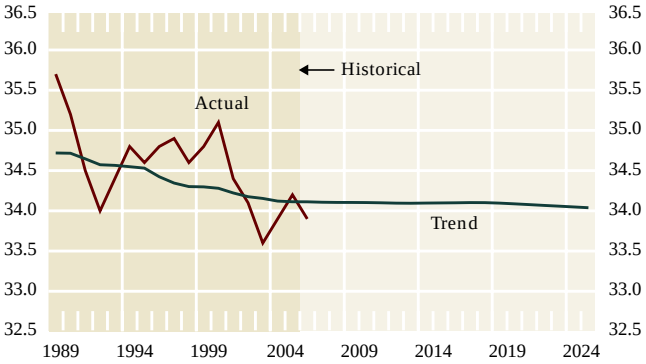
Using the above models, trend labour input growth is projected to contribute considerably less to potential output growth over the next two decades than it has in the past, regardless of which population projection is used (Chart 19). In the medium scenario, labour input growth is projected to fall from 1.3 per cent in 2006 to 1.0 and 0.6 per cent in 2010 and 2015, respectively. This is considerably weaker than the 1.5 per cent growth observed, on average, over the 1980–2006 period. The slowdown in trend labour input becomes especially evident from 2011 to 2020, as population growth continues to slow and the decline in the employment rate accelerates (Chart 20). Over this period, the contributions to trend labour input growth from population growth and the employment rate are expected to fall by 0.3 and 0.4 percentage points, respectively. Growth of the working-age population is projected to fal1 from 1.1 per cent in 2010 to 0.8 per cent in 2020, while the employment rate is expected to fall by 0.2 percentage points per year, on average, over the same period.

Risks Surrounding the Base-Case Scenario

The projection presented in the previous section is a model-based projection and could be subject to a number of risks. In particular, the projection relies on a presumed path for a number of explanatory variables, the evolution of which could turn out to be different than we have assumed in our base-case scenario. This poses both upside and downside risks to our projection.

Chart 18

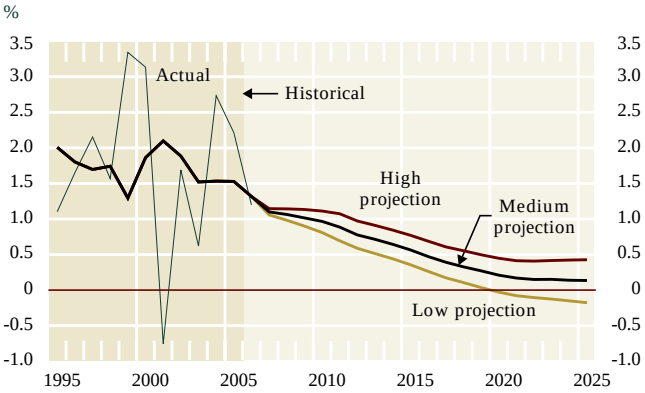
Trend Average Weekly Hours Worked



Source: Statistics Canada and model estimates

Chart 19

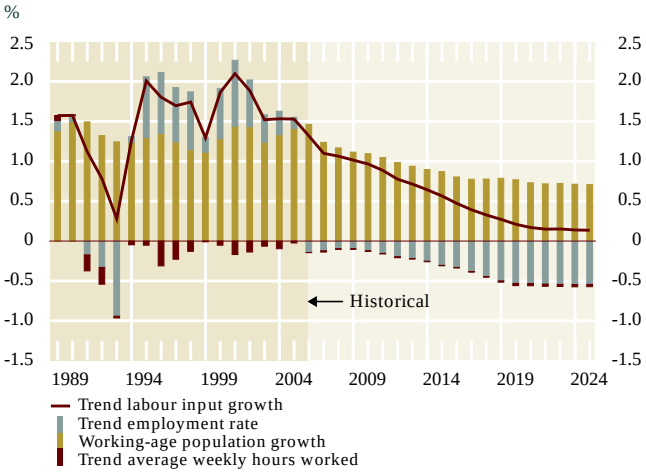
Trend Labour Input Growth Using Alternative Population Projections



Source: Statistics Canada and model estimates

Chart 20

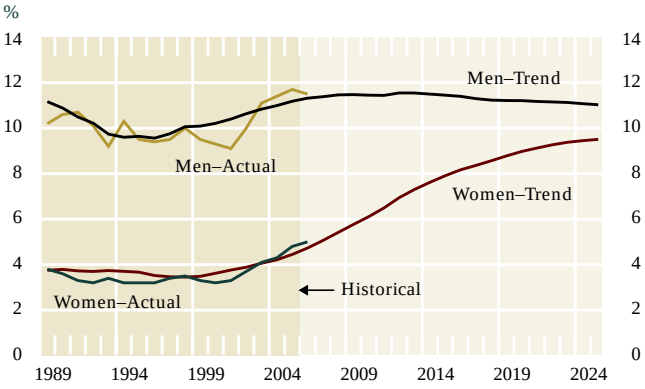
Decomposing the Growth in Trend Labour Input



Source: Statistics Canada and model estimates

Chart 21

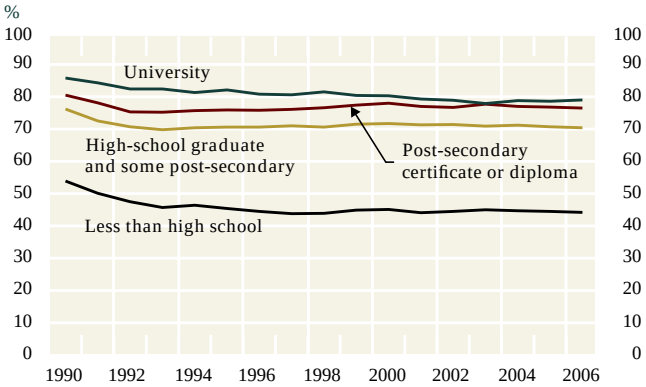
Trend Employment Rates of Men and Women 65 and Over



Source: Statistics Canada and model estimates

Chart 22

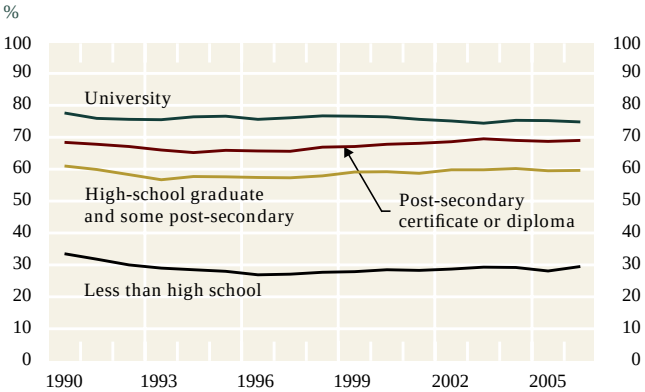
Men: Employment Rates by Educational Attainment



Source: Statistics Canada

Chart 23

Women: Employment Rates by Educational Attainment



Source: Statistics Canada

For example, our base-case scenario assumes that the ratio of net wealth to nominal GDP will stabilize over the projection horizon. However, should net wealth continue to increase as it has over the past number of years, our model suggests that individuals would consume more leisure by reducing the amount they work, which would lower the aggregate employment rate.

Apart from the future path of the explanatory variables, there are several other factors that could help to delay or partially offset some of the projected decline in the employment rate. These factors are not accounted for in this analysis, given their speculative nature and the difficulty in quantifying their respective magnitudes. First, continued improvements in health status and life expectancies could raise the employment rates of older workers. Second, as the pool of labour shrinks, employers and governments may remove barriers to continued labour force participation. From the employers' side, this could mean increased workplace flexibility or changes to the structure of existing pension plans that create large disincentives to remain with an organization past a particular age. Governments have already begun to address some of the barriers to continued labour market participation. Ontario, for example, followed the lead of several other provinces and passed legislation in 2006 that essentially made mandatory retirement illegal. The government might also examine the work disincentives currently built into Canada's income-security system, which have a significant effect on the retirement decisions of both men and women (Baker, Gruber, and Milligan 2003).

Several other factors could help to delay or partially offset some of the projected decline in the employment rate.

Third, our cohort model treats the employment rates of men and women separately. There is evidence, however, that retirement decisions are in fact made jointly. For example, Schirle (2007) finds that wives' participation has a significant and positive impact on the participation rate of older husbands, suggesting a leisure complementarity that our model does not explicitly capture. This poses an upside risk to our base-case scenario, since we project that the employment rates of older men will remain relatively stable, while those of older women will continue to rise over the next couple of decades as cohorts with stronger labour force attachment than their predecessors reach the conventional retirement age (Chart 21). However, even if we used the extreme assumption that the projected increase in the employment rates of older women would affect their male counterparts one-for-one, this would still not be sufficient to keep the aggregate employment rate from falling in the future, although it would alleviate the downward pressure over the next five to seven years.

Fourth, the average educational attainment of the population, or perhaps, more importantly, the nature of work, has changed significantly over the past 30 years. Continued improvements in educational attainment might raise the aggregate employment rate in the future, since employment rates are greater for higher levels of educational attainment (Charts 22 and 23). At the same time, the economy has become increasingly service based, where jobs are less physically demanding than in the past. This shift towards a knowledge-based economy has likely enabled workers to remain in the labour market longer. If this poses a risk to our projection, it is probably less important for women than for men, since these factors are likely at least partially captured by the female cohort effect.

Finally, the analysis presented above was not conducted in a full general-equilibrium framework. In such a framework, the reduction in labour supply would likely push up the real wage and create an incentive for a greater number of younger workers to enter the labour force and for older workers to delay their retirement.

Conclusions

Trend labour input growth has accounted for about half of real output growth over the past 25 years. Since 1980, trend labour input growth has been driven by the growth of the working-age population and a steady rise in the trend employment rate stemming from an increase in women's labour market attachment. Population growth is expected to slow significantly over the next 20 years, and the trend employment rate is projected to decline as older workers become an increasingly greater share of the working-age population. Together, these two factors suggest that trend labour input growth will fall markedly over the next two

decades, which, without an offsetting increase in labour productivity, will imply a lower growth rate of potential output.

As the pool of labour shrinks, firms will have a greater incentive to find ways of improving labour productivity.

The model-based projection presented in this article implicitly assumes that employer and government policies will remain unchanged in the future. Yet the good news is that the aging of the baby boomers is a well-documented and understood phenomenon that will occur slowly over the next few decades. In turn, employers and governments will likely look for ways to address barriers to continued labour force participation, which might help to alleviate some of the labour market pressure generated by this impending demographic transition. As well, as the pool of labour shrinks, firms will have a greater incentive to find ways of improving labour productivity, whether through greater capital deepening or modifying their business practices. Together, these possible initiatives on the part of employers and governments will likely dampen the impact on future potential output growth.

