Editor's Overview

This seventh issue of the *International Productivity Monitor* produced by the Centre for the Study of Living Standards contains seven articles. Topics covered include Canada's long-run economic performance and prospects, the impact of capital accumulation on productivity growth in Canada, differences between Gross Domestic Product and Net Domestic Product, future productivity growth in Canada, and the OECD growth study.

Readers are reminded that in addition to the hard-copy version of the *Monitor* available in English and French, all articles are available online at www.csls.ca under the *International Productivity Monitor*. Unabridged versions of many of the articles are also posted. Comments on the articles are welcome.

With a new government assuming office early in 2004, economic policy directions for Canada may change. In the lead article, **Peter Nicholson**, who until recently served as advisor to the Secretary General at the OECD and is currently serving as policy advisor to Paul Martin, discusses Canada's long-run economic performance, prospects, and policy priorities based on the framework and insights that emerged from the recent study of economic growth released by the OECD. He argues that Canada has performed remarkably well since the mid-1990s, and that by the pro-growth policy prescriptions developed by the OECD, Canada is doing most things right. However, Nicholson points out that our productivity gap relative to the United States is still large and growing and that finding ways to increase productivity growth is an increasing social and political necessity.

Nicholson develops a scorecard on Canada's economic performance based on a three-star rating scheme. He gives Canada three stars for sound macro policies, human capital, and exposure to trade, two stars for productive investment, and one star, or perhaps a little better, for innovation. Despite this strong performance, Nicholson cautions against complacency, particularly given the demographic challenge the country will be facing in the years to come.

A key source of labour productivity growth is increased capital intensity of production that arises through capital accumulation. In the second article, **Someshwar Rao**, **Jiamin Tang** and **Weimin Wang** of Industry Canada examine the impact of capital accumulation on Canada's recent productivity record. A key finding is that the widening of the Canada-U.S. labour productivity gap in both the business sector and in manufacturing in the second half of the 1990s was largely due to the widening of the capital intensity gap between the two countries.

Indeed, the authors find that in the business sector multifactor productivity growth in the two countries was virtually identical at around 2 per cent per year in the 1995-2000 period. This situation is explained by the marked slowdown in the pace of capital intensity growth in Canada after 1995. This development reflected the increased cost of capital relative to labour in Canada, in turn the result of higher prices for investment goods because of the depreciation of the Canadian dollar and low wage increases due to high unemployment. With the recent appreciation of the Canadian dollar and the expected decline in unemployment, the authors project in the medium-term a narrowing of Canada's capital intensity gap with the United States and hence a reduction in the labour productivity gap.

The most widely used measure of economic activity or growth is Gross Domestic Product (GDP). In the third article, **Roland Spant**, a

Swedish trade union economist, argues that Net Domestic Product (NDP) should replace GDP as a measure of economic growth for a number of purposes. The key difference between GDP and NDP is depreciation. With the shift in investment toward information technology assets with relatively short service lives, the share of depreciation in GDP has increased in most OECD countries and GDP growth now exceeds NDP growth. Spant points out that this means that the use of GDP leads to the overestimation of real output growth as well as the potential for non-inflationary real wage gains.

The key determinant of future growth in living standards in Canada will be the rate of growth of labour productivity. This issue of the *Monitor* contains a symposium of three articles that address the likely developments in this area, and factors behind these developments.

The first contribution to the symposium by **Thomas Wilson** of the University of Toronto presents forecasts based on the FOCUS macroeconometric model of the Canadian economy. This model projects labour productivity growth to grow at an average annual rate of 1.7 per cent over the 2002-2025 period. Wilson is somewhat more optimistic, seeing labour productivity growth of around 2 per cent per year. Reasons behind his more rosy scenario include a greater pace of capital deepening due to much slower labour force growth, the realization of productivity gains from past investments in information and communications technologies, a mitigation of future business cycles due to greater use of automatic stabilizers, and continued benefits from trade liberalization.

In the second contribution to the symposium, **Tiff Macklem** of the Bank of Canada compares sources of recent productivity growth in Canada and the United States. Like Wilson, Macklem also sees aggregate labour productivity growth in Canada advancing at around a 2 per cent average annual rate in the medium term. This view is based on the increased share of machinery and equipment investment in GDP, Canada's high degree of exposure to international trade and investment, the supportive macro-economic environment of low inflation and improved fiscal positions, increased spillovers from rapid and sustained U.S. productivity growth, and the significant gap between Canadian and U.S. productivity levels, which suggests potential for catch-up.

In the third and final article in the symposium, **Benoît Robidoux** from Finance Canada observes that there has been a structural improvement in labour productivity growth in Canada since 1996 and that it is likely that this stronger productivity growth of around 2 per cent per year will continue. He points out that future productivity growth in Canada will increasingly depend on productivity trends in the expanding service sector, and in particular on the ability of this sector to incorporate information and communication technologies into the production process.

In early 2003, the OECD released a major report entitled *The Sources of Growth in OECD Countries*. In the seventh and final article, **Martin Neil Baily** from the Institute for International Economics, and former Chairman of the U.S. Council of Economic Advisers reviews the report. Baily notes that key findings include: the diversity in GDP per capita growth across OECD countries, largely reflecting differences in labour utilization; the importance for growth of exposure to international trade, sound macro policies and investment in physical and human capital; and the high returns to growth from business sector R&D activities, in contrast to a lack of any positive effect from government R&D. Baily observes that the report fails to discuss ways to improve employment growth, concluding that combining full employment with high productivity is the key challenge currently facing policymakers.

The Growth Story: Canada's Long-run Economic Performance and Prospects

Peter J. Nicholson*

Canada's economy turned a corner in the 1990s. What happened?

Most Canadians would give a lot of credit to the dramatic about face on the deficit in mid-decade. We finally began to live within our means; made room for taxes to be cut; and came to rely less on bureaucrats and more on entrepreneurs.

Those who follow these issues more closely would also point to the Bank of Canada's successful war on inflation, culminating with the "cleansing" recession that ushered in the 1990s. Credit would also be due to the substantial liberalization of trade following implementation of the Canada-U.S. Free Trade Agreement (FTA) in 1989, and subsequently the North American Free Trade Agreement (NAFTA).

Those less disposed to accord much credit to policy would simply point out that a rising tide lifts all boats. That rising tide included exceptionally favourable global macroeconomic circumstances; the investment boom triggered (irrationally or not) by the promise of information and communications technologies; and the extraordinary dynamism of the United States, from which Canada benefits more than any other country. All combined to make strong Canadian growth inevitable.

True enough. But many of Canada's peers in the club of advanced economies — essentially the member countries of the Organization of Economic Cooperation and Development (OECD) — have not fared nearly as well. And taking a closer look at several factors that are believed to be key drivers of *long-term* economic growth — e.g. investment in physical and human capital; innovation; the state of domestic competition; performance of financial markets; flexibility of labour markets; strength of entrepreneurial behaviour — one sees that Canada has become, in most respects, well-positioned to sustain the momentum established in the mid-1990s.

The objective of this essay is to outline the case for this conclusion. No original research is reported. The perspective is policy-oriented, rather than academic. While we draw on many sources — a number of which have appeared in the pages of the *International Productivity Monitor* — the foundation reference is the work of the OECD's Growth Project launched at the request of member governments in 1999. Specifically, we draw heavily on a recently published compendium of the work to date — *The Sources of Economic Growth in OECD Countries* (OECD, 2003a). That report is reviewed by Martin N. Baily

(2003) elsewhere in this issue. What follows also owes a considerable debt to research incorporated in recent OECD surveys of Canada including, in particular, work by Catte, Jarrett and Rae (OECD, 2002).

We present Canada's economic performance over the past 20 to 30 years as seen through the lens of the OECD's comprehensive investigation of the key drivers of long-run growth. This international analysis is complemented in what follows with a wide range of Canada-specific data, subjectively chosen as indicative of what Canada has been doing right (or wrong). The overall message derives from the *pattern* of evidence and not from any specific indicators.

The bottom line is this. Canada has performed remarkably well within its peer group of OECD countries since the mid-90s, finally reversing the country's 15-year economic swoon that began at the end of the 1970s. This recovery reflects much more than just the fiscal turnaround. In fact, judged by the standards of the pro-growth policy prescription developed by OECD analysts, Canada is now doing most things right.

Of course, the theory and empirical evidence underlying today's conventional wisdom as to what are effective growth-promoting policies is still far from settled. The potentially relevant factors are so numerous and interlinked that policy prescriptions will forever require an overlay of intuitive judgment and tailoring to local circumstances. The economy is certainly not a clockwork.

More significantly, there can be no resting on laurels. While Canada has made a good start, the economic performance gap relative to the United States — the only benchmark that matters to most Canadians — is still large and, until the late 1990s, was growing. The scope and intensity of global competition is not diminishing — think of China. Then there is the quasi-inevitable demographic arithmetic. Statistics Canada projects that within a little more than a decade, the population aged 15 to 65 will begin to shrink as a proportion of the total population, and at an accelerating rate as the baby boom bulge retires. Fewer hands feeding more mouths, while expectations of affluent retirement and life-extending medical miracles increase the age-dependency burden.

Finding ways to increase Canada's rate of productivity growth will therefore be of increasing social and political necessity. In view of the considerable lead time needed to bring about significant change in the nation's stock of human and physical capital and industrial structure, the challenge of impending demographic maturity is already upon us.

Canada's Growth in Historical Perspective

Throughout the post-war period until the end of the 1970s, Canada enjoyed a sustained period of robust growth in per capita output, stronger on average than that of the United States. It was a period when productivity growth in Canada, Western Europe, and particularly Japan, converged toward that of the economic leader (the United States) and unemployment rates were generally low. This happy conjuncture came to an end around the time of the "oil crisis" in the mid-70s giving way to weak growth and rising inflation — a global "stagflation". The deep recession of 1980-81 reflected a determined effort by the U.S. Federal Reserve and other central banks to finally come to grips with the inflationary dynamic that had become embedded in many advanced economies.

Meanwhile, the strong productivity growth that had propelled burgeoning living standards in OECD countries, and the development of the welfare state, throughout the period from 1950 to 1975 abruptly lost momentum for reasons that are still not fully understood. Signs of a sustained

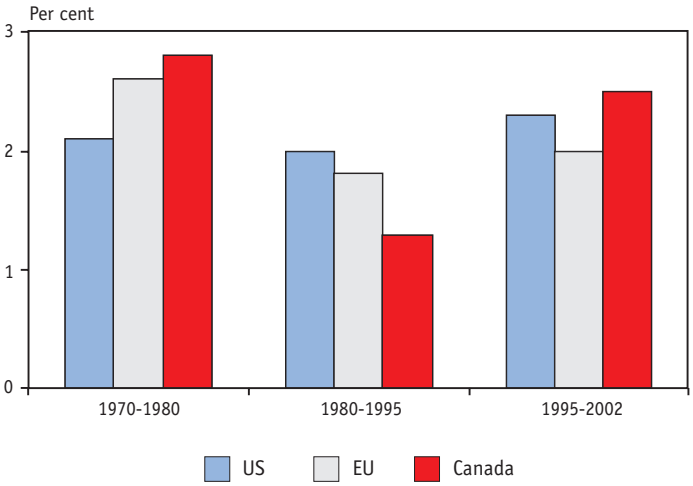
recovery of productivity growth — particularly in the United States, but also in other countries such as Canada, Australia, Finland and Sweden — did not become evident until the second half of the 1990s, and are still not visible in much of Europe. It is too soon to say whether this "new economy" rebound — led initially by the production of information and communications technologies (ICT), particularly in Finland, Sweden and the United States, but now increasingly dependent on effective *uses* of ICT-based services in the economy at large — will produce continuing productivity growth of the magnitude recently seen.

Canada's growth performance has been broadly consistent with the general context just outlined — i.e. exceptionally strong average growth of per capita output in the 1970s, followed by a particularly lackluster performance for the next decade and a half, and finally an impressive rebound after the mid-1990s, with average growth in this latter period outstripping both the United States and the European Union (Chart 1). Canada's lagging economic performance from 1980 through the mid-1990s — and the associated fiscal deterioration and growing gap relative to U.S. output and productivity — has saddled the country with a reputation for second-rate economic performance that has proven hard to shake. But seven or eight years after having turned the corner, a more impressive image for the Canadian economy is deserved and overdue.

Canada's material standard of living, proxied by GDP per capita, ranks second in the G-7 behind the United States and roughly on a par with a group of smaller wealthy OECD countries including Switzerland, Denmark and the Netherlands (Chart 2). But a gap of at least 15 per cent relative to the United States persists. For Canadians, this is the relevant benchmark. Indeed, for those travelling or buying assets in the United States, the gap seems even larger in light of the chronically weak Canadian dollar, the exchange value of which has been considerably less — by as much as 20 per cent — than its purchasing power parity level on which the data in Chart 2 are based. [1]

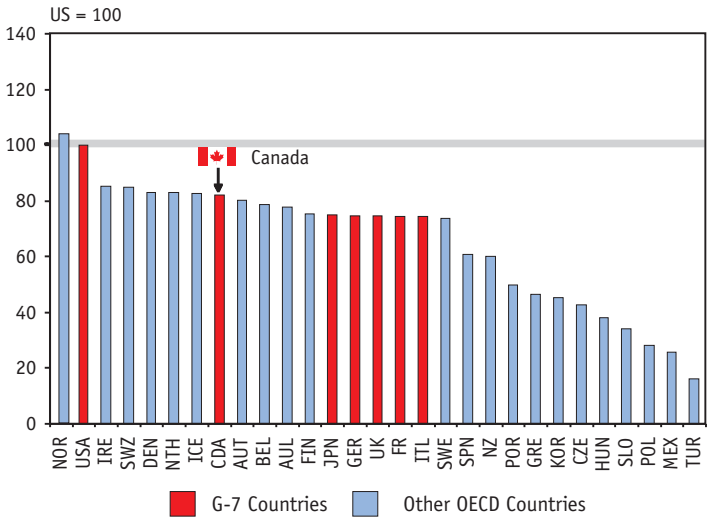
Of course, very few people apart from economists would think to equate their standard of living with their country's GDP per capita. It is a pure abstraction. And while per capita output does correlate with most social and economic indicators of well-being and development, the

Chart 1
Canada's Growth has Recovered Strongly
(Average annual growth of GDP per capita)



Source: OECD, 2003a, Table 1.1

Chart 2
Global Perspective on 'Living Standards'
(Relative GDP per capita* in 2001)

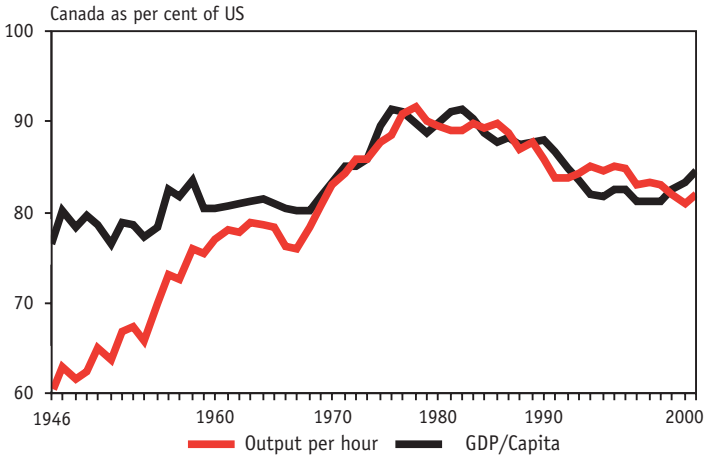


Source: OECD, 2003a, Table 1.1

Chart 3

Has Canada's Catch-up Stalled Permanently?