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Interpreting Canada's Productivity Performance in the Past Decade: Lessons from Recent Research

Richard Dion, Research Department

- *Trend productivity growth in Canada has remained modest in the past 10 years. This contrasts with a sustained productivity resurgence observed in the United States. The rise and fall of Canadian productivity growth centred around the year 2000 largely reflect business cycle developments and the boom and bust in the demand for information and communications technologies (ICT).*
- *Canada has taken less advantage of ICT than the United States and has realized fewer efficiency gains in the production of goods and services. Comparatively moderate wages relative to the price of investment in machinery and equipment (M&E) likely exacerbated the gaps in M&E and technology intensities relative to the United States until at least the early 2000s.*
- *Adjustment costs associated with the reallocation of resources between industries in response to large relative price movements have probably slowed aggregate productivity growth in Canada in recent years. As well, high resources prices would have induced the exploitation of marginal reserves, with significant negative effects on aggregate productivity growth in 2005 and 2006. These phenomena would have intensified the more persistent drag exerted by impediments to innovation.*
- *Canada's lagging performance with respect to innovative activity, the adoption of new technologies, and investment in organizational capital seem to mostly reflect a relatively weak demand for innovation. The latter could partly stem from less competition and fewer rewards from risk taking and, until recently, a slower decline in the price of M&E-embodied technologies relative to labour compensation.*

The past decade in Canada has seen a rise and fall in productivity growth centred around the year 2000, but no shift in the growth of trend productivity from its moderate pace of the previous 20 years. The United States, in contrast, throughout the same period has witnessed a resurgence of the strong productivity growth of the 1960s and early 1970s. In this article, we attempt to shed light on the evolution of Canadian productivity since the mid-1990s, using the United States as a benchmark for comparison. We begin by looking at Canada's trend productivity growth over the past 30 years, alone, and in comparison with other advanced economies. We then examine the sources of productivity growth in Canada over the past decade using growth accounting and decomposition by industry to gain additional insights about differences from the United States. This is followed by an analysis of several factors that likely underpin these results, notably, adjustment costs, a lacklustre demand for innovation, and structural factors. The article concludes with suggestions for further research, particularly in areas where outstanding issues remain.

Canadian Productivity Growth in Perspective

There have been remarkably diverse patterns of labour productivity growth across advanced countries over the past 10 years or so. Labour productivity growth in Canada picked up over the late 1990s, only to fall back in the next five years to the sluggish pace of the 1974–96 period (Table 1). The same profile was observed in Australia and New Zealand, but with much less amplitude. In contrast, average productivity growth in 11 European Union countries has fallen markedly compared with the previous 20 years, while in the United States it has shifted to persistently higher levels. These patterns reflect, to varying degrees, changes in trend productivity growth, business cycle influences, lags in the impact of macroeconomic policies, and the effects of transitory sector-specific developments.

An increase in trend productivity growth has occurred in the United States . . . but not so far in Canada.

By isolating the trend component in labour productivity growth, we can gauge the importance of structural factors and make better judgments about future growth prospects. Methods of detecting changes in trend productivity growth include techniques based on the notion of slow and continuous change in the evolution of equilibrium productivity as well as statistical methods to identify structural breaks or abrupt shifts in the profile of productivity growth. One particularly rich version of the latter uses corroborating evidence from wages per hour worked and consumption per hour worked to estimate a common underlying growth trend (Kahn and Rich 2003).[1] As Chart 1 shows, the profiles of real output, wages, and consumption per hour are similar over the past 30 years.[2] Application of the Kahn and Rich approach to Canada reveals a shift in trend productivity growth in the late 1970s from a high-growth regime of about 2.5 per cent to a low-growth regime of a little over 1 per cent for the total economy, but no shift back to a high-growth regime in the late 1990s (Dolega 2007; Table 2). In contrast, the same technique applied to the United States signals a shift to a low-growth regime in the early 1970s and a switch back to a high-growth regime in the late 1990s. Skoczylas and Tissot (2005) report similar results for Canada and the United States, using a statistical procedure designed to detect structural inflection points. They also find that trend productivity growth shifted down in the euro area in the mid-1990s and in Australia in the early 2000s and has been very low in New Zealand since the early 1990s. Thus, an increase in trend productivity growth has occurred in

Table 1

Gross Domestic Product per Hour Worked: Total Economy

Annual average growth rates (%)

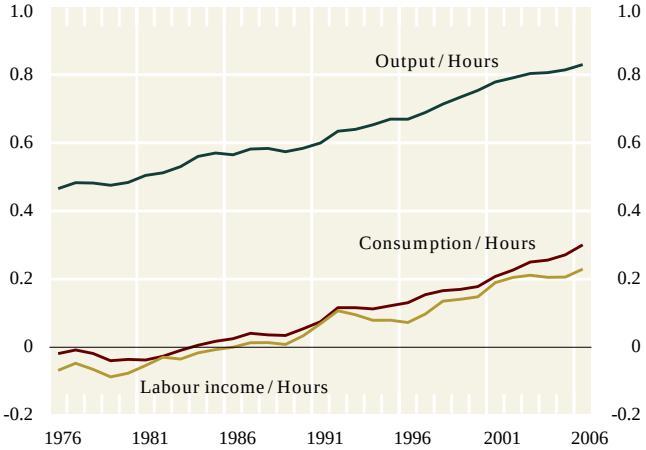
	1974–96	1997–2005	1997–2000	2001–05
Canada	1.2	1.9	2.9	1.1
United States	1.3	2.4	2.1	2.5
European Union (EU-11)*	2.7	1.5	1.9	1.2
(United Kingdom)	(2.2)	(2.1)	(2.5)	(1.9)
Australia	1.7	1.9	2.1	1.7
New Zealand	0.8	1.3	1.6	1.0

* EU-15 excluding Austria, Greece, Luxembourg, and Portugal.
Source: OECD Productivity Database, September 2006

Chart 1

Trends in Real Output, Consumption, and Labour Income per Hour Worked: Total Canadian Economy

Logarithmic values



Sources: National Accounts and Labour Force Survey. Nominal output and labour income are deflated by the GDP price deflator. Nominal consumption is deflated by the price index for personal consumption.

1. Kahn and Rich (2003) show that, under assumptions consistent with the neoclassical growth model, output per hour, real wages per hour, and real consumption per hour will share a common trend over the long run.

2. Tests reveal that the variables are indeed cointegrated.

Table 2

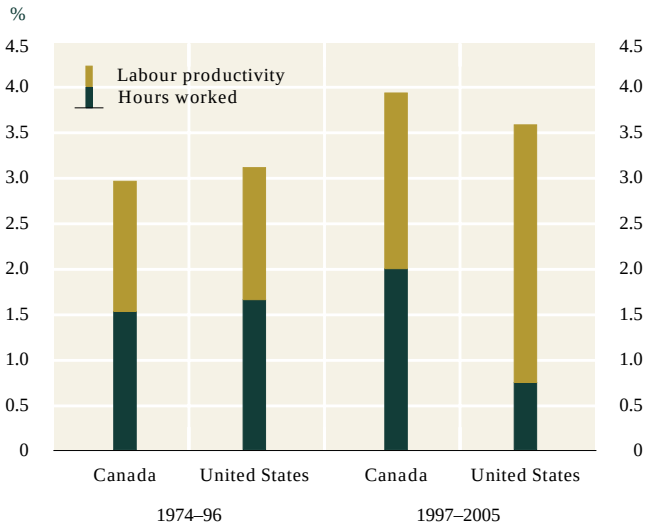
Most Recent Trends in Labour Productivity Growth Rates (%)

	Previous trend		Most recent trend		Sector
	Start	Average	Start	Average	
Canada					
S&T (2005)*	mid-1960s	4.00	mid-1970s	1.25	Business
Dolega (2007)	1966	2.40	1979	1.10	Total economy
United States					
S&T (2005)*	mid-1970s	1.25	late 1990s	3.00	Business
Kahn & Rich (2003)	1974	1.40	1997	2.90	Non-farm business
Euro area					
S&T (2005)*	late 1970s	2.50	mid-1990s	1.50	Business
Australia					
S&T (2005)*	early 1990s	2.50	early 2000s	1.50	Business
New Zealand					
S&T (2005)*	early 1970s	1.25	early 1990s	0.75	Business

* S&T = Skoczylas and Tissot (2005)
Note: Productivity is defined as gross domestic product per hour worked.

Chart 2

Contributions to Real GDP Growth in the Business Sector



Sources: Statistics Canada and the U.S. Bureau of Labour Statistics (data for the non-farm business sector)

the United States in the past decade or so, but not so far in Canada or in most other advanced countries.

This failure did not prevent Canada from achieving a higher rate of output growth in the business sector than the United States over the 1997–2005 period. It did this by relying more on additional workers to increase production (Chart 2). Whereas in Canada productivity growth accounted for nearly half of the gross domestic product (GDP) advance, as it did in the 1974–96 period, in the United States it accounted for 80 per cent of the output gain, a much higher proportion than before.

Examining the sources of the broad movements in Canadian productivity in terms of growth accounting and decomposition by industry provides additional clues about trend productivity growth.

Sources of Productivity Growth in Canada

Growth accounting is an empirical methodology that, in its most common version, decomposes labour productivity growth into three elements:[3] growth in the services of physical capital per hour worked, or *capital deepening*;[4] changes in human capital per job, or *labour quality*, as a result of variations in the levels of education and experience of the workforce; and growth of *total factor productivity* (TFP). TFP is the residual component usually associated with technological change but can also reflect a host of other factors, including variations in capacity utilization and capital adjustment costs;[5] changes in returns to scale

3. Growth accounting based on a "gross output" measure of output also includes the contribution of intermediate inputs.

4. Capital service flows reflect both the growth of capital stocks and capital quality. Such service flows are derived by weighting the growth of the stock of each asset by its respective rental price or user cost. An increase in the share of information and communications technology (ICT) in total capital stock would lead to a rise in capital services per unit of capital stock because the rental price of ICT services is relatively high.

5. These costs may originate from substantial but unrecorded complementary investments in learning and reorganization, especially with ICT, which has attributes of a general-purpose technology. They would cause TFP first to slow down and then to accelerate as they run off. Estimates of the lag before TFP accelerates vary considerably. Using aggregate data, Leung (2004) estimates a lag of three years for computer hardware in Canada, while Basu and Fernald (2006), using industry data, estimate lags of five to 15 years for ICT in the United States. Bosworth and Triplett (2007), on the other hand, generally find no significant effect of ICT intensity on TFP growth in the United States.

Table 3

Canadian Business Sector: Labour Productivity Growth, 1974–2005 (%)

	1974–96	1997–2000	2001–05
Labour productivity	1.4	3.0	1.0
Capital deepening	1.1	1.0	0.7
Information and communications technology (ICT)	0.4	0.7	0.3
Non-ICT	0.7	0.4	0.4
Labour quality	0.4	0.4	0.4
Total factor productivity	0.0	1.6	-0.1

Source: Statistics Canada, Cansim Table 383-0021, 2007

Table 4

U.S. Non-Farm Business Sector: Labour Productivity Growth, 1987–2005 (%)

	1987–95	1995–2000	2000–05
Labour productivity	1.4	2.5	2.5
Capital deepening	0.5	0.9	0.8
Information and communications technology (ICT)	0.4	0.8	0.5
Non-ICT	0.1	0.1	0.3
Total factor productivity	0.9	1.6	1.7
Computers	0.3	0.7	0.3
Services	0.3	0.9	1.1
Others	0.3	–	0.3

Source: Bosworth and Triplett (2007)

and mark-ups of price over marginal cost; unrecorded investment in intangible assets;[6] and measurement errors in outputs and inputs.