(Output per capita and productivity)



Source: Centre for the Study of Living Standards.

relationship is not strictly one-to-one within the group of advanced countries. For example, life expectancy in the United States is actually slightly below the OECD average and about 2.5 years behind that in Canada.[2] The incidence of child poverty and infant mortality in the United States are well above the OECD average. Violent crime in the United States is far more prevalent and the rate of incarceration is among the highest in the world. In fact, the United States lags both Canada and the OECD average on many social indicators, probably reflecting the more unequal distribution of income in the United States than in Western Europe and Canada.

When it comes to national *quality of life*, it is not only average income that matters, but also its distribution. The question as to whether there is, in advanced market economies, some unavoidable trade-off between the rate of growth of output per capita and its more even distribution involves exceptionally complex issues. The empirical evidence assembled with respect to OECD countries is really not conclusive either way (OECD 2001c). The virtue of a focus on GDP per capita — which is adopted in what follows — is that GDP growth expands the scope of society's *choices*. And these choices are likely to be exercised quite effectively in democratic societies since citizens have a rather direct say in how the growing pie should be divided.

The issues addressed in this essay require a long-run perspective. In the nearly six decades since the end of World War II, the growth rate of Canada's GDP per capita has, on average, slightly exceeded that of the United States, thanks largely to a remarkable catch-up in labour productivity (real GDP per hour worked) between the mid-1940s and the late 70s (Chart 3). This is consistent with a "convergence hypothesis" according to which countries, or regions, with relatively low levels of productivity tend over time to close the gap with the productivity leader — i.e. the United States for most of the 20th century — as technology and best practices diffuse from countries at the performance frontier to the laggards (Abramovitz, 1986; Wolff, 2000).[3]

The convergence process has been evident in the post-war catch-up of western Europe and particularly of Japan through the end of the 1980s. Within Canada, a similar catch-up is observed *regionally*. Since at least 1960, per capita output in the Atlantic Provinces has, on average, grown faster than that of Canada as a whole. Meanwhile, Ontario has grown more slowly in *per capita* terms than the national average — and, perhaps surprisingly, more slowly than the Atlantic region — over the past four decades taken as a whole. (This does not necessarily hold true, of course, from year to year, or for selected sub-periods.)

The essential question raised by the trend in Chart 3 is whether Canada has "hit a wall" and is no longer able to keep closing the productivity and output gaps relative to the United States. A similar question is preoccupying many European governments and particularly the G-7 members of "old Europe" where ageing populations and structural rigidities in labour markets have created a pernicious combination.

It might be questioned as to whether Canada needs to actually "catch-up" to the United States. After all, output per capita continues to grow, and a growth rate of even 2 per cent per year implies a doubling of real output per person in only 35 years, or more than four-fold real growth in a lifetime. Looked at another way — if Canada's per capita output grows at 2.5 per cent per year (the average rate between 1995 and 2002), it would take less than seven years for Canada to reach the level of per capita output in the United States today.[4]

Notwithstanding this rational arithmetic, the existence of a persistent "standard of living" gap relative to the United States, in the here and now, is psychologically uncomfortable. And it may have substantive negative implications for growth to the extent that investment and talented people are preferentially attracted to the United States in view of its reputation as economic leader and land of opportunity. While much of this reputation is inherent in the sheer size of the United States, there can be no doubt that Canada's economic attractiveness would improve were it to equal the U.S. economic performance in terms of productivity and living standards.

Although views may therefore differ as to the importance of *eliminating* the per capita output gap with the United States, most Canadians would agree that we should not fall steadily farther behind. This unfortunately was the case from the early 1980s until the mid-1990s. And crucially, the widening labour productivity gap has only very recently appeared to have stabilized (Chart 3).

In fact, weak productivity growth, both absolutely and relative to the United States, has been the Achilles' heel of the Canadian economy for the past 25 years. During the 1980s and early 1990s, this was compounded by sub-par labour utilization — i.e. high unemployment and, for a time, a declining labour force participation rate. But by 2001, Canadian labour input per capita had come close to the U.S. level and considerably exceeded that of most European countries (Table 1). Data for 2002 indicate further relative gains by Canada. Canada's employment rate — i.e. employed persons as a per cent of the OECD's conventionally-defined working age population (aged 15 through 64) — is now almost identical to that of the United States.[5] Although employed Canadians work fewer hours on average than Americans, the proportion of the population that is of working age is about five per cent higher in Canada than in the United States. The combined result is that annual hours worked *per capita* in Canada are only slightly less than in the United States. Pierre Fortin (2003) estimates about a six per cent difference, whereas the OECD data imply virtually no difference.

Table 1
Labour Utilization, 2001

	Canada	US	EU	OECD Ave
Employment Rate[1,3]	71.9%	72.3%	65.3%	66.3%
Unemployment Rate[3] (Standardized)	7.2%	4.7%	7.4%	6.5%
Hours per Employee[2] (US = 100)	91	100	-	-

Notes

1. Total employed as percent of population aged 15-64.

2. Data from Fortin (2003), Table 1. OECD, 2003a cites hours worked per employee in 2000 as follows: United States, 1835 and Canada, 1795, implying an index for Canada of almost 98.

3. Source: OECD (2003b).

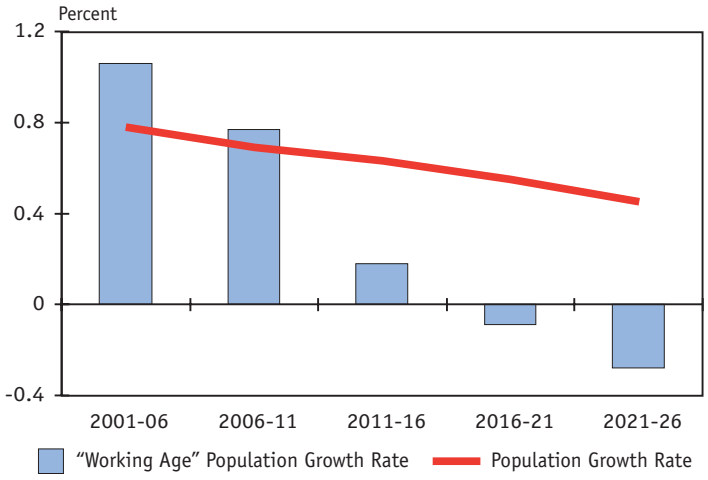
The bottom line is as follows. Since (i) GDP per capita is equal, by definition, to "GDP per hour worked" times "Hours worked per capita"; and (ii) hours per capita are nearly the same between Canada and the United States; then (iii) essentially the entire gap in GDP per capita between Canada and the US is due to the productivity gap. This is also evident from Chart 3.[6]

Having acknowledged Canada's productivity weakness today, the mid-to-long-term outlook is even more challenging (Chart 4). Panel (a) in

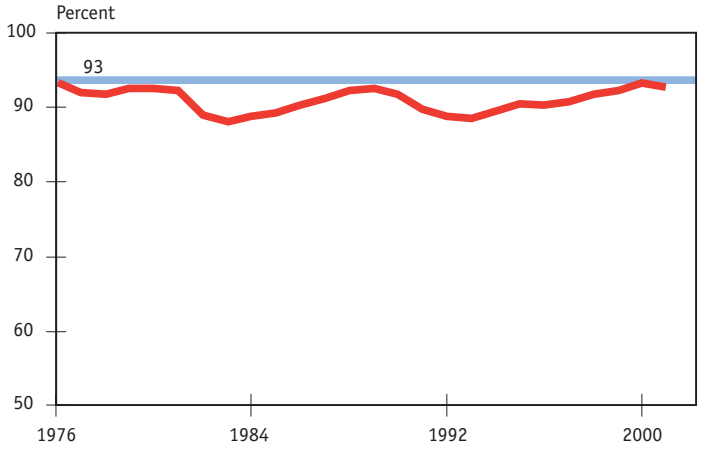
Chart 4

Canada's Growth Expectations

(a) Demographic Projections 2001-26

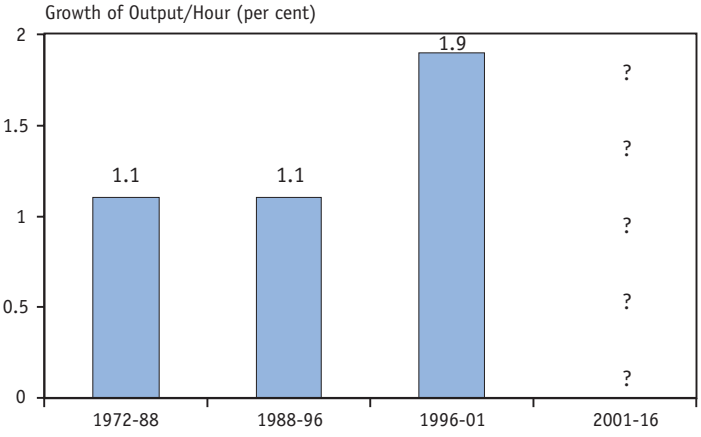


(b) Employment as per cent of Labour Force



(Note: The unemployment rate is 100% minus the plotted trend.)

(c) Trend Labour Productivity Growth



Source: Statistics Canada.

Chart 4 shows that this country's "demographic dividend" — i.e. the situation where the population of working age grows faster than the population as a whole — is soon coming to an end. It is estimated that around 2018, Canada's working age population will actually begin to shrink, and at an increasing rate as the bulge of the baby boom moves into retirement. Based on current trends, the effect of demographics on Canada's growth rate will soon switch from tailwind to headwind (Table 2).

In response, working beyond age 65 will make sense for an increasing number of Canadians in view of better health and jobs that are less physically demanding than they once were, to say nothing of the need to augment pension income. Increased immigration could also mitigate the drag, though Canada's high current levels of immigration (relative to most OECD countries) are already incorporated in the projections in panel (a).

There is some further potential for adjustment through an even higher employment rate — i.e. greater labour force participation and/or lower unemployment combined perhaps with increased annual hours — but the potential for significant increase via this channel appears to be limited based on long-term trends (panel (b) in Chart 4). More to the point: while everyone would welcome lower unemployment, few would consider it progress to draw people reluctantly into the labour force or to lengthen the work week.[7]

The implication of this straightforward line of reasoning is that Canada's long-term growth path will depend almost entirely on the rate of productivity growth. And in view of labour force demographics, *declining* growth of GDP per capita can only be avoided by an *increasing* rate of productivity growth.[8]

Panel (c) in Chart 4, based on data from Robidoux and Wong (2003), indicates that the rate of labour productivity growth has indeed increased in Canada from about 1.1 per cent per

year on average between 1988 and 1996 to 1.9 per cent in the subsequent five years. In light of the impending trend of workforce demographics summarized in Table 2, the challenge is not only to maintain the recent encouraging productivity trend, but actually to intensify it. Meanwhile, the United States appears to be better positioned demographically than Canada in view of its somewhat younger age structure — due to a higher fertility rate — implying a longer period of demographic tailwind in the US. Other things being equal, this will tend to widen the gap in output per capita.[9]

Before addressing the policy factors relevant to promoting output and productivity growth, one further element of the recent context is particularly germane. Chart 5 isolates the primary sources of labour productivity growth in Canada and the United States over the period 1990 to 2000. Although precise estimates of the contributions differ depending on the source, there is broad consensus that the strong productivity revival in the United States has emanated from information and communications technology (ICT), in respect of both its production and use [(Oliner and Sichel, 2002), though for a more skeptical view, see Gordon (2002) and Wolff (2002)]. The story has been similar in Canada, but more muted, reflecting Canada's relatively smaller ICT producing sector and this country's characteristically slower uptake of the technology by businesses. The impact of ICT on European productivity growth has been, with a few exceptions such as Finland, more muted still (van Ark, Inklaar, and McGuckin, 2003). A comprehensive analysis of the contribution of ICT to economic growth has recently been published by the OECD (OECD, 2003d).