Growth accounting reveals that the rise and fall of productivity growth in Canada centred around the year 2000 largely originated from variations in TFP growth, which strengthened markedly until 2000 before turning slightly negative in subsequent years (Table 3). Capital deepening in ICT assets accelerated in the 1997–2000 period but moderated considerably afterwards; with respect to non-ICT assets it settled down to a slower pace from the late 1990s onwards. Labour quality progressed in the past decade at the same rate as over the 1974–96 period.

The rise and fall of productivity growth in Canada centred around the year 2000 largely originated from variations in TFP growth.

Unlike Canada, the United States has experienced an upward shift in productivity growth that has persisted throughout the period (Table 4). Efficiency gains in the production of both information and communications technology (ICT) and services accelerated in the second half of the 1990s, while a steeper decline in ICT prices stimulated heavier investment and capital deepening in ICT assets during this period. In the first half of the 2000s, the direct contribution of ICT diminished, but capital deepening in non-ICT assets started to pick up, and efficiency gains in the production of services and non-ICT goods accelerated.

The growth-accounting results just outlined reflect the boom and bust in the demand for ICT around the year 2000. These shocks had at least some transient effects, first positive then negative, on TFP growth in the ICT-producing sector in both countries. They also affected capital deepening in ICT assets: in Canada, for instance, the growth of ICT capital input intensified markedly in the late 1990s and slowed to a sub-par rate in subsequent years, particularly in 2001–03. The decline in ICT-capital deepening over the 2001–05 period cut productivity growth in the Canadian business sector by 0.4 percentage points per year.

Growth accounting also reveals that business cycle influences drove aggregate productivity growth in Canada but not in the United States. Productivity growth rates tend to be the highest in the immature phase of a business cycle expansion because firms can more fully use labour hoarded during the preceding slowdown. This factor underpinned the strong growth of TFP in the non-ICT-producing sectors in Canada in the late 1990s. As economic growth in Canada fell below its potential rate in the first half of the 2000s, the pace of productivity growth slowed markedly in cyclically sensitive sectors, especially manufacturing (Table 5). Early in the period, this dampening largely originated from the downswing in the U.S. economy, while closer to mid-decade, the appreciation of the Canadian dollar played an important role by slowing output growth. Meanwhile, wholesale trade and retail trade did well relative to other industries with respect to productivity growth, at least in part because they experienced a comparatively brisk expansion of demand and output. This provided support to aggregate TFP growth over the 2001–05 period.

6. These would include, for the most part, research and development (R&D), brand equity, and employer-provided worker training.

Table 5

Average Growth in Output and Labour Productivity by Sector (%)

	1997–2000		2001–05	
	Output	Output per hour	Output	Output per hour
Business sector	5.7	3.0	2.5	1.0
Business sector, goods	5.0	3.6	1.3	0.6
Manufacturing	7.2	4.8	-0.2	0.6
Wholesale trade	7.8	5.1	4.7	3.3
Retail trade	5.7	4.4	4.7	2.4

Source: Statistics Canada, Cansim Table 383-0021, 2007

Table 6

Growth in Output and Labour Productivity in Retail Trade, 2001–05 (%)

	Labour productivity	Output	Hours
Canada[1]	2.4	4.7	2.3
United States[2]	4.2	4.1	-0.1

1. Statistics Canada, Cansim Table 383-0021, 2007
2. Output defined as real value-added from the U.S. Bureau of Economic Analysis, April 2007; hours worked from the U.S. Bureau of Labor Statistics

Business cycle influences drove aggregate productivity growth in Canada but not in the United States.

The absence of a cyclical slowdown in U.S. productivity growth in the early 2000s indicates an absence of labour hoarding that is unusual during an economic slowdown. This likely reflects structural adjustment conducive to faster efficiency gains. These could have arisen from increased competitive pressures in an environment of more flexible and efficient labour markets (Oliner, Sichel, and Stiroh 2007). Another possible source of efficiency gains is the earlier accumulation of ICT facilitating subsequent innovation and enabling organizational changes and other investments needed to fully translate technological adoption into productivity growth. This would go some way towards explaining the strong TFP gains in services, including such ICT-intensive industries as wholesale trade, retail trade, and financial services.[7] As shown in Table 6, hours worked in the retail trade sector were flat in the United States over the 2001–05 period, whereas in Canada they adjusted to the growth in output in a more or less typical fashion.[8]

Net labour reallocation into industries with lower productivity growth reduced aggregate productivity growth slightly over the 1997–2003 period.

The industry approach to growth accounting allows us to quantify the effect on aggregate productivity gains of labour reallocation between industries with different levels or growth rates of productivity. Shifts between industries with different levels of productivity are generally found to have only a small effect and therefore could not have contributed significantly to the patterns of productivity growth of the past decade. Faruqui et al. (2003) estimate that this type of labour reallocation within the Canadian business sector had no net effect over the 1996–2000 period. The second type of reallocation typically refers to long-run shifts of labour to industries with lower-than-average productivity growth, from manufacturing to business services, for example. Tang and Wang (2004) show that this reallocation did slow aggregate productivity growth in Canada over the 1987–98 period, but by less than 0.1 percentage point per year. More recent calculations[9] reveal that net reallocation into industries with lower productivity growth subtracted about 0.15 percentage points from the average annual

7. A cross-sectional analysis by Oliner, Sichel, and Stiroh (2007), however, failed to support the notion that the industries that invested heavily in ICT in the late 1990s reaped a large productivity payoff after 2000.

8. The Canadian and U.S. figures are not strictly comparable because of differences in measurement methodologies, but they are nevertheless indicative of qualitatively different adjustments in the two countries.

9. Net reallocation in this exercise is the difference between aggregate productivity growth and the weighted sum of industry productivity growth rates. The weights correspond to the two-period average industry shares in aggregate nominal value-added. These calculations combine data at the two-digit level for non-manufacturing industries and at the three-digit level for manufacturing industries.

Table 7

Impact of Reallocation and Industry Mix on Labour Productivity Growth in Canada (%)

	Aggregate productivity growth	Industry productivity growth			Net reallocation effect
		Canadian mix	U.S. mix	Difference	
Business sector					
1997–2003	2.11	2.26	2.35	-0.09	-0.15
1987–96	1.01	1.05	0.94	0.12	-0.05
1978–86	1.12	1.25	1.36	-0.10	-0.14
Manufacturing sector					
1997–2003	2.64	3.06	3.08	-0.02	-0.41
1987–96	2.21	2.25	2.47	-0.23	-0.04
1978–86	2.28	2.50	2.64	-0.13	-0.22

Source: Statistics Canada, Cansim Table 383-0021; U.S. Bureau of Economic Analysis, Annual Industry Accounts

growth rate of labour productivity in the business sector over the 1997–2003 period (Table 7). [10] It is worth noting that the gap in productivity growth between goods-producing and services-producing industries in the Canadian business sector has narrowed considerably over time, vanishing between 1996 and 2001, and turning negative in the first half of the 2000s.

To summarize, in the past 10 years, Canada, unlike the United States, has not moved to a higher trend productivity growth rate. Relative to the previous 20 years or so, capital deepening has moderated somewhat in Canada, and the stronger pace of TFP growth that underpins the higher average growth rate of labour productivity essentially reflects a cyclical upswing in the late 1990s. Net labour reallocation into industries with lower productivity growth reduced aggregate productivity growth slightly over the 1997–2003 period.

10. Bosworth and Triplett (2007) estimate that net labour reallocation into industries with lower productivity growth subtracted about 0.25 percentage points from the average annual growth rate of U.S. labour productivity over the 1995–2005 period. Taking into account the reallocation of intermediate inputs in addition to labour can make quite a difference. Bosworth and Triplett (2007) find that a more favourable shift of intermediate inputs into industries that have higher productivity growth provided considerable support to aggregate productivity growth in the United States over the 2000–05 period relative to the 1995–2000 period.

Explaining Canada's Weak Trend Productivity Growth

Growth accounting allows us to trace the sources of productivity growth, but it cannot explain how capital deepening and TFP growth relate to more fundamental factors. In this section, we explore these deeper questions by analyzing the potential role of three sets of factors: reallocation and adjustment costs, impediments to innovation, and structural elements of the Canadian economy. Impediments to innovation go a long way towards explaining low trend productivity growth in Canada.

Reallocation and adjustment costs

In recent years, large relative price movements associated with the surge in commodity prices in Canada and the appreciation of the Canadian dollar may have led to greater reallocation of labour and capital across industries, resulting in more resources being diverted from production to searching out, hiring, and training labour and setting up or adapting production systems. This may have caused an increase in adjustment costs that slowed aggregate productivity growth, but should, however, be a transitory phenomenon.

Aggregate adjustment costs would have increased either because the volume of reallocation has increased or because the average cost for a given volume of reallocation has risen. Since labour turnover at the industry level accounts for one-fifth of the total labour turnover at the firm level (Kavcic and Yuen 2005), even a substantial increase in this turnover component may have had only a moderate impact on total labour turnover. In fact, the extent to which total labour turnover would have intensified in recent years remains to be determined. Even if it had not increased, the average adjustment costs for a given volume of reallocation may have risen for two reasons. First, skills are less easily transferable between industries than within industries, so an increase in reallocation between industries relative to within industries would result in higher adjustment costs. Second, average adjustment costs may have risen if employers had to hire a larger proportion of workers with low skills and little experience in the face of more widespread labour shortages and generally firm labour market conditions. Overall, it seems reasonable to expect that increased adjustment costs would have slowed productivity growth in recent years, but measuring these costs is a challenge.

Increased adjustment costs would have slowed productivity growth in recent years.

Another channel through which large relative price movements have likely affected aggregate productivity growth is the impact of high resources prices on the resources sector itself. High prices for energy, metals, and minerals would have contributed to slow productivity growth in the mining and oil and gas extraction industries by encouraging the exploitation of marginal reserves. Industry productivity data show that TFP in these industries fell by 7.5 per cent in 2005, after having declined by 4.2 per cent in 2004 and 3.5 per cent in 2003, a pattern consistent with the jump of energy prices to very high levels in 2005. Quarterly productivity data reveal that labour productivity in the same industries fell slightly more in 2006 than in 2005, at a time when energy prices remained elevated and metals prices surged to exceptional levels. This points to a further substantial decrease in TFP in 2006. Assuming that this decrease was the same as in 2005 and taking 2003 as a benchmark, the 4-percentage-point fall of TFP growth in 2005–06 relative to the benchmark subtracts 0.4 percentage points from annual labour productivity growth in the business sector.[11] These calculations suggest that diminishing returns in extraction industries had a significant negative impact on aggregate productivity growth in 2005 and 2006.