Two important messages are conveyed in Chart 5. First, Canada's productivity growth rate during the 1990s matched the United States on average for the business sector as a whole, excluding the ICT-producing sector and the intensive-use ICT sectors. (Intensive users include, for example, financial institutions, large wholesalers and retailers, and professional services firms). Second, the potential for continuing ICT-based productivity growth appears to be very large as this general-purpose technology diffuses throughout the economy. The raw tech-

Table 2
Projected Work Force Demographics For Canada

	Ratio of Working Age Population to Total Population[1]	Contribution to Growth Rate of GDP per Capita[2] (per cent)	
2001	.6854	0.3	Demographic
2006	.6950	0.0	"Tailwind"
2011	.6975	-0.5	
2016	.6820	-0.6	Demographic
2021	.6607	-0.7	"Headwind"
2026	.6371		

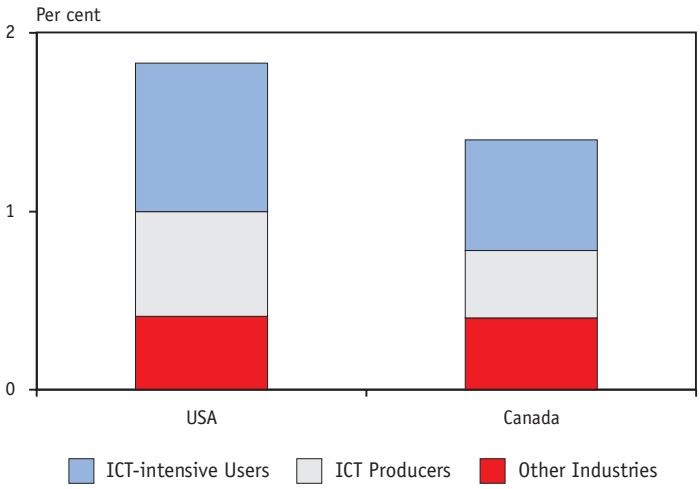
Notes

1 Population aged 15-64 divided by total population.

2 Annual rate of change (per cent per year) of the working age population ratio, averaged over the 5-year intervals. For interpretation see footnote 7 in text.

Source: Based on Statistics Canada medium growth projection of population by age.

Chart 5
Sources of Business Sector Productivity Growth
(Average annual increase of output per employed person, 1990-2000[1])



Note

1 Sector contributions are individual sector productivity growth rates weighted by workforce shares

Source: OECD.

nological possibilities themselves are still developing rapidly and much more efficient usage patterns will emerge as young cohorts of "super ICT-literate" workers come to dominate the labour force. It is almost certain that this emerging generation will create applications for ICT that cannot be conceived today, but which will become dominant in the future economy.

Canada is well-positioned to take advantage of the ICT potential in light of an excellent communications infrastructure, high levels of internet usage and a diverse, talented software production sector. Close integration with the U.S. economy also gives Canada an important advantage as a fast follower of the ICT technology leader. This underlines the importance of developing maximally efficient channels of technology diffusion/adoption, particularly by Canadian small and medium-size businesses.

Determinants of Long-run Economic Growth

Having outlined the broad dimensions of the growth challenge facing Canada — essentially, the productivity challenge — the question becomes what is to be done in policy terms? And this begs the antecedent question: in seeking to promote output and productivity growth, what matters most?

Stated this way, the question really has no honest answer. This is because the factors that determine economic growth are in constant dynamic interaction, feeding back and feeding forward on one another in a complex web of mutual interdependence. The situation is analogous to a living organism where one is hard put to say which is more important — the heart, lungs, liver, or kidneys. Take away any one of these and you're dead.

A *system* perspective is therefore required. Chart 6 schematically represents some of the more important "organs" of the economic system and indicates several of the prominent causal pathways interconnecting them. The point of the diagram is not to define a "system dynamics" model of the economy, but rather to convey some idea of the number and complexity of factors that a comprehensive economic growth policy should address.

We start from essentially a definitional proposition. An economy grows (i) when more people are put to work (growing labour supply); and/or (ii) when workers collectively produce more value of goods and services in successive intervals of time (growing productivity). To enhance productivity, one can invest to augment raw labour with (a) increasing amounts of "human capital" (e.g. formal education; on-the-job training; or simply acquired experience) and (b) increasing amounts of physical capital. Thus *investment*, and the savings needed to finance it, lies at the heart of the growth process.[10]

The other key determinant is *innovation*, interpreted broadly to encompass not only activity associated with lab coats, but also incremental improvements emanating from the shop floor; more effective managerial techniques (working smarter); entrepreneurial creativity; and acts of sheer imagination that end up creating new sources of value (e.g. in arts and entertainment).

Investment and innovation are thus the foundation of economic growth. They are, moreover, interdependent since innovation usually produces new investment opportunities with higher prospective returns while investment in new equipment, in R&D, and in human capital are critical precursors to innovation.

This much is quite obvious. What is more subtle and important is to correctly identify the high-leverage factors and incentives that promote investment and innovation in the first place. These should be the focus of economic growth policy.

Chart 6

Growth Processes & Policy: A Complex Web

The principal factors by which growth is directly generated (the circles) are affected by policies (the rectangles) both directly and through intermediate "agencies" such as the investment climate; state of competition; diffusion of technology and best practices; etc. The diagram is only illustrative and does not attempt to capture all relevant factors and interactions.

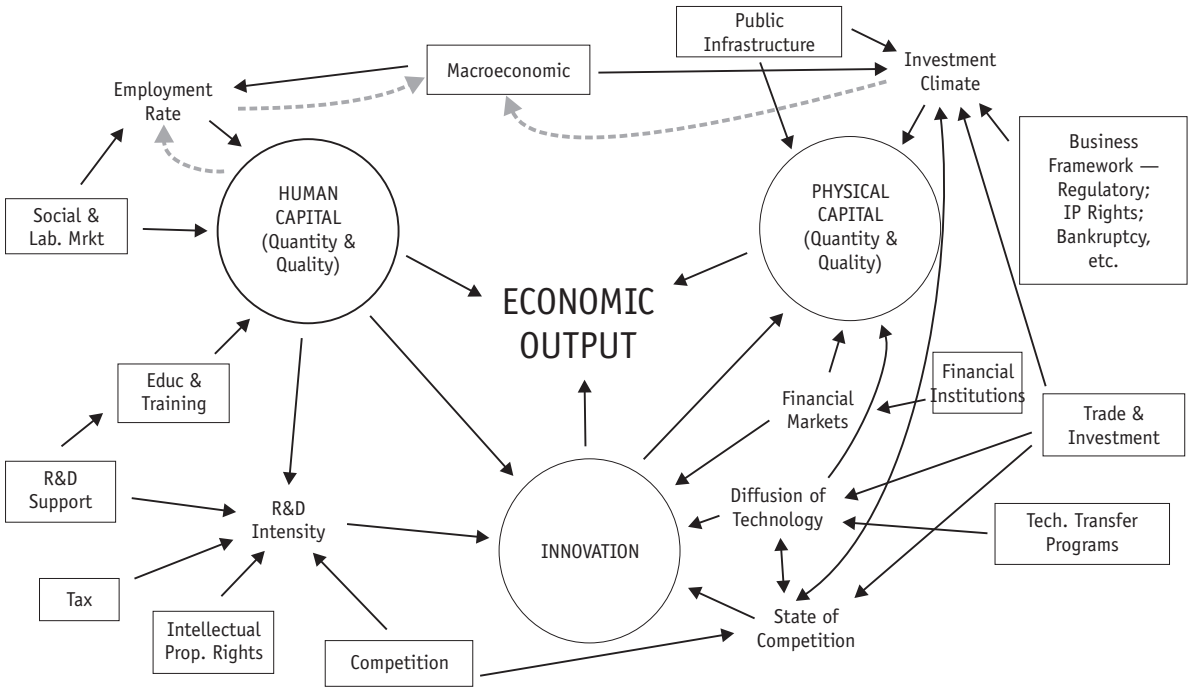


Table 3

Quantifying Some Key Growth Drivers*

Impact on level of GDP per capita in steady state

Driving Factor	Definition	Change	Impact	Typical Change over 80s and 90s in OECD
Human Capital	Average years of education	+ 1 Year	4% - 7%	+ 1.5 years in G-7
Physical Capital	Private non-res. Invest. as % GDP	+ 1 pct. pt.	1.3%	Variable
R&D	Business R&D % GDP	+ 0.1 pct. pt.	> 1.2%	About 0.1 pct. pt.
Trade Exposure	Ave of Exp/Imp % GDP	+ 10 pct. pt.	4%	About 10 pct. pts
Tax Burden	Govt. Revenue % GDP	+ 1 pct. pt. (0.6%)	– (0.7%)	About 1.5 pct. pts
Inflation Level	Final Consumption Deflator	- 1 pct. pt.	0.4% - 0.5%	About 4 pct. pts.
Inflation Variability	Standard Deviation	- 1 pct. pt.	2%	About 2/3 pct. pts

* Based on regression analysis of 21 OECD countries over 1971-98.

To this end, the OECD has carried out an ambitious research project to identify, and to quantify approximately, the primary sources of economic growth in advanced countries. The study applied state-of-the-art econometric techniques to data from 21 countries over almost three decades (1971-98). The findings are summarized in a recently published 250-page report (OECD, 2003a).[11] The period covered encompasses three global recessions; the productivity slowdown after the mid-1970s and the first stages of the post-1995 "new economy" rebound; the successful struggle to tame inflation and runaway deficits; and the evolution of a more open global economy. The statistical analysis therefore has considerable power to identify factors most relevant to growth in advanced democratic, market-oriented societies.

Key quantitative results are summarized in Table 3. The "impact" column in the table gives the estimated sensitivity of GDP per capita to small changes in what were identified as the principal growth drivers.[12]

The interpretation of the table can be illustrated by the first row, *Human Capital*. The OECD analysis adopted as a rough proxy for human capital the average number of years of education in the population aged 25-64. (This indicator was calculated for each country in each year.)[13] The estimated effect of increasing the average education level by one year is to increase the *level* of GDP per capita by 4 per cent to 7 per cent relative to what it otherwise would have been, holding all else constant. (The range in sensitivity corresponds to different estimation models.) The response of GDP to a one-time increase in the education level would of course not be instantaneous. The rate of convergence to a new "steady state" growth path (at a higher level of GDP) was also estimated — the data suggest that covering half the "distance" to the new steady state seems to take about four to five years.

Note that all of the impacts reported in Table 3 refer to the effect of the driver in question on the *level* of GDP per capita, not on the long-term *growth rate* of GDP per capita. The difference is somewhat subtle. During the time the economy is responding to the change in a driver that has a positive impact, the measured growth rate will increase as GDP adjusts to a new higher level. But eventually the response to the one-time jolt peters out and growth reverts to its original *speed*, other things being equal. Of course, in the real world, the growth drivers are changing continuously so the economy is always adjusting, thus confounding the interpretation of whether observed changes in the trend growth rate are quasi-permanent or transitory.[14]

It must be emphasized that the estimates in Table 3 are based on multi-country observations and reflect many simplifying assumptions in the choice of econometric models. Only very general inferences can therefore be drawn as to policy directions for a specific country since other factors in the local context will always be important. Moreover, there would eventually be diminishing returns to continued increases in the drivers. For example, Canada already has among the highest levels of human capital in the world, at least as measured by years of education per worker and the proportion of workers with post-secondary education. It is likely that adding a further year of formal schooling would therefore have less impact on Canada's growth rate than on that of a country with much lower average education. It is also not the case that more of a good thing is necessarily better, since channelling investment into one particular area implies foregone opportunities in others that may provide even higher returns.

The following observations further elaborate the picture summarized in Table 3.

Human Capital: There is obviously more to human capital formation than years of schooling. Workplace training and lifelong learning under-

taken by people on their own behalf clearly increase and update human capital. But the most potent influence could be the early childhood and pre-natal environment where lifelong potentialities can be enhanced or crushed. There is strong evidence that early intervention to mitigate disadvantage has vastly greater payoff than later attempts at remediation (Heckman and Caneiro, 2003).

Physical Capital: The amount and quality of investment in productive capital is the most familiar and well-established driver of productivity growth. Its effect is via two primary channels: (i) "capital deepening" whereby output per worker is boosted simply by more capital per worker — a tractor is usually better than a hoe; and (ii) the embodiment of technological innovation in new generations of capital — microchip technology being the most spectacular contemporary example. Of course, capital does not come free and over-investment can leave it "stranded", out of productive use at least for a time (e.g. today's thousands of kilometers of unlit optical fibre).

The policy challenge is to create an optimal *climate* for investment (see Chart 6) so that private sector actors are motivated to make investment for which both private and, ideally, social returns exceed cost. Sound macroeconomic policy, including taxation, is evidently a key contributor to an hospitable investment climate. But so are business framework policies related, for example, to intellectual property rights, competition, labour market regulations, and foreign investment, as well as complementary supply-side investments by government in public infrastructure, research and education. Trade policy can also have an important influence via the complementarity frequently observed between trade liberalization and increased investment, either to take advantage of expanded opportunities or to meet new competition. Public policy in support of safe and efficient financial institutions is also needed to ensure that capital is efficiently channelled from savers to investors across the entire spectrum of risk. Overlaying all of these specific attractions is the need to minimize uncertainty by making policy transparent and as stable and predictable as possible in view of the fact that capital investments always entail longer-term commitments.

Research and Development: R&D might be taken as a broad proxy for innovation, though it is only one input and directly affects primarily the production of new goods and services rather than more efficient ways of doing things. Of course, new goods and services resulting from R&D can greatly enhance efficiency when incorporated in production processes — the use of ICT innovations being a prime example. The "downstream" effects of R&D are therefore pervasive. This probably explains the empirical fact that there is a strong correlation across OECD countries between R&D intensity (business spending on R&D expressed as a per cent of GDP) and productivity growth. Canada's chronically low level of R&D intensity (see Chart 11 in the next section) implies that there is unexploited opportunity to increase productivity, and possibly its long-run *rate* of growth.

Trade Exposure: Increased trade exposure appears to be a potentially potent source of productivity growth, reflecting not only gains from comparative advantage, but also the opportunity to exploit scale economies (i.e. specialization to serve a global market), and the spur to innovation arising from exposure to stiffer competition and more rapid diffusion of best practices to domestic producers. While Canada can continue to gain from even greater trade liberalization, there are limits in view of the prevailing extent of openness and Canada's already exceptionally high level of trade activity (see Chart 9 in the next section).