Impediments to innovation

Innovation refers to the conception, acquisition, and adaptation of new ideas, technologies, and practices that enhance business processes or products. Innovation may be technological, organizational, or marketing in nature. It enhances productivity growth through two channels. The first is innovative activity, a key element of which is research and development (R&D). Models of endogenous innovation and growth predict that the intensity of R&D relative to GDP positively impacts TFP growth through higher rates of both invention and technology transfer, the latter reflecting a greater capacity to understand and assimilate the discoveries of others (Griffith, Redding, and Van Reenen 2004). The second channel is through the adoption of new ideas and technologies (Baldwin and Sabourin 2004), which are often embodied in capital goods and directly reflected in capital deepening.

Innovation can only be measured by relying on surveys of technology adoption by firms or on proxies for innovation activity, such as business R&D spending relative to GDP, patents granted per worker, or investment in M&E or ICT per worker. Although each of these proxies has drawbacks as a measure of innovation, they all confirm survey results in suggesting a sub-par innovation performance in Canada relative to many countries belonging to the Organisation for Economic Co-operation and Development (OECD), including the United States (Jaumotte and Pain 2005).[12]

Canada's relatively weak performance in terms of R&D and other indicators of innovation appears to arise less from deficient supply conditions than from a lower demand for innovation.

Because of the high concentration of research in a few industries, the smaller share of research-intensive industries in Canada significantly contributes to a relatively low aggregate R&D intensity (ab Iorwerth 2005).[13] Beyond that factor, Canada's relatively weak performance in terms of R&D and other indicators of innovation appears to arise less from deficient supply conditions than from a lower demand for innovation.

11. This estimate is based on the assumption that the weight of mining and oil and gas extraction in the business sector averages about 10 per cent in 2005–06, compared with 7.4 per cent in 2003, the last year for which information is available. The weight is based on the share of industry nominal value-added in business sector value-added (OECD 2001). A two-period average of this share is used as the weight to reflect the fact that real GDP for the business sector is a chained-dollar aggregate. The weight is expected to rise when the relative prices of energy and metals increase significantly.

12. Surveys reveal that Canadian manufacturing plants have tended to adopt fewer advanced technologies than their U.S. counterparts (Baldwin and Sabourin 1998). Moreover, manufacturing firms that introduce product innovations draw a lower proportion of their sales from these products than do their European counterparts (Mohnen and Therrien 2003).

13. In fact, Canada does proportionately more research than the United States in at least three research-intensive industries: office and computing machines; pharmaceuticals; and radio, television, and communications equipment (ab Iorwerth 2005).

On the supply side, Canada enjoys low bureaucratic barriers to entrepreneurship, high rates of firm entry and exit,[14] a relatively high proportion of university-educated workers, a relatively flexible labour market,[15] and an abundant supply of venture capital to finance innovative activity (OECD 2006; IMF 2005). In most of these dimensions, including continuing employee education and training, Canada does not fare quite as well as the United States, but this would explain only part of the innovation gap. Moreover, the Canadian economy is highly integrated with the U.S. economy through trade, capital flows, and a large stock of U.S. direct investment in Canada. This should facilitate access to foreign R&D, new technologies, and best management practices.[16] Since the size of the science and engineering workforce relative to total employment has evolved in much the same way in Canada and the United States over the 1980–2001 period and by 2001 was the same in both countries (Beckstead and Gellatly 2006), the human capital base for assimilating and adapting new foreign technologies and for doing R&D should have been comparable in the two countries. Yet the apparent productivity of this workforce in terms of innovative activity and technology adoption has been significantly lower in Canada. Perhaps among U.S. scientists and engineers there is a higher proportion of exceptionally talented individuals, drawn from all over the world by the opportunity of matching up with other very talented individuals.[17] This higher density of talent would provide a comparative advantage in inventing new products and processes. Another possibility, which might better explain the lower technology intensity in Canada, is that scientists and engineers are less effectively deployed in industries and their skills less fully used because the demand for innovation is lower.

One indication of weaker demand for innovation in Canada is the difference in the premium for university-educated employees relative to other workers. As shown in Chart 3, this premium is much smaller in Canada than in the United States even though the proportion of university-educated workers is somewhat lower in Canada (Kryvtsov and Ueberfeldt 2007).[18] These combined facts point to a relatively soft demand for highly skilled workers, reflecting a smaller productivity differential in favour of university-educated workers in Canada and / or a reduced demand for innovation, given that skills complement technology or capital quality in production.[19] To the extent that this complementarity is stronger for equipment than for structures, the lower skills premium in Canada would partly reflect a lower M&E-embodied technology intensity in production,[20] and, hence, a weaker demand for innovation. Broadly consistent with this conclusion is the finding by Rao, Tang, and Wang (2006) that, relative to the United States, a lower ratio of M&E capital to labour in Canada is a key determinant of the weaker Canadian TFP in the business sector over the 1987–2003 period. The reasons for the more sluggish demand for innovation in Canada are not entirely clear, and at this stage they are more in the realm of hypotheses requiring validation.

One reason may be a limited *initial* supply of skills. Beaudry, Doms, and Lewis (2006) find that the U.S. cities where college-educated labour was cheapest and most abundant in 1980 were those that adopted the personal computer most intensely between 1980 and 2000 and saw the returns to college education catch up the fastest. A similar phenomenon likely took place among Canadian cities. However, there is no study yet on the extent to which Canadian cities had, on average, a lower initial supply of skills than U.S. cities. The fact that the earnings premium of university-educated workers was higher in Canada than in the United States in the first half of the 1980s suggests that a lower initial supply of skills may have slowed the adoption of ICT in Canada. This would not have lasted long, however, because the skills premium in

14. This facilitates the experimentation and testing of new ideas and the adoption of best-practices technology.

15. The resulting moderate cost of adjusting labour makes it easier for firms to adopt new technologies and better work practices, and to innovate more generally.

16. Lileeva (2006), for example, finds relatively important productivity spillovers from foreign direct investment in science-based supplier industries to domestically controlled manufacturing plants.

17. For more details on this matching theory, see Easterly (2001).

18. Evaluated at a purchasing-power-parity rate of 0.84, real earnings per hour worked in Canada in 2000 were lower than in the United States by about 15 per cent for university-educated workers and by about 5 per cent for other workers.

19. As an example of the relationship between skills and innovation, Autor, Levy, and Murnane (2003) show that the shifts in tasks associated with computerization can explain 60 per cent of the estimated relative demand shift in favour of college-educated labour in the United States between 1970 and 1998.

20. Hornstein, Krusell, and Violante (2005) explain the linkages among the skills premium and the relative productivity of skilled workers, the relative supply of skilled workers, and M&E-embodied technology relative to hours worked by skilled labour.

Canada soon fell below that in the United States (Chart 3).

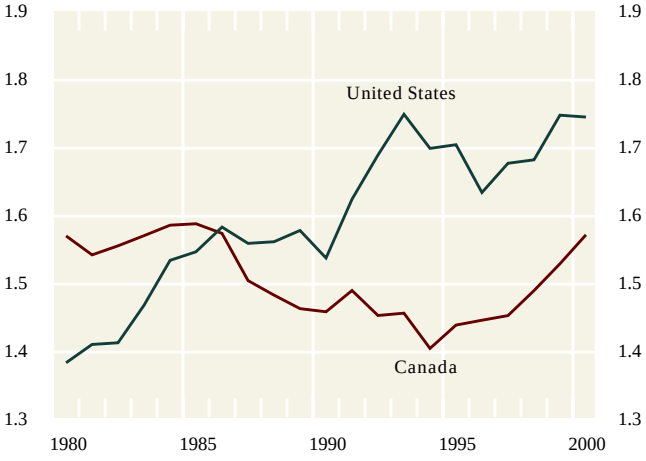
A second reason may be less competition, which blunts incentives for incumbent firms to innovate in order to protect or reinforce their market position (Aghion et al. 2005). More regulation would be one reason for less competition, but it is not the only one. Conway et al. (2006) estimate that product market regulation that restrains competition is more prevalent in Canada than in the United States and find that this type of regulation holds back productivity growth mainly by slowing the adoption of ICT. Thus, more regulation could go some way towards explaining why capital deepening in ICT assets has been lower in Canada.[21] In the retail trade sector, Wal-Mart and other big-box stores are less widespread in Canada than in the United States and as a result would have generated fewer competitive pressures in local markets, and fewer incentives to adopt new technologies and organizational innovations to boost productivity (Sharpe and Smith 2004).

A third reason may be fewer rewards and more aversion to risk taking. For Canadian firms, the smaller size of local markets in non-tradable product sectors would limit the returns to innovation and inhibit innovative activity. It could explain in part why R&D intensity in the services sector is lower in Canada than in the United States, which in turn contributes to the weaker aggregate R&D intensity in Canada (ab Iorwerth 2005). Fewer rewards for the relatively high risks associated with innovation might also result from higher marginal tax rates on personal income, [22] lower compensation for high-level managers, and larger bankruptcy costs or stigma facing Canadian entrepreneurs. Finally, a lower educational level of managers in Canada than in the United States (Institute for Competitiveness and Prosperity 2005) could make them less attuned to radically new technologies and business practices and less prone to undertake organizational change.

A final reason, which reflects cyclical rather than structural forces, relates to relative factor prices. Empirical work in Canada and New Zealand, for example, suggests that moderation in the price of labour relative to capital would lead to less capital/labour substitution (Leung and Yuen 2005; Hall and Scobie 2005) and, hence, less absorption of capital-embodied technologies. In this light, comparatively moderate wages relative to the price of M&E investment (Chart 4) would have contributed to the gap in

Chart 3

University-Education (Skills) Premium*



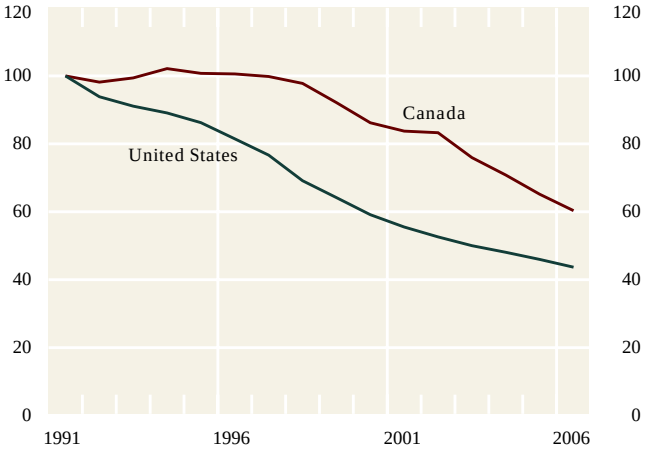
*Ratio of earnings per hour worked of university-educated to other workers

Source: Kryvtsov and Ueberfeldt (2007)

Chart 4

Price of Investment in Machinery and Equipment Compared with Labour Compensation per Hour*

1991 = 100



*Labour compensation per hour in the business sector in Canada and non-farm business sector in the United States

21. Part of the considerable impact in Canada relative to the United States found in the OECD study arises not just from more regulation in Canada but also from the much greater distance of Canada from the technological frontier, which, in the OECD approach, magnifies the negative impact of regulation.

22. The marginal fiscal burden for entrepreneurs of medium and large businesses was also considerably higher in Ontario than in five large U.S. states in 2004 (Chen and Mintz 2004).

technology intensity in Canada, compared with the United States, from the early 1990s to at least 2003, when the appreciation of the Canadian dollar started reducing the price of imported M&E.[23] Inasmuch as the substitution of M&E for labour is more sensitive to changes in wages than equipment costs, as work by Rao, Tang, and Wang (2007) and by Leung and Yuen (2005) suggests, the evolution of factor prices could have had an even more prolonged negative impact on M&E intensity in Canada relative to the United States.

The translation of technology adoption into productivity growth depends to some degree on complementary investments in the reorganization of business practices, particularly when ICT-based technologies are involved. Canadian firms probably lag behind U.S. firms in terms of organizational capital and management practices. Work by Bloom, Sadun, and Van Reenen (2005) suggests that, over the 1995–2003 period, U.S. firms would have adopted organizational forms that facilitated the adoption of ICT to a greater extent than their foreign competitors. On average, they are much better managed than European firms, and this has been strongly associated with a superior record in trend TFP (Bloom and Van Reenen 2006).

Structural aspects of the economy

Structural factors, such as industry mix, the size of local markets, average firm size, and the quality of public infrastructure, are likely to influence the evolution of productivity to the degree that they act as constraints on the adoption or effective use of new technologies, the achievement of scale economies, or the intensity of competition.

The industry mix in Canada, with its heavier weight on resource-based industries, transportation, construction, and utilities, and lower weight on ICT-using industries, had a slightly negative effect on labour productivity growth in the business sector as a whole over the 1997–2003 period (Table 7).[24] Within the much narrower manufacturing sector, the industry mix was also less conducive to productivity growth in Canada than in the United States, although to a lower degree than in previous periods. The less favourable manufacturing mix largely stems from the smaller size of the computer and electronic products industry, which usually registers above-average productivity growth rates.

The industry mix in Canada . . . had a slightly negative effect on labour productivity growth in the business sector as a whole over the 1997–2003 period.

The limited size and lower demand density of local markets in Canada compared with the United States likely reduce the potential for economies of scale and productivity gains by restraining the average size of establishments in industries in which geographic market segmentation operates. Such industries would include, for instance, the retail trade sector and the restaurant industry (Campbell and Hopenhayn 2002), and manufacturing industries with low value-to-weight products like ready-mix concrete (Syverson 2001). Size appears to matter as well in banking services. Allen, Engert, and Liu (2006) find that although Canadian banks are as productive as those in the United States, they are less efficient in terms of scale and have more to gain in terms of efficiency from becoming larger.

At the aggregate level, the average firm size is smaller in Canada than in the United States, reflecting 25–30 per cent fewer employees per firm in both the smallest (0 to 19 employees) and the largest (500+ employees) firm-size categories (Table 8). This would be associated with lower productivity in Canada because productivity varies positively with size at the firm or plant level in both Canada and the United States (Baldwin, Jarmin, and Tang 2004).[25] A shift in the distribution of firm size towards smaller (larger) firms, holding productivity differentials constant across firm sizes, would restrain (boost) aggregate productivity gains. In fact, the distribution of firm size shifted towards larger firms between 1998 and 2004, but more so in Canada than in the

23. It would be more appropriate to use a measure of wages for non-highly skilled workers than a measure for all workers, since skills and capital-embodied technology are complementary inputs in production. Data availability is a constraint.

24. This result is obtained by comparing the weighted sums of average productivity growth rates by industry over the 1997–2003 period, alternatively using as weights the two-period nominal value-added shares by industry for Canada and the United States.

25. Small firms use fewer advanced technologies and less capital per worker and provide less training to employees. One reason may be that investment is more adversely affected in small firms by profit uncertainty or a lower probability of survival.

Table 8

Average Number of Employees per Firm by Size, Canada and the United States, 2001

	Average number of employees	
Firm size (employment)	Canada	United States
0–19	3.1	4.1
20–99	40.3	39.3
100–499	190.8	192.4
500+	2372.6	3321.1
Total	13.3	23.2

Source: Canada: Statistics Canada, *Business Dynamics in Canada, 2001*, February 2005. United States: U.S. Small Business Administration

Table 9

Changes in Firm Size Distribution, 1998–2004

Percentage

Firm size (employment)	Canada	United States
0–19	-2.3	-0.4
20–99	-0.3	0.0
100–499	-1.3	0.3
500+	3.9	0.0

Source: Statistics Canada, Labour Force Survey; U.S. Small Business Administration

United States (Table 9).[26] As a result, ouput per employee would have increased by nearly 0.15 percentage points per year in Canada and 0.01 percentage point per year in the United States over this period, keeping the productivity levels by firm size at their 1997 values.

A final structural factor to be considered here is investment in public infrastructure, which appears to have positive effects on productivity growth in the business sector. Harchaoui and Tarkhani (2003) find that an increase in the services of public capital contributes to TFP growth in the Canadian business sector, especially in transportation, trade, and utilities. Capital stock data indicate that the average age of bridges, sewer systems, roads and highways, and wastewater treatment facilities rose markedly between the mid-1970s and the late 1990s before stabilizing in the early 2000s and edging down in 2003 (Gaudreault and Lemire 2006). This suggests a trend decline in services per unit of infrastructure until recently, with likely negative effects on efficiency gains in the economy. It remains to be seen how this evolution compares with that in the United States.[27]

Conclusion and Areas for Further Research

Much uncertainty surrounds the root causes of Canada's failure in the past decade to follow in the footsteps of the United States towards a higher growth rate in trend productivity. Canada appears to have taken less advantage of ICT and has also experienced fewer efficiency gains in the production of services and non-ICT goods. Capital deepening in non-ICT assets was stable in the past half-decade instead of intensifying as it did in the United States, possibly held back by a lower rise in wages relative to the price of M&E investment than in the United States, at least until 2003. Increased adjustment costs associated with reallocation of resources in response to large relative price movements have likely had negative effects on TFP growth in recent years. As well, high resources prices would have encouraged the exploitation of marginal reserves, with significant negative effects on productivity growth in 2005 and 2006. These phenomena would have exacerbated the drag exerted by a persistently lagging performance in Canada with respect to innovative activity, adoption of new technologies, and investment in organizational capital. This lagging performance seems to reflect less a deficiency in supply conditions than a lacklustre demand for innovation, which in turn could stem from less competition, fewer rewards for risk taking and, from the early 1990s to at least 2003, a slower decline in the price of M&E investment relative to labour compensation per hour. As well, the smaller size of local markets for non-tradable products could have limited the scope for economies of scale and the incentives for innovation.

In spite of the enormous volume of research on productivity in the past decade, many hypotheses still need to be tested and issues need to be better understood in a Canadian context. The preceding analysis points to several potentially fruitful avenues for further research, including the following topics:

26. Data for Canada are from the Labour Force Survey. This is not the best source of information on firm-size distribution, but it does provide a timely indication of changes in this distribution.

27. Calculations by Kamps (2006) for the OECD countries, based on the same assumptions across countries about depreciation rates, show that government net capital stock per capita at 1999 purchasing-power parities for gross fixed-capital formation was nearly 37 per cent lower in Canada than in the United States in 2000 and had grown slightly slower in Canada than in the United States between 1990 and 2000.

1) Quantifying the size and timing of adjustment costs and spillover effects for different assets and industries would help to interpret the dynamics of productivity growth and measure the contribution of changes in capital composition.

2) Estimating the effect of movements in relative factor prices on capital deepening would shed light on the robust rate of net job creation and the sluggish pace of innovation in the past decade relative to the United States.

3) Using longitudinal microdata to investigate the relationships between large relative price movements, labour turnover at the firm level and productivity growth and, more generally, how firms adjust to specific macroeconomic shocks.

4) Investigating the potential role of structural factors in holding back economies of scale and the demand for innovation in Canada.

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Efficiency and Competition in Canadian Banking

Jason Allen and Walter Engert,[*] Department of Monetary and Financial Analysis

- *A safe and efficient financial system is important for the development and longer-run growth of the economy. Recent research at the Bank of Canada has considered various aspects of efficiency in Canadian financial services, specifically in the banking industry.*
- *The research summarized in this article suggests that, overall, Canadian banks appear to be relatively efficient producers of financial services. As well, some efficiency gains from becoming larger appear to be possible.*
- *The research implies as well that Canadian banks do not exercise monopoly or collusive-oligopoly power, and that banking can be considered a monopolistically competitive industry.*
- *However, data limitations constrain the ability to examine these issues in great depth.*
- *The analysis reported here also indicates that past legislative and regulatory changes have benefited efficiency in Canadian financial services and might have improved contestability. This points to the importance of continuing to promote efficiency and competition in financial services in Canada.*

A safe and efficient financial system is important for the development and longer-run growth of the economy. Indeed, a recent comprehensive survey of the research literature suggests that the quality of financial service provision is a key ingredient for economic growth (Dolar and Meh 2002). Recent research at the Bank of Canada has considered various aspects of efficiency in Canadian financial services, particularly in the banking industry. In this article, we summarize the main insights from this research.

To provide context, we begin in the next section with a brief review of the recent history of the Canadian banking industry, with a particular focus on the evolution of the governing legislation since 1980. Basic performance measures of banking efficiency are then considered, followed by a discussion of efficiency and economies of scale based on econometric methods. We also review a key influence on efficiency, the nature of competition in Canadian banking, and then present concluding remarks.

The Evolution of Canadian Banking

Historically, the structure of the Canadian banking industry has been relatively stable. From 1920 to 1980, for example, Canada consistently had 11 banks (Bordo 1995). As well, prior to 1980, the financial services industry had been segmented (by legislation, regulation, and practice) into distinct "pillars": commercial banking, trust business, insurance underwriting and brokerage, and securities underwriting and dealing. There were also constraints on the entry of foreign banks into the Canadian market.

In the past 25 years, with changes in market practice and a series of revisions to the governing financial legislation, there has been a significant evolution of the Canadian banking industry. Key characteristics have

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been the entry of foreign banks and the expansion of banks into the range of financial services, including the trust business, insurance underwriting and sales (although not through bank branches), and securities underwriting and dealing.[1]

There has been a substantial evolution of the Canadian banking system over the past 25 years, including numerous changes that have affected the powers, organization, and competitive pressures in the industry.

A feature of all federal legislation concerning financial institutions, including the Bank Act, is a sunset provision that requires a periodic review of the policy framework and legislation that govern financial services. This formal review process led to important legislative amendments in 1980, 1987, 1992, 1997, and 2002 that have contributed to the development of more diversified and more market-oriented activities on the part of Canadian banks. In addition, important changes to the legislation regarding the entry of foreign banks into Canada were made in 1980 and 1999.

Specifically, the 1980 Bank Act revisions allowed banks to establish subsidiaries in various financial services markets, such as venture capital and mortgage lending. The mortgage-loan subsidiaries could raise deposits that were exempt from reserve requirements (which existed at the time). As a result, the banks could compete more effectively in the mortgage-lending market with trust companies, whose deposits were not subject to reserve requirements. As well, foreign banks were allowed to establish bank subsidiaries in Canada. Before this revision, the possibility of foreign bank entry had been curtailed by amendments to the Bank Act in 1967. Nevertheless, from 1967 to 1980, foreign banks operated in Canada on a limited scale through non-bank affiliates that issued commercial paper in Canada carrying their parent bank's guarantee, thereby funding their activities in sales and business finance.[2] Following the 1980 Bank Act revision, all such affiliates were to be incorporated as subsidiaries, subject to the provisions of the Bank Act, and able to conduct the full range of banking activities. This legislative change led to many foreign bank subsidiaries opening in Canada, with the number peaking at around 50 in the mid-1980s.