Tax Burden: Table 3 shows that an increased tax burden has the expected directional impact on GDP — i.e. a larger tax take depresses output,

other things being equal. But the impact is complex and depends in part on the nature of the tax and, particularly, on the use to which funds are put. Tax increases to fund programs that blunt incentives or to prop up inefficient enterprises clearly dampen growth. This is in addition to any adverse impact of higher taxes on work incentives or entrepreneurial risk taking. On the other hand, taxes to fund productive public infrastructure, and to enhance human capital can obviously be growth-promoting. The bottom line message of the OECD impact analysis is that skepticism is warranted in respect of proposals to increase the size of government relative to the economy. In practice, and on balance, there is likely to be a cost in terms of lower output. This may be justified in light of other public objectives but the potential cost should be weighed in the decision.

Inflation: Perhaps the most surprising implication of the OECD analysis is the estimated strength of the impact of inflation reduction, both in respect of level and variability. Reducing the level of inflation appears to affect growth largely by improving the capital investment climate. Reducing the uncertainty caused by volatility of inflation has little impact on the propensity to invest, but increases growth through a more efficient allocation of resources made possible by more reliable price signals.

Unfortunately, the potential of inflation control to spur extra growth in Canada (and in most OECD countries) has been exhausted. Indeed, *deflation* has actually become a concern in some quarters. The key message of the OECD analysis is that there would be a heavy price to pay if inflation beyond two to three per cent were again to take root given: (i) its inherent tendency to accelerate, and (ii) the recession-inducing response this would elicit from central banks.

The analysis summarized in Table 3, notwithstanding its multidimensionality and rigour, still omits important elements of the growth story, namely those that defy explicit quantification. Two of the most powerful growth drivers are *competition* and the *diffusion* of technology and best practices broadly in the economy. (Of course, both of these interact in various ways with elements that are included in Table 3, such as trade exposure, capital investment, R&D.)

Competition is important not only because it makes businesses more responsive to the wishes of customers but also because it creates a powerful incentive to innovate and continually to increase efficiency so as to expand, or defend, market position. Competition thus creates a climate conducive to entrepreneurship. For all these reasons, competition is, in most cases, an extremely potent driver of productivity growth.

But even this conclusion must be qualified. Competition can, under some circumstances, become excessive and degenerate into a downward spiral of price cutting that actually stifles investment and generates cycles of business failure. The airline industry appears to be prone to this type of market failure. Competition can also diminish the incentive to invest in innovation if competitors are able to appropriate some of the returns without adequate compensation to the original investor. This is why patent protection is essential in, for example, the pharmaceutical industry, but again only up to a point. Creating an optimal state of competition, sector by sector, is therefore an exceptionally subtle policy challenge, but the potential payoff in terms of productivity growth is correspondingly large.

Rapid diffusion throughout the economy of leading-edge technology and best practices is a particularly powerful productivity driver. Japanese manufacturers have accomplished this to great effect, systematically scouring the world for the best ideas, then adapting them at home to achieve remarkably rapid productivity growth and world leadership in several industries. Another significant example has been the so-called "Ag Rep" system which spearheaded the

dissemination of scientifically-based agricultural practices to farms throughout North America, triggering revolutionary productivity gains in that sector during the 20th century.

More broadly, a generalized diffusion process, as previously noted, underlies the productivity convergence among OECD countries, and across Canadian regions. Efficient techniques and channels of technology diffusion to Canada from abroad are particularly important. This is because even in the best of circumstances, this country, given its relative size, would not originate more than about five to ten per cent of potentially relevant innovation.

Foreign direct investment, and the embodiment of leading-edge technology in new capital investment by domestic firms, are primary channels of diffusion. Geographical clusters of related activity — e.g. California's Silicon Valley, agricultural biotech in Saskatoon, ICT in Ottawa — are also important agents of diffusion, obviously for the firms in the cluster itself, but also because successful clusters become high-profile centres of influence over much broader areas. Silicon Valley has inspired countless would-be imitators. Clusters are exceptionally fertile breeding grounds for talent, a proportion of which ends up somewhere else, thereby spreading the experience and extending networks of personal contacts.

A major objective of a diffusion strategy must be to improve the rate at which best practices/technologies are adopted by smaller businesses. (Canadian small and medium-sized enterprises (SMEs) appear chronically to lag their U.S. counterparts in this regard.) The Ag Rep system was very effective for small farmers and the Industrial Research Assistance Program (IRAP) of the National Research Council of Canada has been successful in promoting productivity, primarily in smaller manufacturers. Today's challenge, with potential for extremely high payoff, is to develop policies and programs to stimulate more rapid diffusion of ICT-enabled practices in virtually all sectors of the economy.

Canada's Growth Scorecard

We turn now to several illustrations that indicate how Canada has performed, and is currently positioned, in respect of many of the principal productivity drivers identified in the OECD growth study, and summarized in Table 3. The following indicators — covering macroeconomic policy, capital investment, trade exposure, human capital and R&D — include some of those employed in the OECD's quantitative analysis, as well as others not included in that work but which nevertheless illustrate the themes.

The message of these indicators, taken collectively, is that Canada now stands among the leaders in its peer group of OECD countries in most of the key measures believed to underlie superior long-run economic performance.

Macroeconomic Policy: Canada's fiscal turnaround is reflected in Chart 7 which traces the evolution since 1981 of net government debt — federal and provincial/state combined for Canada and the United States. The figures, with liabilities offset by assets, represent the National Accounts basis of presentation which permits cross-country comparison based on similar definitions.[15] The budget dynamics underlying Chart 7 are shown in Table 4 which confirms that Canada's fiscal turnaround has not been duplicated, either in magnitude or duration, by the United States or the European Union group of countries. And while total government spending in Canada — 40.6 per cent relative to GDP in 2002 — is still five percentage points above the comparable U.S. level, the reduction in Canada since 1994 has been nine percentage points of GDP versus less than one percentage point in the United States (Table 5).

Table 4
Total Government Budget Surplus/(Deficit)

	1997	1998	1999	2000	2001	2002	2003	2004
Canada	0.8	0.5	1.4	2.4	1.8	1.3	1.1	0.9
US	-1.2	-0.2	0.1	0.9	-0.2	-2.4	-4.0	-3.9
EU	-1.8	-1.4	-0.7	-1.0	-1.2	-1.6	-1.4	-1.5

Source: OECD (2003b:223).

Table 5
Total Government Outlays
(Consumption and transfers relative to GDP, per cent)

	1985	1994	2002	Decrease 1994-2002
Canada	48.3	49.7	40.6	9.1 pct pts
US	36.5	36.5	35.6	0.9 pct pts
EU	49.6	51.5	47.7	3.8 pct pts

Source: OECD (2003b:220).

Canada's fiscal turnaround, combined with credible control of inflation, has largely erased the risk premium in Canadian interest rates relative to those in the United States, contributing to an improved investment climate. Expenditure restraint has finally created room for selective tax cuts — e.g. bringing the average corporate income tax rate down progressively from 46.6 per cent in 2000 to a scheduled 33.4 per cent in 2007 and below the current comparable U.S. rate of 40 per cent (Finance Canada, 2003). Budget surpluses are now a net source of national savings — compared with a draw on savings equal to 9.1 per cent of GDP in 1992.

The policy challenge is to stay the course and continue to pay down debt so as not to further burden the next generation of taxpayers who will have to cope with an ageing population. It is therefore important to resist the temptation to treat fiscal discipline as "yesterday's" issue. We should have learned how quickly things can accelerate out of control and how difficult it is to muster the political consensus to set them right again.

Capital Investment: A tight correlation exists between the level of business investment in machinery and equipment and productivity growth. The boom in business capital formation in the 1990s in North America (Chart 8), though to some degree excessive, has laid a foundation for future growth. Particularly important will be the extent to which businesses are able to take increasing advantage of installed ICT infrastructure (i) through new business processes, and (ii) by more fully employing the assets now in place.

Chart 8 shows that the investment boom began earlier in the United States and carried to a higher peak than in Canada. Still, the average compound rate of growth of business fixed capital formation in the United States over the period 1994-2000, at 9.9 per cent, was only slightly higher than the average in Canada at 8.9 per cent. The EU average was 5.7 per cent (OECD, 2003b:200). And while Canada lags the United States in ICT-related investment, it still ranks with the United States, Finland and Australia as the OECD leaders in ICT capital employment, and is thus well-placed to exploit the potential of this general-purpose enabling technology (OECD, 2003a:45, 46).[16]

Trade Exposure: Foreign trade stimulates productivity growth via several channels — compet-

itive pressure; economies of scale as a result of market expansion; gains from specialization in areas of comparative advantage; and trade-related capital investment. Accordingly, Canada's increased trade exposure has been a plus and stands out among G-7 countries (Chart 9).[17]

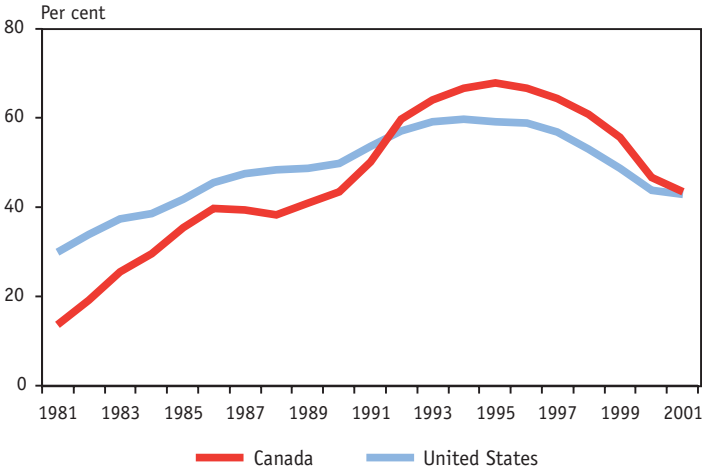
The impact of increased trade on Canada's productivity growth has been less than perhaps was anticipated and certainly has not been sufficient to close the gap with the United States. But there is evidence that productivity has indeed increased in the sectors most liberalized under the FTA/NAFTA. On the other hand, those agreements had relatively little impact on the machinery and ICT sectors, the areas in which productivity growth potential has recently been greatest and which led to the growing gap vis-à-vis the United States.

Looking forward, even if Canada does not substantially increase its overall trade exposure there is much scope to shift the *composition* of exports toward greater technological content, including ICT-based services. That is the main opportunity and challenge. Canadian trade will continue to be concentrated overwhelmingly with the United States given the irreversible extent of integration of the North American economy. Although some have been understandably concerned about Canada's dependence on the U.S. market, it is ultimately of great benefit in terms of long-run productivity growth to be so closely linked to the global leader.

Human Capital: Modern economies depend increasingly on "knowledge" as raw material and the analysis and manipulation of "information" as the principal source of growing added value. Success in the knowledge economy depends on growing investments in human capital, primarily through universal and more advanced education; sophisticated training; and lifelong learning.

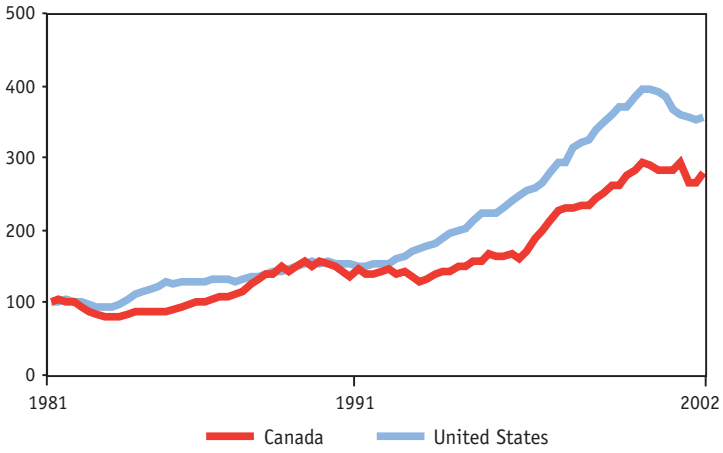
In terms of formal education, Canada's population is among the world's most well-endowed, ranking second in the OECD behind Germany

Chart 7
Net Debt as per cent of GDP
(National Accounts Basis)



Source: OECD (2003b:228).

Chart 8
Machinery and Equipment Investment
(Volume terms, 1981 = 100)



Source: OECD.

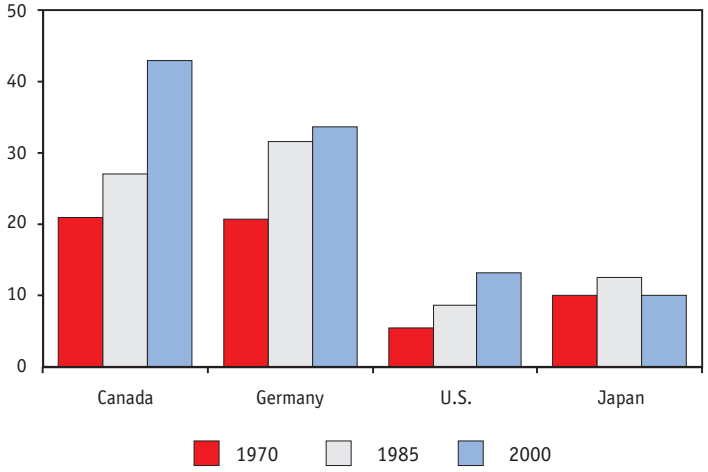
in average years of schooling in the labour force (Table 6), and first in the proportion of younger persons with post-secondary education (OECD 2003a). But what about the *quality*, not just the quantity, of Canadian education?

One significant indicator has been provided by results of the recently-initiated Program of International Student Assessment (PISA) under auspices of the OECD (OECD, 2001b). This involved very large and rigorously-controlled cross-country testing of 15-year olds in respect of practical capabilities in reading, science and

Chart 9

Growing Foreign Trade Exposure

(Average of exports and imports, per cent of GDP)



Source: OECD Economic Survey of Canada, Sept 2001:117.