In 1987, Canadian banks (both domestic and foreign) were permitted to invest in corporate securities dealers, as well as distribute government bonds. All major banks subsequently made substantial investments in the securities business and purchased control of most of the existing investment dealers. The 1987 amendments also allowed financial intermediaries to conduct brokerage activities. Following legislative revisions in 1992, Canadian banks were allowed to enter the trust business through the establishment or acquisition of trust companies. Most trust companies were subsequently purchased by Canada's largest banks. In this regard, the financial difficulties that many trust companies experienced following the collapse of the speculative real estate boom in the late 1980s contributed to the ability of the banks to acquire them. In 1997, new legislation included various changes to update and revise the amendments made in 1992.

In 1999 (pursuant to provisions of the North American Free Trade Agreement), foreign banks were allowed to directly establish branches in Canada, without having to establish a subsidiary. However, foreign bank branches were restricted to wholesale activities; that is, deposits made at such branches must have a minimum value of $150,000.[3] By the end of 2006, in addition to 22 domestic banks there were 50 foreign banks operating in Canada, including 26 foreign bank subsidiaries and 24 foreign bank branches. Finally, legislative changes in 2002 provided for modest increases in the range of business powers available to Canadian banks; for example, they were allowed to own finance companies. As well, there was a moderate decrease of the

1. For discussions of these and related developments in Canada, see Daniel, Freedman, and Goodlet (1993); Freedman (1998); and Engert et al. (1999).

2. According to MacIntosh (1984), by the time of the 1980 Bank Act revisions, there were about 60 foreign banks represented in Canada, including some with several offices.

3. There were concerns among policy-makers that unrestricted entry of foreign bank branches at the retail level could create risks for the Canada Deposit Insurance Corporation and for the Office of the Superintendent of Financial Institutions that would be difficult for these agencies to manage, given the foreign control and supervision of such branches. As a result, foreign bank branches were allowed to take only deposits significantly above the deposit insurance coverage limit.

Box 1: Canadian and U.S. Banks

To investigate efficiency and economies of scale, Allen, Engert, and Liu (2006) considered a sample that includes the six major Canadian banks, which comprise over 90 per cent of the assets of the Canadian banking sector. The banks are Royal Bank Financial Group, Bank of Montreal, Canadian Imperial Bank of Commerce, TD Bank Financial Group, Bank of Nova Scotia, and National Bank. The efficiency comparisons reported consider total U.S. banks and a sample of 12 U.S. bank holding companies (BHCs).

The BHCs are selected from the top 20 U.S. banks in terms of assets as of 31 December 2004. They were selected because there are continuous data from 1986 to 2004, and because most of these banks have a business mix broadly similar to that of the Canadian banks, benchmarked in a specific manner. That is, most of these BHCs make a similar proportion of revenue from retail banking. The BHCs are JPMorgan Chase & Co., Bank of America Corp., Wachovia Corp., Wells Fargo & Co., U.S. Bancorp, SunTrust Banks Inc., National City Corp., Citizens Financial Group Inc., BB&T Corp., Fifth Third Bancorp, Keycorp, and The PNC Financial Services Group Inc.

With regard to the research on contestability in Allen and Liu (forthcoming), 10 domestic banks and 15 foreign banks operating in Canada were considered. The 10 domestic banks are Royal Bank Financial Group, Bank of Montreal, Canadian Imperial Bank of Commerce, TD Bank Financial Group, Bank of Nova Scotia, National Bank, Canadian Western Bank, Laurentian Bank, Citizens Bank of Canada and Manu-Life Bank. The 15 foreign banks operating in Canada that are included in the study are Bank of Tokyo-Mitsubishi, Mizuho Corporate Bank, Sumitomo Mitsui Banking Corporation, HSBC Bank of Canada, JP Morgan Chase Bank, ING Bank, Bank of China, Bank of East Asia, BCPBank Canada, BNP Paribas, CTC bank of Canada, International Commercial Bank of Cathay, MBNA Canada, National Bank of Greece, and ABN Amro Bank.

restrictions that preclude concentrated holdings of bank equity.

In addition to the various changes that have affected the powers, organization, and barriers to entry in banking, the regulatory regime was also fundamentally reformed during this period, through a series of changes to the incentives and powers of the regime (Engert 2005). The key measures were:

- the establishment of a clear mandate for the supervisor, focused on protecting the interests of depositors and other creditors, and which recognizes that financial institutions can fail;
- the creation of the authority and obligation for the supervisor to act promptly and pre-emptively with regard to troubled institutions; and
- the establishment of the authority and means for other safety-net agencies (notably the Canada Deposit Insurance Corporation) to influence the supervisory process.

In turn, these changes have influenced the environment in which financial institutions operate and have sharpened their incentives to manage risk appropriately, in part to avoid becoming subject to supervisory intervention.

Performance Measures

Clearly, there has been a substantial evolution of the Canadian banking system over the past 25 years, including numerous changes that have affected the powers, organization, and competitive pressures in the industry. In this section, we begin our examination of efficiency in Canadian banking by considering some basic performance measures. As a frame of reference, the performance measures for Canadian banks are compared with samples of U.S. banks.

More specifically, based on work by Allen, Engert, and Liu (2006), we report simple performance measures for the six largest Canadian banks (which account for the great majority of Canadian banking assets), total U.S. commercial banks, and a subset of U.S. bank holding companies (BHCs). (See Box 1 for more on these banks.) The data used in this study are from the balance sheets and income statements reported by these institutions to the banking supervisors in Canada and the United States. To make the data comparable, all variables are deflated by the consumer price index

(CPI) excluding food and energy prices, in their respective countries. As well, the data are converted to a common currency using a Canada / U.S. dollar exchange rate that reflects the relative purchasing power of these currencies in the financial services sector of the two countries.[4]

Expense ratio

The expense ratio, which is defined as the ratio of non-interest expense to net operating revenue (net interest income plus non-interest income), is often used by analysts to evaluate bank performance.[5] Chart 1 presents the expense ratio for Canadian banks, a sample of U.S. BHCs, and total U.S. banks. The expense ratio of Canadian banks was lower than that of U.S. banks in the late 1980s and early 1990s. This measure, however, has been trending up at the Canadian banks and down at the U.S. banks over the sample period, so that the expense ratio of Canadian banks currently exceeds that of U.S. banks.

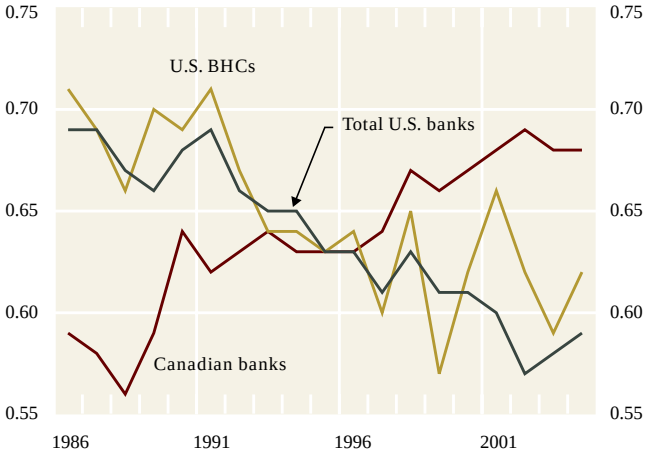
Allen, Engert, and Liu's (2006) analysis indicates that the difference in the expense ratios between the Canadian and U.S. banks can currently be attributed to higher overall labour costs (wages and benefits) at the Canadian banks compared with the U.S. banks in their samples.

Labour productivity ratio

The authors also examine measures that consider the output produced by banks, relative to labour input. Bank output is difficult to measure, however, on both conceptual and pragmatic grounds. Indeed, it is widely believed that official (national accounts) statistics on output and productivity in financial services industries are subject to large errors. Maclean (1996, 1997), for example, concludes that productivity growth in financial services as measured in Canadian official statistics is probably significantly underestimated (see

Chart 1

Expense Ratio



also Triplett and Bosworth 2004 or Diewert 2005).[6] As noted above, the analysis in Allen, Engert, and Liu (2006) does not rely on national accounts data; their data are from balance sheets and income statements reported to bank supervisors.

Another important consideration concerns the price index used to deflate nominal output to produce a measure of "real output." To most accurately measure real output in banking, nominal variables should be deflated by a price index that specifically measures the prices of banking services, instead of a more general price index, like the GDP deflator or the CPI. Use of a more general price index could be misleading if there was a substantial difference between the evolution of prices in financial services and prices more generally. However, no bank-specific price measures exist for Canada, so Allen, Engert, and Liu (2006) use the CPI excluding food and energy prices to deflate nominal output measures (total assets and net operating income).[7]

4. Rao, Tang, and Wang (2004) suggest, after detailed calculations, a purchasing-power-parity (PPP) exchange rate of 1.09 for financial services (in 1999), which is used here.

5. The denominator of this ratio—particularly net interest income—depends on the risk differential between assets and liabilities. A change in the expense ratio can therefore be caused by changes in risk taking and not necessarily by changed efficiency. A change in the mix of a bank's services or products (say, towards non-traditional banking services) can also affect this ratio by altering the mix of inputs and expenses. Thus, we prefer the term "expense ratio" to "efficiency ratio," as it is sometimes called.

6. The difficulty in measuring service industries (such as finance and health care) is a longstanding problem for the statistical systems in most countries. To address this problem, Statistics Canada is putting into place a program to improve the measurement of outputs and prices in service industries in Canada, including financial services.

7. Consequently, the resulting measures could arguably be considered measures of real income rather than real output.

Chart 2

Assets per Employee

US$ millions

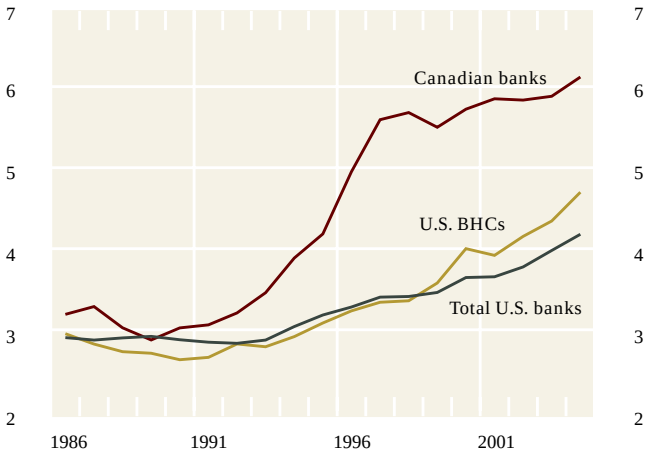


Chart 3

Net Operating Revenue per Employee

US$ thousands

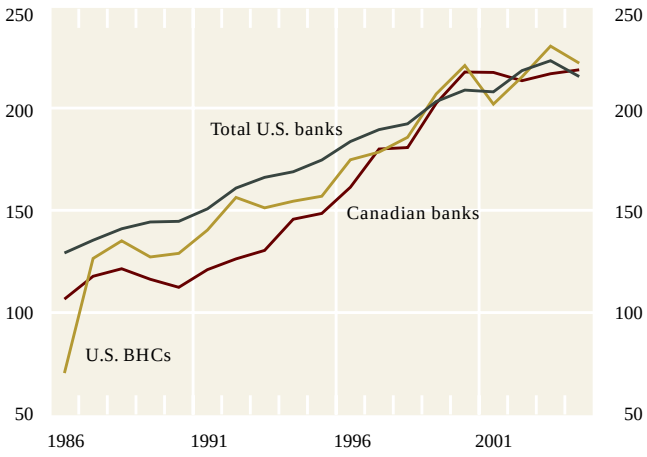


Chart 2 compares total assets per full-time equivalent employee of Canadian banks, the U.S. BHCs, and total U.S. banks. By this measure, the productivity of Canadian banks has been considerably higher than that of U.S. banks in the past decade.[8] As is the case when using the expense ratio as a measure of efficiency, there are challenges inherent in using assets per employee as a measure of productivity. The decision of banks to have loans, for example, on-balance sheet or off-balance sheet (via securitization), is a response to historical, institutional, and regulatory differences across countries. (Freedman and Engert 2003 discuss different patterns of securitization in Canadian and U.S. banking, and reasons for these differences.) It is therefore possible that banks use different approaches to generate similar profits.

Given these factors, the authors consider a measure that internalizes differences in asset generation, disposition, and management, and focuses on overall results. Specifically, Chart 3 shows net operating revenue per full-time equivalent employee of Canadian banks, the U.S. BHCs, and total U.S. banks. According to this measure, Canadian bank employees were less productive than their U.S. counterparts in the late 1980s, but started to catch up in the early 1990s. In fact, according to this measure, the three groups of banks have converged since the late 1990s.

8. Including in total assets an approximation of non-traditional activities (discussed below), such as those related to off-balance-sheet assets, does not change this conclusion.

Cost Inefficiency and Economies of Scale

In this section, we discuss results from recent Bank of Canada research that considers another means of gauging bank efficiency, based on econometric methods, using disaggregated bank data (Allen and Liu 2005; Allen, Engert, and Liu 2006). Specifically, we examine how efficiently banks transform inputs into outputs and consider returns to scale in Canadian banking. The analytical framework uses a standard tool in the research literature on such questions (the translog cost function).

Methodology

In this framework, researchers study how efficiently inputs are transformed into the financial services that a bank sells to consumers. To do so, a model that relates costs to measures of bank output and input prices is estimated. The analysis also takes account of technological progress and the effects of regulatory changes. In addition, the model incorporates variables to measure unique influences on cost structures specific to each bank in the sample. Essentially, the idea is to estimate the empirical relationship between costs and the financial services that a bank produces, while recognizing the impact of technological change and the influence of the regulatory environment.

Inferences regarding economies of scale are drawn from observing how the banks' estimated cost structures vary with the scale of output. The efficiency with which inputs are transformed into outputs is measured through terms in the model that capture residual, unexplained influences on the cost structures of the banks. Since the model accounts for identifiable influences on the cost structure of a bank, any unexplained influences on costs are considered to be the result of inefficiency or waste, and so form the basis for the measure of "cost inefficiency"—which is our focus here.

In this framework, the most efficient bank is considered to be the bank with the lowest inefficiency measure, and is also taken to represent the best-practice or benchmark institution, that is, the efficient frontier in that banking system. Then each bank's distance from that efficient frontier is measured. An efficient banking system overall, according to this measure, is represented by relatively small inefficiency measures.

Data

The model includes the costs of labour, capital, and deposits, measured respectively as: the average hourly wage of bank employees; expenses on real estate and fixtures as well as information and communication technology plus related costs; and the effective interest rate paid on deposits.

Bank output is divided into five categories: consumer loans, mortgage loans, non-mortgage loans, other financial assets on the balance sheet, and an asset-equivalent measure of non-traditional activities. The latter is aimed at capturing the growing importance of activities such as wealth management and securities trading.

To measure these activities, the authors use the asset-equivalent approach introduced by Boyd and Gertler (1994). This adjustment assumes that non-traditional activities yield the same rate of return on assets (ROA) as traditional activities, and so the assets that are required to produce non-interest income can be calculated by dividing non-interest income by the ROA of traditional activities. Allen, Engert, and Liu (2006) also consider the effects of increasing the assumed return on off-balance-sheet activities by 5 to 10 percentage points; the impact on the results reported below is marginal.

The model is estimated using quarterly data from 1983 through 2004 for the Canadian banks, and from 1986 through 2004 for the U.S. BHCs (discussed in Box 1). Separate models are estimated for the Canadian and U.S. banking industries, given the differences in the development of the institutional and regulatory environments in Canada and the United States.

Results

For the Canadian banks, the analysis suggests that there are increasing returns to scale of about 6 per cent, suggesting that the Canadian banks could gain (modestly) from being larger. As regards the measure of cost inefficiency for Canadian banks, this research finds that the gap between the efficient frontier (the best-practice bank) and other banks averages less than 10 per cent, depending on the model specification considered. More refined measures of technological change in the model (capturing investment in employee training and automated banking machines, for example) lead to estimates of cost inefficiency among Canadian banks averaging about 6.5 per cent. As well, the results indicate that Canadian banks have tended to move closer to the efficient frontier over time.

For the U.S. case, increasing returns to scale are also found, but, at about 2 per cent, these are considerably smaller than in the Canadian sample. Estimates of cost inefficiency for the sample of U.S. banks indicate that the average gap between the efficient frontier and other banks is greater than 10 per cent, which is a typical result in the research literature on U.S. bank efficiency (for example, Berger and Mester 1997). In the model that best fits the data in Allen, Engert, and Liu (2006), the average measure of cost inefficiency for U.S. BHCs is about 14 per cent. As well, cost inefficiency among the U.S. BHCs has not narrowed appreciably over the sample period.

A striking feature of the results is that the measure of cost inefficiency for Canadian banks is comparatively low, suggesting that Canadian banks are relatively efficient according to this measure.

In various studies of bank efficiency in different countries, inefficiency measures similar to those found by Allen, Engert, and Liu for the U.S. case are not

unusual (see Berger and Humphrey 1997, for example.) That is, cost-inefficiency measures in excess of 10 per cent, as found for the U.S. case, seem to be typical of other countries as well. However, a striking feature of Allen, Engert, and Liu's results is that the measure of cost inefficiency for Canadian banks is comparatively low, suggesting that Canadian banks are relatively efficient according to this measure.

Notably, the authors also find that technological progress and legislative changes have reduced the cost structures of banks in both Canada and the United States. For example, in Canada, the revisions to the financial legislation in 1987 and 1997 appear to have been particularly beneficial in reducing the cost structures of Canadian banks.

Competition in Canadian Banking

An important dimension to consider when evaluating efficiency is competition. In this regard, other things being equal, a more competitive environment is generally expected to lead to more efficient outcomes. In this section, we report recent research by Bank of Canada staff (Allen and Liu forthcoming) that considers the state of competition in Canadian banking.

Concentration, competition, and contestability

Canada has a highly concentrated banking market; for example, the largest six banks account for more than 90 per cent of the assets in the banking system. Formal measures of concentration in banking (such as the Herfindahl-Hirschman Index) are typically in a range that points to what economists would interpret as a medium or high degree of market concentration.

It is important to keep in mind, however, that such assessments neglect the competition (especially in retail and small-business banking) provided by credit unions and caisses populaires, of which there are about 1,000 in Canada, and which are particularly prominent in certain regions of the country, such as British Columbia, Saskatchewan, Quebec, and parts of the Atlantic provinces. Insurance companies are another source of competition in financial services; indeed, the major life insurance companies rank among the very largest financial services firms in Canada.

Traditionally, it has been believed that a more concentrated industry is less competitive, and liable to compromise economic efficiency. However, empirical research on this idea provides mixed results. For example, a study by Bikker and Haaf (2002) on 23 European countries found support for the traditional view that concentration impairs competition. In contrast, a more recent study by Claessens and Laeven (2005), using a data set of almost 4,000 banks from 50 countries, concludes that competition is not negatively related to concentration. These authors find that greater competition in financial services is most clearly related to an absence of barriers to entry (including with regard to foreign bank entry), and a policy framework that places few restrictions on the activities of financial services firms.

The latter paper points to the notion of "contestability," which refers to the ability of firms to enter a market and compete with incumbents. Specifically, a market is considered to be contestable if barriers to entry are not prohibitive and if firms can exit from the industry without enduring punitive costs, so that firms are not discouraged from entering in the first place. The key idea is that a firm may be compelled to be more competitive and efficient by the prospect of new entrants. As a result, instead of considering only simple concentration measures to assess the degree of competition in an industry, economists tend to focus more on measures of market conduct to gauge the degree of contestability in an industry.[9]

Recent research by Bank staff (Allen and Liu forthcoming) measures contestability in the Canadian banking industry. This line of research, following the seminal work of Rosse and Panzar (1977) and Panzar and Rosse (1982, 1987), focuses on testing statistically for three forms of market structure: monopoly or collusive oligopoly on the one hand; perfect competition on the other; and an intermediate market structure, called monopolistic competition.

The specific test relies on basic propositions of economic theory and involves measuring the effect on firm revenue of an increase in input costs.[10] For instance, if the costs of a monopolist or collusive-oligopolist firm increase, it will raise its price and, given market conditions that exist in a monopoly setting, the revenue of the firm will fall. On the other

9. For a comprehensive discussion of the measurement of firm conduct in different market structures, see Bresnahan (1989). Northcott (2004) provides a recent review of the research literature on competition in banking.

10. This test relies on the fact that a profit-maximizing monopolist always operates at an elastic point on its market demand curve, whereas a competitive group of firms need not (Shaffer 1982).

Box 2: What Is Monopolistic Competition?

Monopolistic competition describes an industry structure combining elements of both monopoly and perfect competition. Similar to perfect competition, there are a number of sellers, and conditions of entry and exit are not prohibitive. In a monopolistically competitive industry, however, products are somewhat differentiated, and firms invest heavily in establishing intangibles such as brand recognition and loyalty, for example.

Each firm in a monopolistically competitive industry has some degree of market power over the prices of the goods and services that it sells. The degree of market power is related to certain factors, including, for example, the extent of barriers to entry into the industry and the extent of successful product differentiation (and brand loyalty) created by the firm. However, although the products of a monopolistically competitive firm are differentiated somehow from those of its competitors, there are substitutes for those products so that the demand for the firm's products will depend on the prices charged by rivals producing similar (but also somewhat differentiated) products.

Monopolistic competition is probably the most prevalent market structure in modern economies. Consider the markets for many consumer goods, for example, such as breakfast cereals, beer, fast food, toothpaste, or sports shoes, among others. Each is characterized by a handful of dominant firms offering differentiated (but similar) products aiming to establish a brand, and there is considerable investment by the firms in those industries to create brand recognition and loyalty (through advertising, for instance). As well, arguably the most prominent class of macroeconomic models used by economists today (so-called New Keynesian models) features monopolistic competition to characterize firm behaviour. Indeed, firm behaviour in the Bank of Canada's primary monetary policy model is monopolistic competition.