Table 6

Average Years of Education of Working Age Population

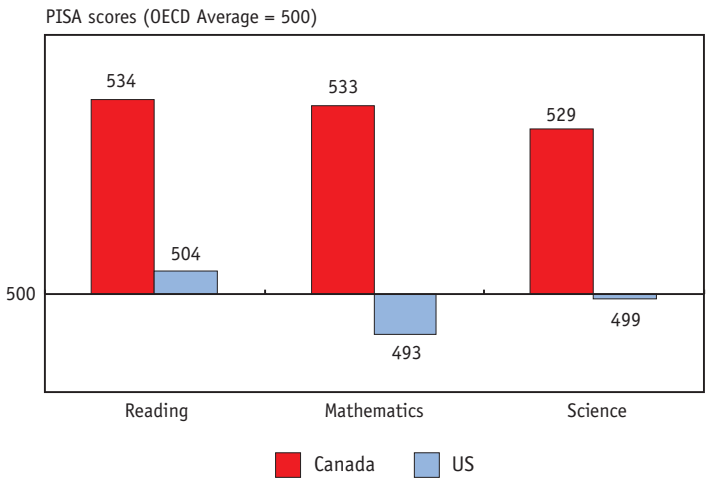
	1970	1980	1990	1998	Increase (Years)
Canada	11.37	12.10	12.47	12.94	1.57
US	11.57	12.23	12.59	12.71	1.14
Germany	9.47	11.41	12.89	13.55*	4.08

Source: OECD (2003b:220).

Chart 10

Human Capital Potential

(Mean country performance in PISA*)



* Program for International Student Assessment (OECD).

mathematics (Chart 10). Canadian students scored exceptionally well in the first PISA survey in 2000, ranking near the top of the OECD in all three categories.[18] Canada also had a relatively shallow gradient in its results as a function of students' socio-economic status. This stood in marked contrast, for example, to Germany and the United States where social disadvantage was reflected in much poorer scores. Canada's results exceeded those of the United States even at elite levels — i.e. considering only the top 10 per cent of performers in each country, Canada's average was greater than that of the United States.

While this first PISA survey (which will be repeated at regular intervals) is only one indicator of future human capital potential — albeit a significant one in view of the unprecedented scope and rigour of its methodology — it does show, perhaps surprisingly to many parents, that Canada's grade school system, *on average*, is doing a good job by international standards.[19]

Research and Development: Canada has been a perennial laggard in the league tables of R&D spending relative to GDP. While its R&D ratio has been gradually inching upward, including particularly the proportion performed by business, Canada's ranking within the OECD has actually dropped a couple of notches, from 12th in the 1980s to 14th in the 90s (Chart 11).

R&D is obviously not the whole story in an assessment of innovation performance, but high R&D intensity, and particularly the proportion performed by business, does correlate with productivity growth and with other measures of commercialization of innovation — e.g. patents, technology licenses.

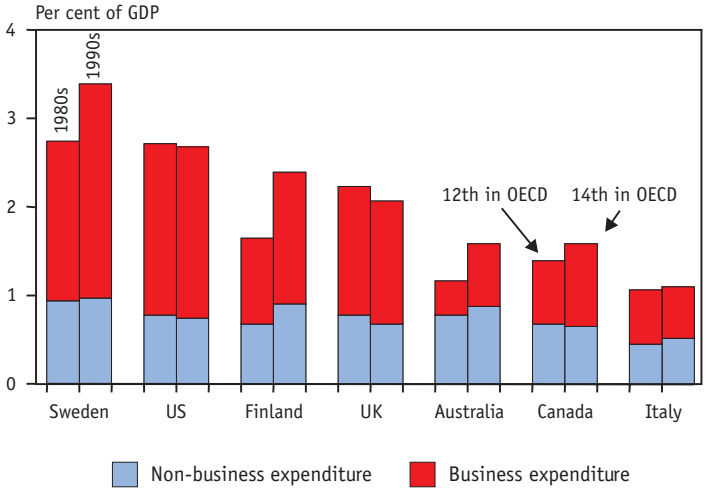
It is important therefore to understand, more deeply than we now do, why Canada continues to lag in the bottom half of its OECD peer group? Part of the answer is industrial structure. The Canadian economy, notwithstanding its growing technological orientation, is still relatively dominated by industries that exhibit low R&D inten-

sity regardless of where they are located — e.g. resource-based manufacturing.

But even on a matched industry basis, Canadian R&D spending (as a share of value-added) is in most sectors far below that of the United States (OECD, 2000). This is probably because many of Canada's large, technically-advanced firms are affiliates of foreign (usually U.S.) multinationals. Most R&D is performed in the home country. The auto industry is a striking example. Very little R&D is performed in Canada despite substantial production value-added in this country. Of course, Canada benefits greatly from the R&D embodied in capital equipment installed in auto plants and in other facilities where foreign investment carries with it technology and leading-edge production practices. On the other hand, Canadian R&D intensity in the communications equipment and semiconductors sector is estimated to exceed that of the United States, reflecting the activity of Nortel and the large number of other Canadian-based firms in this segment.

How might Canada's R&D effort be increased? First off, it is difficult to force-feed business R&D spending. Firms are already motivated to perform R&D to the extent it is profitable to do so relative to alternative investments.[20] The policy objective therefore is to create in Canada an R&D *environment* that is attractive to multinational firms, including those headquartered in Canada, which increasingly scan the world for the best places to locate activity. Canada already offers one of the most attractive R&D tax credit regimes, and in recent years has done much to increase the supply potential of research universities — e.g. through the Canada Foundation for Innovation; Millennium Research Chairs; and commercially-oriented "centres of excellence" at both the provincial and federal levels. These initiatives take time to pay off, but there is no doubt that solid groundwork is being laid in respect of research infrastructure and the supply of highly qualified people.

Chart 11
R&D — Why Isn't Canada Catching Up ?



Source: OECD (2003a:63).

Many other factors are of course relevant to the innovation process — particularly competition; diffusion of best practices; supply of risk-oriented venture capital; and a hospitable environment for entrepreneurs. Here the picture is more encouraging than in the case of R&D. Surveys by the OECD suggest (a) that Canada's venture capital sector is second only to the United States in terms of support for early stage, high-tech firms; and (b) that barriers to entrepreneurship in Canada are, on the whole, near the lowest in the OECD.[21]

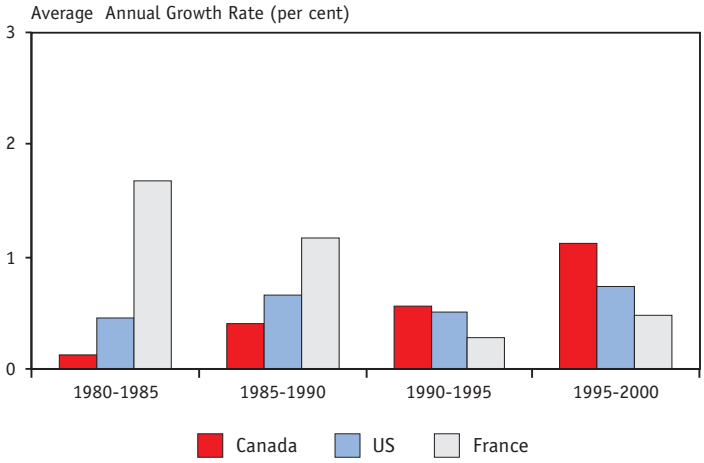
Taken as a whole, therefore, the evidence is very mixed in respect of Canada's innovation performance and potential. The good news is that there is plenty of room for improvement and policy has become strongly oriented in this direction. Perseverance will be required because the structural impediments, particularly to the increase of R&D intensity, are pervasive and of very long standing.

Economic Efficiency: There is strong evidence that the *efficiency* of the Canadian economy is growing at an increasing rate. Chart 12 compares the growth rate of multifactor productivity (MFP) of Canada, the United States and France (the latter as a proxy for G-7 Europe) averaged over five-year intervals from 1980 to 2000. Multifactor pro-

Chart 12

Canada's Efficiency is Accelerating

(Growth of business sector Multi-Factor Productivity*)



* Adjusted for improvement in "quality" of both human and physical capital to capture the "efficiency" residual (disembodied technical change).

Source: OECD (2003a:50).

Chart 13

Canada's Growth Score Card

Growth Drivers	Three-Star Rating
• Sound Macro Policies	***
• Human Capital	***
• Exposure to Trade	***
• Productive Investment	**
• Innovation	*?

ductivity growth measures the rate of increase in GDP that cannot be accounted for simply by growth in the inputs of labour (hours worked) and capital (volume of capital stock). The data in Chart 12 have been adjusted for "quality" improvements in both labour and capital. The growth of MFP thus reflects an increase in the pure efficiency with which the economy combines labour and capital to generate output. While there are significant measurement challenges in the estimation of MFP growth, it is reasonably certain that it has been accelerating in Canada from extremely anemic levels in the 1980s. The recovery of MFP growth is arguably the single most encouraging trend in recent Canadian economic performance.

Conclusion — The Growth Scorecard

The story sketched in this essay defies adequate summary. No proposition stands without qualification. This reflects in part huge gaps in our understanding of the growth process itself, and in part historical and cultural contingencies which cause measures that may be strongly growth-enhancing at one place and time to have possibly quite a different impact at another.

With that caveat, it may nevertheless be helpful to summarize the message — i.e. the writer's *opinion* — as to where Canada stands in respect of what are generally believed to be the principal drivers of long-run growth of output and productivity. With apologies to the Michelin restaurant guide, Chart 13 assigns a subjective "one, two, or three star rating" to Canada's recent performance and current position in respect of five major growth drivers. The judgmental ratings are relative to the performance of Canada's peer group of highly developed countries.

It is difficult to fault Canada's achievement and positioning in respect of the macroeconomic policy environment, human capital development, and trade exposure. But even three stars still leaves room for improvement. And staying on top may be the toughest challenge. For example, in the domain of human capital (here interpreted broadly to also encompass labour market performance) Canada's labour market policies have become more growth-friendly, but there has recently been regrettable back-sliding in respect of Employment Insurance rules, the reform of which had been hard won. Secondly, Canada's generally strong advocacy of freer trade is undercut to some extent by continued protection of supply-managed agricultural commodities. And finally, while fiscal policy is in good shape overall — particularly when compared with the apparent loss of discipline in the United States — pressures to increase spending, *ad hoc*, are building.[22]

Canada's performance in respect of business investment has been strong, but not outstanding relative to a number of OECD peers, hence a two-star rating. It remains to be seen whether the investment by Canadian firms in ICT during the past five to seven years, while less than that which occurred in the United States, may nevertheless have been more efficiently allocated. Concern has also been expressed regarding the marked decline of Canada's share of global foreign direct investment (FDI) between the mid-1980s and late 1990s, while the already dominant share attracted by the United States has risen.[23]

Finally, Canada's rating in respect of innovation is equivocal. Is it one star or perhaps a little better? The jury's still out. Indicators have been improving in absolute terms, but less so in relative terms. On the other hand, the efficiency of Canadian business overall, as measured by MFP growth, has picked up substantially. If sustained, and augmented with growing capital per worker, this augurs well for stronger labour productivity growth in future.

The bottom line message of this essay is that Canada's economy is on the right track for the longer run. The payoff from a decade of improved practices in both the public and private sectors is finally becoming visible, notwithstanding the recent cyclical weakness. The biggest risk is that an impression of success may breed complacency as policy-makers turn their attention to squeakier wheels. Complacency is not justified. Canada has only turned the corner, positioned finally to make up the ground lost since 1980 and, much more significantly, to achieve the sustained productivity growth that will be needed as the population ages. This will not be easily accomplished. It will demand policy innovation and sustained commitment. It must be understood that productivity growth is not an end in itself, but rather the economic means by which the welfare of the entire society can be expanded.

Notes

* Peter Nicholson was special advisor to the Secretary-General of the OECD and is currently a policy advisor to the Honourable Paul Martin. The author wishes to thank Peter Jarrett and Dirk Pilat at the OECD, Paul Henri Lapointe and colleagues at Finance Canada, and Andrew Sharpe at the Centre for the Study of Living Standards. All opinions expressed are solely those of the author, who also assumes responsibility for any remaining errors. Email: pnicholson @paulmartin.ca.

1 Little significance should be attached to small differences in country rankings in Chart 2. These change from year to year and are subject to many measurement issues at both the national and cross-national level that cloud strict comparability. The most recent OECD comparisons (OECD, 2003c) indicate that in 2002 Canada's GDP per capita was fourth highest in the OECD after Norway, United States and Ireland and was 16 per cent below that of the United States based on multilateral PPPs (or 15 per cent, if based on Statistics Canada's bilateral PPPs.) Some estimates have placed the gap currently at as little as 13.5 per cent (Finance Canada, private communication). It is hard to find any two sources that produce precisely the same numbers for even such standard statistics as GDP per capita, particularly in the context of international comparisons where different estimates of purchasing power parity are encountered. Of course, there is no doubt as to the existence of a significant gap between the United States and other OECD countries. But whether the gap between the United States and Canada is about 15 per cent or closer to 20 per cent depends on whom, and when, you ask.

2 In 1999, U.S. life expectancy was 76.7 years; the OECD 30-country average was 76.9, and Canada's average was 79 years.

3 Convergence is not inevitable. Indeed, many poor developing countries have slipped even farther behind during the past 25 years, while others like Korea, Thailand, Taiwan and now China, continue to close the gap with the West. Also, countries like Argentina that were positioned comparably to Canada in the pre-war period, somehow failed to stay on the growth escalator. The convergence hypothesis must therefore be qualified. Catch-up depends on developing institutions — and in particular governance systems — that are conducive to investment and development, as has been the case for the most part in the OECD group.

4 Assuming Canada's output per capita is currently about 85 per cent of the U.S. level, it would reach 100 per cent after six and a half years of 2.5 per cent average compound growth.

5 The employment rate is thought to be a superior metric to the unemployment rate since it includes the combined effect of the labour force participation rate and unemployment rate, neither of which is wholly independent of the other. The most recent data (2003) indicate essentially no difference between the employment-to-population ratios in Canada and the United States.

6 Significantly, labour productivity in several OECD countries *exceeds* that of the United States — e.g. Netherlands, Belgium, Norway and Italy (OECD 2003a). On the other hand, these countries, Norway excepted, have lower employment rates and far fewer hours worked per employee. For example, the average Dutch worker puts in about 25 per cent fewer hours annually than his American counterpart, reflecting a larger proportion of part-timers and a very large number of people on disability pensions. High productivity allows more scope for the work-leisure trade-off (while holding total output constant), though it must be acknowledged that the low labour input in Europe is not entirely voluntary and reflects some policy short-comings. Moreover, the high European productivity numbers are due in part to shedding the least productive workers and to high ratios of capital per worker.

7 The growth impact of even a very significant permanent reduction in the unemployment rate would be relatively modest. Suppose unemployment were permanently cut from 7 per cent to 4.5 per cent. This represents an increase in the employment ratio (relative to labour force) from .930 to .955 or 2.7 per cent. If reaching the new higher level took, say, five years, it would add about a half percentage point to GDP growth per year on average during that period, all else being equal. After year five, there would be no further impact on growth other than via changes in the size of the labour force; hours worked; or productivity. Of course the *level* of GDP at year five would be about 2.5 per cent higher than otherwise would have been the case and this higher level would represent the new permanent base on which the (steady-state) growth rate would then operate. The impact on the level of GDP would thus be large and persistent.

8 GDP per capita can be decomposed, by definition, into the product of: GDP per hour, hours per worker, workers per working age population, and working age population per total population. The rate of growth of GDP per capita (per cent change per year) is closely approximated by the sum of the growth rates of the factors in the product. Assuming that: (i) growth in annual hours worked per employed person, and (ii) growth of the ratio of employed to the working age population, are both small numbers, it follows that growth in GDP per capita is governed essentially by *growth* in labour productivity plus growth in the fraction of the total population that is of working age. As the latter "growth" rate turns *increasingly* negative — i.e. the demographic headwind picks up strength — then productivity growth must *increase* at a corresponding rate to keep the growth rate of GDP per capita from declining.

9 Jorgenson, Ho and Stiroh (2003) have projected U.S. labour productivity growth over 2001-11, estimating a range from 1.1 per cent per year (pessimistic) to 2.4 per cent (optimistic) with a base case of 1.8 per cent. A very rough implication is that Canada must at least sustain its recent trend rate of productivity growth to avoid a widening gap in output per capita.

10 There is a fundamental trade-off between current consumption and investment. The latter represents postponed consumption so as to generate a higher rate of growth and thus greater consumption possibilities in the future, to be enjoyed either in later life or by subsequent generations. The "choice" of a society's investment/consumption ratio is of course implicit, being the result of millions of daily choices by consumers and businesses. These choices can, in a blunt way, be influenced by policy — e.g. a tax on consumption, like the GST, creates some bias in favour of investment, all else being equal.

11 The countries included in the data base are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

12 Many other factors were tested in the regression analyses — e.g. the impact of different compositions of government spending among investment, consumption and transfer payments; the effect of financial institutions; the impact of "distortionary" taxes (ratio of direct to indirect tax receipts). Some of these were found to have statistically significant effect, but the detailed interpretation of the results is beyond the scope of this essay — refer to Chapter 2 of OECD (2003a).

13 This and other metrics used in the analysis are admittedly rough, reflecting limitations of available and comparable cross-country data over a lengthy time period. The quantitative results must therefore be regarded only as indicative though greater confidence might be attached to the indicated *relative* importance of the various drivers, rather than to the absolute magnitude of their impact.

14 There are deeper theoretical issues involved here. Some theories — so-called *endogenous* growth theories — assume there are significant spillover effects from investments in, for example, human capital or R&D, in the sense that these activities increase the rate at which innovation is generated and incorporated into the economy thus "permanently" affecting the growth *rate* of GDP and not just its one-time level. If this theoretical view is correct (empirical evidence so far is mixed), then some of the impacts in Table 3 would be significantly greater than reported.

15 Debt includes the funded portion of pension liabilities to government employees, but not the unfunded portion. The latter is, for example, included in the Public Accounts definition of gross debt in Canada which results in a higher ratio relative to GDP on that basis.

16 The level of investment in machinery and equipment in the overall economy in Canada (M&E investment as per cent of GDP) is actually among the lowest in the OECD and has declined from about 10 per cent in the 1970s to roughly 8 per cent in the 1990s. (Korea and Japan rank highest.) This reflects the growing services orientation of the Canadian economy. And while the United States also has a relatively low M&E investment ratio (just over 9 per cent in the 1990s), it exceeds Canada's ratio and by an amount that increased over the last decade (Finance Canada, private communication).

17 Note that larger countries like the United States and Japan are expected to exhibit less "trade intensity" relative to GDP than smaller countries simply because their large domestic markets are relatively more self-sufficient. Thus Chart 9, in a sense, overstates Canada's "scale-adjusted" trade orientation relative to the other three countries. Note

also that the dollar value of exports is considerably greater than the domestic value-added to those exports since the exported products will often include considerable import content. Nonetheless, the very large *increment* in Canada's trade exposure since 1985 is impressive.

18 Canadian 15-year olds ranked 2nd in reading literacy; 5th in science; and 6th in mathematics. Leaders in the latter two categories were Korea and Japan. Finland was 1st in reading and had the best results overall.

19 The results across Canadian schools were of course not uniform with some significant differences among and within provinces. By exposing such differences, the PISA program can be expected to inspire extra effort by the laggards, especially if the differences in results become widely known by parents.

20 One might question the federal government's goal of getting Canada, by 2010, into the top five in the world in terms of R&D as a percentage of GDP. While in principle a laudable objective, it is primarily determined by private sector behaviour. In this regard, market signals are a more reliable guide than government exhortation. On the other hand, public sector support for more basic research and R&D related to government mandates should be increased since there is strong evidence that the returns for society as a whole from R&D of this type are very large.

21 OECD (2001a:77 and 82). Canada is ranked next to best in the OECD, just behind the UK, on an index of barriers to entrepreneurship, combining measures of barriers to competition, regulatory opacity and administrative burdens on start-ups. According to this analysis, Canada still has room for improvement in respect of administrative burden.

22 A roster of recommendations for policy improvements in a number of domains is included in the OECD's various Economic Surveys of Canada.

23 The OECD cites Canada for relatively tight restrictions on FDI and although these restrictions have declined substantially over the past 20 years, the liberalization in other countries has been even greater, at least on paper. (See OECD, 2003b:169-173, where several caveats are noted with respect to cross-country comparison of FDI restrictions.)

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Canada's Recent Productivity Record and Capital Accumulation

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Canada's relatively good economic performance and the stellar record on the trade front in the second half of the 1990s seriously mask its underlying competitiveness problem.[1] Canada's labour productivity growth lagged behind that of the United States in the last 15 years and this situation is generally pervasive across industries and provinces (Rao, 2002). In a world of increased globalization of production and innovation activity, and fierce international competition for productive resources, physical capital, skilled workers and intellectual capital (innovation activities) have become highly mobile across countries and among regions and industries within a given country. Hence, Canada's ability to attract and retain internationally mobile resources, and create a virtuous cycle of strong economic growth and improvements in quality of life for its citizens will critically depend on its success in making progress in closing the productivity and living standards gaps vis-à-vis the United States, its largest trading partner and one of the most prosperous and dynamic economies in the world.

The causes of the widening productivity and living standards gaps between the two countries have been studied extensively. In a number of recent studies, we examined the role of differences in innovation, human capital and the production and use of Information and Communication Technologies (ICTs) in the widening of the Canada-U.S. labour productivity gap.[2] The objective of this article is to analyse in some detail the contribution of capital accumulation to labour productivity growth in Canada and the widening of the Canada-U.S. labour productivity gap in the 1990s, especially in the latter half of the decade.[3] The following are some of the key research questions we hope to address:

- Did the pace of increase in capital intensity (the capital-labour ratio) slow in Canada in the 1990s? Was the slowdown pervasive across industries or concentrated in a few large industries?
- How much of the inter-industry variation in labour productivity levels across Canadian industries can be explained by the variation in capital intensity levels?
- Is the impact of machinery and equipment (M&E) capital on productivity significantly larger than the impact of structures capital?
- How much of the Canada-U.S. labour productivity gap can be accounted for by the capital intensity gap between the two countries?
- What role has capital intensity played in the widening of the Canada-U.S. productivity gap?

- What role did the differences in trends in the relative rental price of capital to labour cost in the two countries play in the widening of the capital intensity gap?
- What were some of the key drivers of different trends in the relative rental price of capital to labour in the two countries?

Our empirical results indicate that the slowdown in capital intensity growth in the 1990s was pervasive across all Canadian industries. Inter-industry variation in capital intensity explains a large part of the productivity level differences across Canadian industries. In addition, the slowdown in capital intensity growth was a major drag on labour productivity growth in the second half of the 1990s. Our regression results suggest that M&E capital exerts a much bigger impact on productivity than structures capital. Furthermore, the widening of the capital intensity gap also contributed significantly to the widening of the Canada-U.S. labour productivity gap. After controlling for industry specific effects, the differences in trends in the relative rental price of capital (the ratio of the rental price of capital to the wage rate) in Canada and the United States played a significant role in the widening of the capital intensity gap between the two countries. The depreciation of the Canadian dollar and the unemployment rate gap seem to have mainly contributed to the faster increase in the relative rental price of capital in Canada in the 1990s, hence to the widening of the capital intensity and the labour productivity level gaps between the two countries.

The article is organized in the following way. In the next section we examine recent trends in labour productivity in Canadian and U.S. industries. In the third section we discuss changes in the two types of capital intensities: M&E and structures. In this section, we also examine the role of the two types of capital intensities in inter-industry differences in Canadian labour productivity levels and the Canada-U.S. labour productivity gap. Using the growth accounting framework, we also assess the role of capital intensity in Canada's labour productivity growth as well as in Canada-U.S. labour productivity growth differentials in the 1990s. In the fourth section we examine the sources of the widening of the capital intensity gap between the two countries. In this section, we also discuss possible reasons for the faster growth in the relative rental price of capital in Canada. In the last section we summarize the key findings of our paper and explore their research and policy implications.

Canada's Productivity Record: An Industry Analysis

Based on data from the July 2003 issue of the *OECD Economic Outlook*, in the second half of the 1990s (1995-2000) real GDP per worker for the total economy increased at an annual rate of 1.7 per cent, compared to 1.0 per cent per year during the 1987-1995 period.[4] But, despite the large acceleration, Canada's productivity growth lagged behind the United States and a number of OECD countries in the second half of the last decade. Indeed, labour productivity growth in the United States averaged 2.4 per cent per year resulting in a significant widening of the Canada-U.S. labour productivity gap.

Nevertheless, productivity growth in Canada varied greatly across industries. For instance, during the 1987-2000 period, labour productivity (real GDP per worker) increased at a healthy pace (above 2.5 per cent per year) in a number of Canadian industries: primary industries, rubber and plastic products, furniture and fixtures, primary metals, fabricated metals, machinery and electrical and electronic equipment, refined petroleum and wholesale trade (Table 1). On the other hand, in many other industries, labour productivity either declined or remained stagnant. These industries included construction, leather, textiles, lumber and wood, printing and publishing, other manufacturing and retail trade.

Table 1
Labour Productivity Growth by Industry
(Average annual rate of change)

Industry	Canada			United States		
	1987-1995	1995-2000	1987-2000	1987-1995	1995-2000	1987-2000
Primary industries	3.1	3.8	3.4	0.9	2.4	1.5
Construction	-1.4	2.0	-0.1	0.2	-0.3	0.0
Manufacturing sector	3.2	1.5	2.5	2.9	4.5	3.5
Food & kindred products	1.8	0.9	1.4	1.6	-5.2	-1.0
Rubber & plastic	3.1	2.4	2.9	4.2	4.2	4.2
Leather	1.9	-1.1	0.7	4.2	-0.6	2.3
Textiles	-0.3	2.5	0.8	2.9	3.4	3.1
Lumber & wood	-2.1	1.3	-0.8	-3.2	-1.1	-2.4
Furniture and fixture	2.9	4.1	3.4	0.8	1.1	0.9
Paper & allied	0.9	2.6	1.5	0.0	1.1	0.4
Printing and publishing	-1.8	-1.0	-1.5	-2.6	0.0	-1.6
Primary metals	2.8	3.8	3.2	2.6	2.2	2.5
Fabricated metal	2.6	3.0	2.8	1.6	0.8	1.3
Machinery, electrical and electronics	6.7	2.1	4.9	9.4	16.1	12.0
Transportation equipment	5.4	-0.6	3.0	0.8	1.9	1.2
Non-metallic	-1.8	6.0	1.1	3.0	0.9	2.2
Refined petroleum & coal	6.9	2.0	5.0	0.6	4.4	2.0
Chemicals & allied	3.4	-2.7	1.0	2.3	1.6	2.0
Other manufacturing	-1.3	1.4	-0.2	0.3	1.0	0.6
Transportation & warehousing	1.9	0.2	1.3	1.8	1.4	1.7
Communications & utilities	1.5	5.7	3.1	3.9	1.5	3.0
Wholesale trade	3.4	2.6	3.1	2.9	7.1	4.5
Retail trade	-0.1	1.8	0.6	1.2	4.8	2.6
Business sector	1.0	2.1	1.4	1.4	2.6	1.8
Total economy	1.0	2.0	1.4	1.1	2.0	1.5

Note: Labour productivity is defined as real GDP per worker.

Sources: Statistics Canada (Cansim Table 379-0017 for real GDP and Table 282-0008 for employment) and U.S. Bureau of Economic Analysis.