From a theoretical perspective, it can be shown that monopolistic competition is less efficient than the ideal of perfect competition. This inefficiency is essentially the result of producing and promoting a (possibly excessive) variety of products. However, because a number of firms are competing and both entry and exit are possible in this form of market structure (contestability), monopolistic competition is not generally considered to be a problem from the perspective of competition policy.

hand, if the costs of firms operating in perfect competition rise, there will be an equivalent proportional increase in its prices, and given relevant market conditions, its revenue will increase in a one-for-one fashion. If the firm was operating in an environment of monopolistic competition, its price response to an industry-wide cost increase would lie between these preceding cases, as would the effect on its revenues. Specifically, the effect of a cost increase on firm revenues would be positive, but less than a one-for-one increase.

Measuring contestability: The H-statistic

The method developed by Panzar and Rosse (1987) allows researchers to estimate the nature of the competitive behaviour of firms based on the properties of (reduced-form) revenue equations. Specifically, this methodology allows one to estimate a statistic, called the H-statistic, that measures the extent to which the revenues of a firm change in response to a change in input prices. Put differently, the H-statistic is the sum of the elasticities of the revenue of a firm with respect to changes in input prices.[11]

Consistent with the preceding discussion, the H-statistic equals 1 if the market can be characterized by perfect competition; that is, in this case, revenues respond in a one-for-one manner to input-price changes. Most importantly, the H-statistic is less than 0 if the underlying market structure is a monopoly or a collusive oligopoly; that is, revenues respond negatively to cost changes. Notably, an H-statistic in this

11. Given that there is incomplete information on prices and quantities of inputs and outputs in banking, one of the main advantages of the Panzar-Rosse methodology is its relatively modest data requirement. At the same time, this implies a partial-equilibrium analysis, where the industry demand curve, in effect, is fixed. The empirical significance of this simplification does not appear to have been explored in the research literature. The scarcity of data also means that it is very difficult to conduct a general-equilibrium analysis of competition.

range would suggest firm behaviour injurious to consumer welfare. Finally, the H-statistic ranges between 0 and 1 for other intermediate forms of market structure, which are broadly characterized as monopolistic competition. (See Box 2 for more on monopolistic competition.)

Many researchers have applied this methodology to study competition in the financial sector, specifically banking, in numerous countries. The main idea is to test statistically for evidence of monopoly or collusive-oligopoly behaviour (an H-statistic less than 0). An early application of the methodology to the Canadian financial system is Nathan and Neave (1989), which studies competition in banking in the early 1980s. Shaffer (1993) uses a variation of the H-statistic to study competition among Canadian banks from 1965 to 1989. The H-statistic methodology has also been applied widely to other countries. For example, Molyneux, Altunbas and Gardener (1996) find evidence of collusive-oligopoly behaviour in the Japanese banking sector in 1986–88. Using a sample from 1987 to 1994, Rime (1999) concludes that monopolistic competition characterized the Swiss banking system. Examples of large cross-country studies are Bikker and Groeneveld (2002) and Claessens and Laeven (2004, 2005).

Empirical studies of banking generally do not find perfect competition nor monopoly or collusive-oligopoly behaviour, and instead find evidence of monopolistic competition in the banking systems of most countries. The research literature generally concludes that the Canadian banking system can be reliably considered to be a case of monopolistic competition and suggests that it ranks among the most contestable in the world.

While these cross-country studies yield interesting results, they should be interpreted with caution, for a few reasons. First, the H-statistic relies on the assumption that markets are in equilibrium (which can be tested, and often is in empirical work, including that by Bank of Canada staff reported here). By comparing the H-statistic across countries, these studies implicitly assume that the banking systems in these countries are consistently in equilibrium during the sample period. Second, it might be the case that environmental conditions (such as regulatory treatment) vary significantly across countries, which can complicate cross-country comparisons. Third, the research literature has not agreed on a robust way of mapping the H-statistic into specific inferences about competitive conduct for all ranges of the statistic, particularly when H is between 0 and 1. As a result, linear interpretations of the H-statistic may be problematic. Simply put, it may not be meaningful to rank-order similar H-statistics across countries or different sample periods to compare degrees of contestability when H lies between 0 and 1 (which is often done).

Finally, a recent working paper, Bikker, Spierdijk, and Finnie (2006), has raised doubts regarding some previous estimates of contestability. These authors suggest that many empirical studies using the H-statistic to measure contestability in banking over-estimate the level of banking competition because of a systematic misapplication of the method.[12] In the work conducted by Bank of Canada staff reported here, both the traditional application of the method and the approach recently recommended by Bikker, Spierdijk, and Finnie (2006) are considered.

Methodology

To calculate the H-statistic for Canadian banks, Allen and Liu (forthcoming) estimate a model that relates the revenues from banking outputs to the costs of banking inputs. Banks are considered to produce one composite output, which consists of loans and other investments, as well as non-traditional sources of revenue. As noted by Allen and Liu (2005), in the past decade, banks have been generating a larger share of their income from non-traditional sources (such as depositor services, wealth management, underwriting, and foreign exchange trading). Indeed, in the past five years, income from such sources has typically surpassed that from traditional banking activities. Accordingly, these authors take account of such non-traditional revenue sources in their calculations, following the asset-equivalent approach described above.

The model includes expenses on salaries, pensions, and employee benefits, as well as expenses on premises, computers, and equipment; the cost of deposits; and a series of bank-specific factors that reflect various behavioural and risk considerations (for details, see Allen and Liu forthcoming).

12. This has to do with how variables are represented in the estimated equations; for a discussion, see Allen and Liu (forthcoming). Briefly put, the standard approach followed in many econometric studies to control for bank size using total assets transforms the revenue equation into a price equation, and therefore, the elasticities are with reference to price, and not revenue, as they should be.

Data

The data are quarterly observations for 10 domestic and 15 foreign banks operating in Canada from 2000 to 2006. The number of banks in this study is constrained by data availability. (See Box 1 for more on the banks considered in this study.) The data set is from the banks' consolidated monthly balance sheet and quarterly consolidated statement of income, collected by the Office of the Superintendent of Financial Institutions. Because the research focuses on the domestic market, the authors limit inclusion of variables to those booked in Canada. (All data are deflated by the GDP deflator.) The assets of the banks in this sample account for 98 per cent of the total Canadian-dollar assets of the banking sector.

Results

When Allen and Liu (forthcoming) estimate the H-statistic measure of contestability in the conventional manner, they obtain results very similar to those for Canada in previous studies, such as Claessens and Laeven (2004) for 1994–2001, Claessens and Laeven (2005) for 1987–96, and Nathan and Neave (1989) for 1983 and 1984. All of these studies conclude that Canada's banking system is characterized by monopolistic competition. Similarly, Shaffer (1993) concludes that there was no monopoly or collusive-oligopoly market power in Canadian banking from 1965–89. Results from various studies relevant to Canada are summarized in Table 1.

The overall conclusion is that Canadian banks do not exercise monopoly or collusive-oligopoly power.

When the H-statistic methodology is adjusted as suggested by Bikker, Spierdijk, and Finnie (2006), Allen and Liu find quantitatively smaller estimates of contestability, as expected. However, the overall conclusion remains that Canadian banks do not exercise monopoly or collusive-oligopoly power. (For complete results for various hypothesis tests, see Allen and Liu forthcoming.)

Table 1

Measures of Contestability in Canadian Banking

Study	H-statistic	Period	Sample	Conclusion
Nathan and Neave (1989)	1.06	1982	all banks	perfect competition
	0.68	1983	all banks	monopolistic competition
	0.73	1984	all banks	monopolistic competition
Shaffer (1993)	not reported	1965–89	all banks	no monopoly power
Bikker and Haaf (2002)	0.60	1991	all banks	monopolistic competition
	0.62	1997	all banks	monopolistic competition
	0.74	1991	small banks	monopolistic competition
	0.63	1991	medium-sized banks	monopolistic competition
	0.56	1991	large banks	monopolistic competition
	0.60	1997	large banks	monopolistic competition
Claessens and Laeven (2004)	0.67	1994–2001	all banks	monopolistic competition
	0.67	1987–2001	all banks	monopolistic competition
	0.67	1992–96	all banks	monopolistic competition
Bikker, Spierdijk, and Finnie (2006)	-0.001[a]	1987–2004	all banks	not applicable[a]
Allen and Liu (forthcoming)	0.67	2000–2006	25 major banks	monopolistic competition
	0.35[b]	2000–2006	25 major banks	monopolistic competition

a. The authors dismiss their results for Canada as meaningless, because their tests indicate that the banking system was not in equilibrium during their sample period.
b. This estimate is based on the methodology proposed by Bikker, Spierdijk, and Finnie (2006); see text for a brief elaboration.

It is interesting that the Allen and Liu study, which focuses on the latest time period, and uses more detailed data as well as more-refined model specifications than previous work, produces H-statistics that lead to the same conclusions as earlier studies. Also, the Canadian financial sector has experienced significant legislative and regulatory change, as well as substantial consolidation, including the acquisition by banks of mortgage and loan companies, trust companies, and other financial service providers. At the same time, there has been substantial new entry by foreign

banks. The empirical results suggest that regardless of the substantial structural changes that took place in the past 25 years, Canadian banks have behaved consistently in a monopolistically competitive fashion over this period.

There seem to be a couple of possible explanations for this consistency. Considering that the H-statistic appears to be robust to measurement errors (Genesove and Mullin 1998), and given the wide range of estimates that imply monopolistic competition (between 0 and 1), rejecting this conclusion might be difficult from a statistical perspective. At the same time, the reductions of barriers to entry and activity restrictions that accompanied the legislative reforms of the past 25 years might have increased contestability of the market, and thereby countered possible anti-competitive effects associated with the consolidation across financial services over the same period.

Finally, while Allen and Liu (forthcoming) consider alternative definitions of banking output and prices to take into account the diversified business mix of Canadian banks, the framework used allows for only a single composite output. It is possible that cost structures and pricing strategies (as well as market power) differ between the various business lines of a diversified bank. As a result, it would be better to estimate an H-statistic for each business line. However, this requires detailed data for each business line, which, unfortunately, does not exist.

Conclusions

The research summarized here suggests that, overall, Canadian banks appear to be relatively efficient producers of financial services. As well, some efficiency gains from becoming larger appear to be possible. The research also indicates that Canadian banks do not exercise monopoly or collusive-oligopoly power, and that banking can be considered to be a monopolistically competitive industry.

However in the course of conducting the work reported in this article, it has become clear that a constraint on more precise study of the issues considered is a shortage of relevant, detailed data.

This experience indicates the importance of continuing to promote efficiency and competition in financial services in Canada.

As noted above, past legislative and regulatory changes have benefited efficiency in Canadian financial services, and might have improved contestability as well. Looking forward, this experience (as well as economic reasoning) indicates the importance of continuing to promote efficiency and competition in financial services in Canada.

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