Like Canada, productivity growth also varied considerably across industries in the United States during the 1987-2000 period. Canada's labour productivity growth lagged behind that of the United States in machinery and electrical and electronic equipment, communication and utilities, wholesale trade, and retail trade (Table 1). On the other hand, Canada performed better than the United States in primary industries, food and kindred products, furniture and fixtures, primary metals, fabricated metals, transportation equipment, and refined petroleum products.

The large widening of the Canada-U.S. manufacturing labour productivity gap in the second half of the 1990s was largely due to Canada's relatively lower productivity growth in the machinery and electrical and electronic equipment industry. In this industry, labour productivity increased by 16.1 per cent per year in the United States, compared to a mere 2.1 per cent in Canada (Table 1). However, Canada's performance in other manufacturing industries, on average, was better than that in the United States.

There is also a great deal of variation in labour productivity levels across Canadian industries. For instance, real GDP per worker varies from a low of $27 thousand ($1997) in retail trade to a high of over $120 thousand in the chemicals and allied products industry in 1998.[5] The top five industries in terms of labour productivity levels are: chemicals and allied products, communications and utilities, wholesale

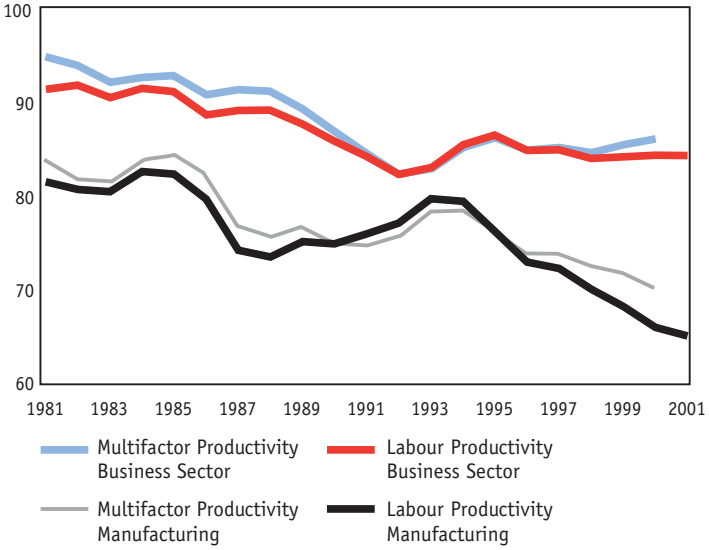
trade, primary metals and refined petroleum. The bottom five industries are retail trade, other manufacturing, leather, textiles, and furniture and fixtures. In general, labour-intensive industries have low productivity levels. On the other hand, resource-based and high-tech industries display high productivity levels.

Canada's labour productivity in the business sector was about 16 per cent below the U.S. level in 2001, compared to 14 per cent in 1990 (Chart 1).[6] A similar picture emerges from the multifactor productivity level gap in the business sector. More importantly, in the manufacturing sector, the battle ground of fierce international competition, the Canada-U.S. labour productivity gap increased from about 25 per cent in 1990 to around 35 per cent in 2001. Canada's productivity challenge is not confined to a few large industries. Instead, the problem is generally pervasive across Canadian industries (Chart 2). But, Canada performs well or exceeds the U.S. productivity levels in mining, construction, paper and allied products, primary metals, lumber and wood, furniture and fixtures and transportation equipment. On the other hand, in electrical and electronic equipment and machinery industries, Canadian productivity levels are only about 30 per cent of the U.S. levels.[7]

Capital Accumulation and Labour Productivity

Capital accumulation is a key driver of living standards, because it contributes directly towards an increase in labour productivity by providing more capital per unit of labour input. Capital formation, especially M&E capital, also raises the productivity of all other inputs, in other words increases total factor productivity (TFP), by facilitating an effective utilization of new and state of the art technologies.[8] Hence, capital accumulation contributes both directly and indirectly towards raising labour productivity.

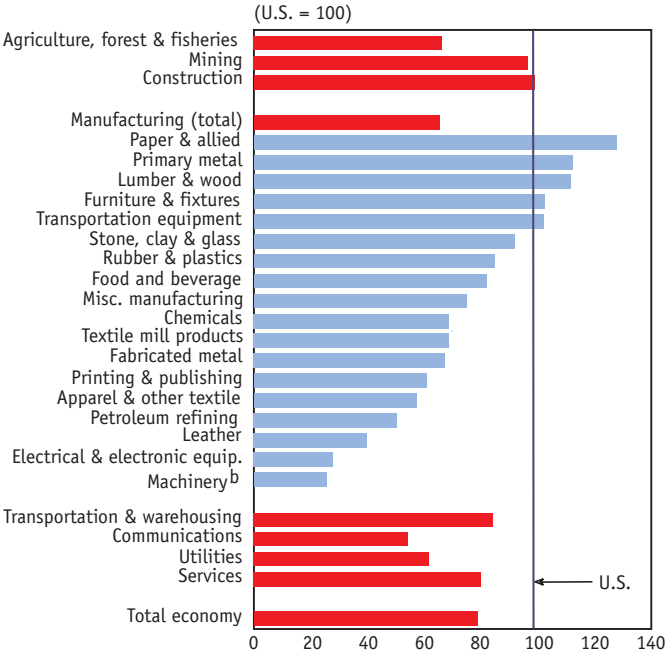
Chart 1
Relative Productivity Levels in Canada
(U.S.=100)



Notes: Labour productivity is defined as real GDP per worker, PPP based. Multifactor productivity is the residual of labour productivity minus the contribution from capital stock intensity.

Sources: Statistics Canada, U.S. Bureau of Labor Statistics, and U.S. Bureau of Economic Analysis.

Chart 2
Relative Labour Productivity Levels[a] of Canadian Industries, 2000

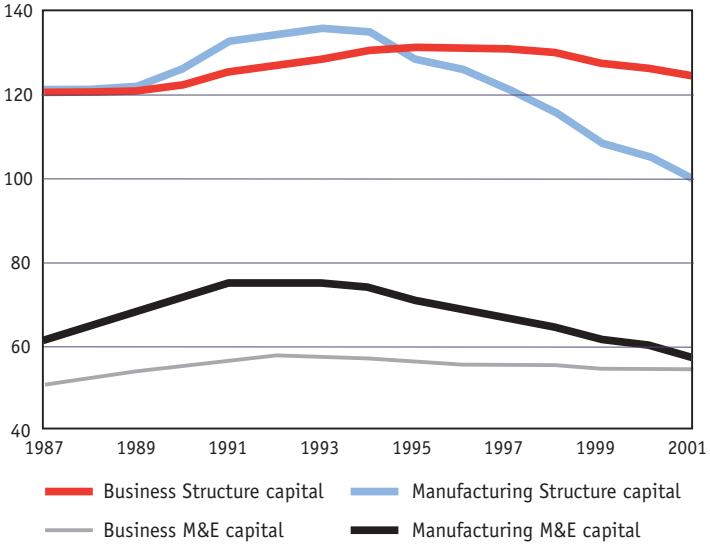


Notes: a GDP per worker in 1990 dollars.

b Machinery includes computer and office equipment industry.

Source: Industry Canada computations based on data from Statistics Canada, U.S. Bureau of Economic Analysis, and OECD STAN (98).

Chart 3
Relative Canadian Capital Intensity in the Business and the Manufacturing Sectors, 1987-2001
(U.S.=100)



Notes: Capital intensity is defined as capital stock per worker. Canadian capital stock in 1997 dollars are converted into U.S. dollars using the investment PPP from Statistics Canada (2002) (0.69 for M&E and 0.94 for structures).

Sources: Statistics Canada and U.S. Bureau of Labor Statistics.

In this section, we first examine the recent trends in capital intensity, measured as capital stock per worker, in Canadian and U.S. industries, disaggregated by two types of capital: M&E and structures. Next, we analyse the impact of the two capital intensities on labour productivity. Finally, we discuss the role of capital accumulation in inter-industry variation in labour productivity levels in Canada and the Canada-U.S. labour productivity gap.

Recent Trends in Capital Intensity

The capital stock consists of machinery and equipment and structures. Capital intensity is defined as capital stock per worker.[9] Aggregate capital intensity in the Canadian business sector increased at a slower pace in the latter half of the 1990s, compared to the 1987-95 period (Appendix Table 1). This slowdown was mainly due to an absolute decline in structures capital intensity in the manufacturing sector. In addition, the M&E capital intensity in this crucial sector more or less remained constant between 1995 and 2000. The following manufacturing industries registered an absolute decline in total capital intensity during this period: lumber and wood, fabricated metals, machinery and electrical and electronics equipment, transportation equipment, petroleum and coal products and chemicals. On the other hand, total capital intensity increased at a healthy pace in primary industries, primary metals, communications and utilities and wholesale trade. These industries also registered a significant increase in M&E intensity.

As expected, there is a considerable variation in capital intensity across Canadian industries. The top five capital intensity industries in 2000 were: communications and utilities, petroleum and coal products, paper and allied products, primary metals and chemicals. They were also the top five in terms of M&E intensity. On the other hand, furniture and fixtures, textiles, retail trade, construction and printing and publishing were at the bottom end of the spectrum. It is very surprising that the machinery and electrical and electronics industry has one of the lowest intensities for both M&E and structures.

The M&E capital intensity in the business sector in 2000, on average, was only 55 per cent of the U.S. level, and the gap widened between 1995 and 2000 (Chart 3).[10] In the manufacturing sector, the M&E intensity gap increased from about 30 per cent in 1995 to 40 per cent in 2000. Furthermore, the Canadian advantage in structures intensity in this sector declined from 29 per cent in 1995 to just 5 per cent in 2000. In all two-digit manufacturing industries, with the exception of lumber and wood and paper and allied products, M&E capital intensity is considerably below the U.S. level (Appendix Table 2). More importantly, in the machinery and electrical and electronics equipment industry, it is only 30 per cent of the U.S. intensity. Similarly, there is also

a large M&E intensity gap in primary industries and service industries. However, Canada's structures intensity exceeds by a large margin the U.S. levels in many industries: primary industries, construction, leather, lumber and wood, paper and allied products, primary metals, petroleum products, chemicals, transportation and warehousing and communications and utilities.

Contribution of Capital Intensity to Productivity Growth

Since M&E capital is the carrier of new and state of the art technologies, its impact on labour productivity is expected to be significantly larger than structures capital. In an effort to obtain an empirical estimate of the relative importance of the two types of capital intensities, using pooled industry and time-series data, we estimated an equation for labour productivity for Canada as well as the United States:[11]

$$(1) \quad \Delta \ln LP_t = \alpha + \beta_1 \Delta \ln k_{ME,t} + \beta_2 \Delta \ln k_{ST,t} + \varepsilon_t ,$$

where $\Delta \ln LP_t$ is the change in log of real value added per worker in year *t* from *t-1*; and $\Delta \ln k_{ME,t}$ and $\Delta \ln k_{ST,t}$ are the change in log of M&E capital intensity and log of structures capital intensity. Capital intensity is defined as capital stock per worker.

As expected, the coefficient on the M&E capital intensity is positive and statistically significant in both countries.[12] On the other hand, the coefficient on the structures intensity, while positive, is either statistically insignificant or weakly significant. More importantly, in all equations, the estimated elasticity of labour productivity with respect to the M&E capital intensity is close to or more than three times that of the structures elasticity. For instance, in the manufacturing sector, the M&E elasticity is 0.54, compared to the structures elasticity of 0.19. These results imply that without taking into consideration the differences in elasticities of the two capital intensities and changes in the composition of the capital stock, we will obtain an inaccurate estimate for the contribution of capital accumulation to labour productivity.

How much of the variation in labour productivity levels across Canadian industries can be explained by inter-industry differences in capital intensities? Our regression results imply that the differences in capital intensity, especially M&E intensity, explain very well the large inter-industry differences in labour productivity levels in Canada. For instance, the top five industries in terms of M&E intensity are also the top industries in labour productivity levels — communications and utilities, paper and allied products, primary metals, petroleum and coal products and chemicals. Similarly, the bottom five industries in M&E capital intensity, with the exception of wholesale trade, also have the lowest levels of labour productivity — retail trade, furniture and fixtures, leather and textiles. The simple correlation between M&E capital intensity and labour productivity levels across Canadian industries in 2000 is 0.65, while with structures it is only 0.47.

Can differences in M&E intensity between Canadian and U.S. industries also explain the large inter-industry variation in the Canada-U.S. labour productivity gaps? The answer is again yes. For example, in construction, lumber and wood, and paper and allied products, the M&E intensity in Canada is either equal to or higher than in the United States (Appendix Table 2). In these industries, Canada's productivity levels are either comparable to or higher than in the United States (Chart 2). Similarly, in industries where the M&E intensity gap is large, the Canada-U.S. labour productivity level gap is also large: machinery and electrical and electronic equipment, petroleum and coal products, textiles and fabricated metals. Moreover, in the manufacturing sector, the M&E intensity gap is about 40 per cent, while the labour productivity gap is about 35 per cent. There is a strong

Table 2
Sources of Labour Productivity Growth in Canada and the United States

	Canada		U.S.		U.S. minus Canada	
	1987-95	1995-00	1987-95	1995-00	1987-95	1995-00
Business Sector						
Growth: (per cent per year)						
Labour Productivity	1.0	2.1	1.4	2.6	0.4	0.5
Contribution: (percentage points per year)						
Multifactor Productivity	0.4	1.9	1.1	2.0	0.8	0.1
Total Capital Intensity	0.6	0.2	0.2	0.6	-0.4	0.4
Manufacturing Sector						
Growth: (per cent per year)						
Labour Productivity	3.2	1.5	2.9	4.5	-0.3	3.0
Contribution: (percentage points per year)						
Multifactor Productivity	2.1	1.7	2.3	3.5	0.2	1.8
Total Capital Intensity	1.1	-0.2	0.5	0.9	-0.5	1.1

Note: Labour productivity is defined as real GDP per worker

Sources: Statistics Canada, U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis

positive correlation (0.66) between the M&E intensity gap and the Canada-U.S. labour productivity gap across industries in 2000. More importantly, the widening of the M&E intensity gap seems to have played an important role in the widening of the manufacturing labour productivity gap between 1995 and 2000.

Sources of the Canada-U.S. Labour Productivity Gap: Growth Accounting[13]

In this section, we examine the Canada-U.S. labour productivity growth differentials as well as level gaps. We first deal with the growth differentials.

Canada-U.S. labour productivity growth differentials

Using the growth accounting framework, we estimate the contribution of capital intensity growth to labour productivity growth in the business sector as well as the manufacturing sector. Following Jorgenson, Gollop and Fraumeni (1987), we express labour productivity growth in each country as a function of growth in TFP and capital intensity:[14]

(2) $$\Delta \ln LP_t = \Delta \ln MFP_t + \bar{v}_{K,t} \Delta \ln k_t ,$$

where $\Delta \ln LP_t$ is the change in log of real value added per worker in year *t* from *t-1*; $\Delta \ln MFP_t$ is the change in log of the level of multifactor productivity (MFP) in year *t* from *t-1*;[15] $\Delta \ln k_t$ is the change in log of capital intensity, defined as capital stock per worker, in year *t* from *t-1*; and $\bar{v}_{K,t}$ is the two-year average income share of capital in year *t* and *t-1*.

Using equation (2), we analyse the contribution of capital accumulation to labour productivity growth. In the business sector, labour productivity (real GDP per worker) in Canada increased from 1.0 per cent per year during the period 1987-95 to 2.1 per cent per year during the second half of the 1990s. U.S. labour productivity growth exceeded Canadian growth in both periods by 0.4-0.5 percentage points per year. All of the increase in labour productivity growth in Canada was due to the acceleration in MFP growth (Table 2). As a matter of fact, the contribution of capital intensity to labour productivity growth declined in Canada by 0.4 percentage points per year between the two

periods. On the other hand, in the United States, the capital contribution increased by 0.4 percentage points per year during this period. Hence, the widening of the labour productivity growth differential in the business sector during the latter half of the 1990s was largely (80 per cent) due to the widening of the capital intensity gap.

Developments were different in the manufacturing sector. Labour productivity in the U.S. manufacturing sector increased by 4.5 per cent per year during the second half of the 1990s from 2.9 per cent in the period 1987-1995, compared to a deceleration in Canada from 3.2 to 1.5 per cent per year. The widening of the capital intensity gap explains about 37 per cent of the labour productivity growth differential in the latter half of the 1990s (Table 2).

Canada-U.S. labour productivity level gap

Using the growth accounting framework, we can also estimate the contribution of the capital intensity gap to the Canada-U.S. labour productivity gap in the business sector as well as the manufacturing sector. As in Lee and Tang (2001), the theoretical framework for productivity gap and source comparisons between Canada and the United States is based on a translog production function:

$$(3) \quad \Delta \ln LP_{CA/US} = \Delta \ln MFP_{CA/US} + \bar{v}_{K,CA/US} \Delta \ln k_{CA/US},$$

where $\Delta \ln LP_{CA/US}$ is the log of real value added per worker in Canada (PPP-based) relative to the United States; $\Delta \ln MFP_{CA/US}$ is the log of the level of multifactor productivity in Canada relative to the United States; $\Delta \ln k_{CA/US}$ is the log of capital intensity in Canada (PPP-based) relative to the United States; and $\bar{v}_{K,CA/US}$ is the two-country average income share of capital.

Using equation (3), we estimate the contribution of the capital intensity gap to the Canada-U.S. labour productivity gap in the business sector as well as the manufacturing sector. These results are reported in Table 3.

In the business sector, the labour productivity gap is estimated to be about 16 per cent in 2000. The capital intensity gap accounted for 12 per cent of this gap (Table 3). In the manufacturing sector, the labour productivity gap was 34 per cent in 2000. The growth accounting framework suggests that about 16 per cent of this gap was due to the capital intensity gap. However, as pointed out earlier, these are lower bound estimates because M&E capital affects labour productivity more than structures capital.

In summary, capital intensity played a major role in the widening of the labour productivity gap in the latter half of the 1990s in both the business and the manufacturing sectors. In addition, the capital intensity gap accounted for between 12 to 16 per cent of the Canada-U.S. labour productivity gap in 2000. But, the actual contribution of capital intensity could be significantly higher because the M&E intensity gap is considerably bigger than the total capital intensity gap and its impact on labour productivity is also considerably larger than structures capital.[16]

Causes of the Canada-U.S. Capital Intensity Gap

Why is Canada significantly less capital intensive than the United States, especially in M&E capital? Why did the capital intensity gap increase in the second half of the 1990s? What explains the large inter-industry differences in the capital intensity gap? Did depreciation of the Canadian dollar play a role in the widening of the capital intensity gap in the 1990s by raising the relative cost of capital in Canada relative to the United States? These are some of the important questions we address in this section.

Firms minimize their costs of production of goods and services or maximize their profits sub-

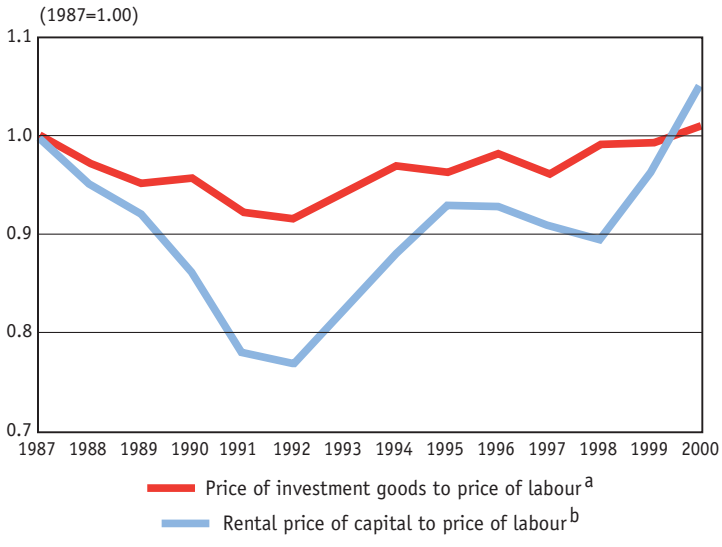
Table 3
Sources of the Canada-U.S. Labour Productivity Gap in 2000

Business Sector	
Relative labour productivity in Canada (U.S.=100)	84.4
Relative MFP in Canada (U.S.=100)	86.2
Relative total capital intensity (U.S. =100)	94.5
Canada-U.S. labour productivity gap	15.6
Contribution (%):	
Multifactor Productivity	87.9
Total Capital Intensity	12.1
Manufacturing Sector	
Relative labour productivity in Canada (U.S.=100)	65.8
Relative MFP in Canada (U.S.=100)	70.3
Relative total capital intensity (U.S. =100)	84.5
Canada-U.S. labour productivity gap	34.2
Contribution (%):	
Multifactor Productivity	84.0
Total Capital Intensity	16.0

Note: Labour productivity is defined as real GDP per worker. The percentage contribution is calculated based on equation (3).

Sources: Statistics Canada, U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis.

Chart 4
Trends in Factor Prices in the Business Sector in Canada Relative to the United States
(US=100)



Notes: a Ratio of investment goods price to the price of labour.
b Ratio of the rental price of capital to the price of labour.

Sources: Statistics Canada and U.S. Bureau of Labor Statistics.

ject to their production function constraints. Under these assumptions, each firm will choose the mix of capital and labour based on relative input prices. Hence, the optimal level of capital intensity, defined as capital stock per unit of labour, is a function of the ratio of the rental price of capital to the wage rate:

$$k = f\left(\frac{r}{w}\right), \quad (4)$$

where k is capital intensity, r is the rental price or user cost of capital services, and w is the wage rate of labour. According to this model, capital intensity will be negatively correlated with the ratio of the rental price of capital to the wage rate. For simplicity, in this paper we refer to the price ratio as the relative rental price of capital.

According to equation (4), the inter-industry differences in capital intensity in Canada depend on the differences in the relative rental price of capital. In addition, the capital intensity gap between Canada and the United States will be determined by the gap in the relative rental price of capital between the two countries. Furthermore, trends in the capital intensity gap between Canada and the United States will be influenced by trends in the relative rental price of capital in the two countries.

As shown in Chart 4, the aggregate relative rental price of capital in Canada rose significantly faster than in the United States during the 1990s, a dramatic reversal of the steady decline between 1987 and 1991, suggesting that it might be an important factor in the widening of the capital intensity gap between the two countries. To examine empirically its role in the capital intensity gap, and hence the labour productivity gap, we regress capital intensity in Canada relative to the United States on the relative rental price of capital in Canada relative to that in the United States. The regression model is:

$$k_{i,t}^{R} = \beta\left(\frac{r}{w}\right)_{i,t}^{R} + \sum_{i=1}^{21} a_i I_{i,t} + \varepsilon_i, \quad (5)$$

where $k_{i,t}^{R}$ denotes the capital intensity in Canada relative to the United States in industry

i in year t; $\left(\frac{r}{w}\right)^{R}_{i,t}$ is the relative rental price of capital in Canada relative to the United States in industry i in year t; and $I_{i,t}$ is the industry dummy for industry i in year t.

We ran two separate regressions based on this model, using pooled industry and time series data between 1987 and 1998.[17] In the first regression, capital intensity is regressed on the relative rental price of capital in Canada relative to the United States. However, we do not have data on industry-specific relative rental prices of capital. Therefore, we used the aggregate data for the business sector. Consequently, the relative rental price of capital does not vary across industries in any given year, but varies over time.

In the second regression, to overcome this data problem, we used industry specific relative prices of investment goods (prices of investment goods relative to the wage rate) in Canada relative to the United States. They vary across industries and over time.

Like the aggregate relative rental price of capital, the aggregate relative price of investment goods also increased steadily in Canada relative to the United States in the 1990s (Chart 4). Nevertheless, the rate of decline prior to 1992 and the pace of increase thereafter was significantly lower than that of the relative rental price of capital. This is because trends in the latter, in addition to being affected by the price of investment goods, are also influenced by trends in real interest rates, corporate tax rates and tax credits in the two countries. For instance, the gap between the Canadian and U.S. real interest rates narrowed dramatically between 1987 and 1992. This trend seems to explain a large part of the divergence between the trends in the relative rental price of capital and the relative price of investment goods during this period.

After controlling for industry-specific effects, the coefficients on the relative rental price of capital and the relative price of investment goods gaps are negative and statistically significant in the two regression equation.[18] In addition, the long-run impact is more than three times that of the short-run impact.[19] These results imply that differences in the relative rental price of capital and the relative price of investment goods in Canadian industries relative to their American counterparts contributed significantly to the capital intensity gap between Canada and the United States. The widening of the relative rental price of capital and relative price of investment goods gaps also played an important role in the widening of the capital intensity gap between Canada and the United States.

Reasons for the Widening of the Relative Rental Price of Capital Gap between Canada and the United States

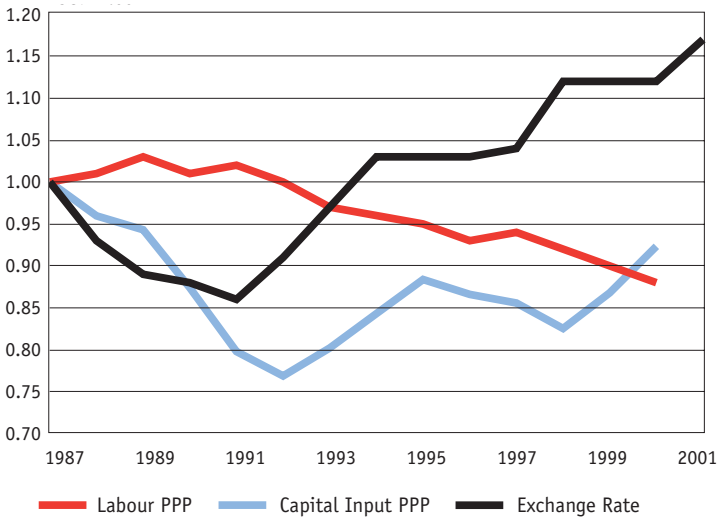
The next question is what were the factors behind the widening of the relative rental price of capital gap. A change in the relative rental price of capital in Canada relative to the United States could be due to either a change in the capital cost in Canada relative to the United States or a change in the Canadian wage rate relative to the United States or a combination of the two. We examine these alternative sources, based on purchasing power parity (PPP) prices for the two inputs. The PPP price for the capital input is defined as the ratio of the Canadian dollars required by Canadian firms to purchase the standard service of capital input in Canada to the U.S. dollars required by U.S. firms to use the same standard capital service in the United States. Similarly, the PPP price for labour is the ratio of Canadian dollars paid by Canadian firms for a standard hour worked in Canada to U.S. dollars paid by U.S. firms for the same standard hour worked in the United States (Lee and Tang, 2001).

The PPPs for capital and labour inputs followed very different trends in the 1990s. The PPP for the labour input trended downwards

Chart 5

Exchange Rate and Purchasing Power Parities for Capital and Labour Inputs

(1987=1.00)



Note: Labour input PPP is simply defined as the ratio of average hourly wage rate in Canada in Canadian dollars to that in the United States in U.S. dollars. Similarly, capital input PPP is defined here as the ratio of capital income per unit of capital stock in Canada to that in the United States.

Sources: Statistics Canada and U.S. Bureau of Labor Statistics.

gradually (Chart 5), implying that labour cost in Canada grew at a slower pace than that in the United States during this period. On the other hand, the PPP for the capital input declined sharply over the 1987-92 period but increased steadily from 1992.[20] It followed closely the movements in the value of the Canadian dollar relative to the U.S. dollar. These different trends for labour and capital input prices in the two countries were mainly responsible for the widening of the relative rental price of capital gap and hence the widening of the capital intensity gap between Canada and the United States.

Trends in capital and labour PPPs can be due to many factors such as trends in real interest rates, the price of investment goods, corporate tax rates and tax credits, the exchange rate and labour market conditions in the two countries.[21] Here, we examine two important factors: trends in the Canada-U.S. exchange rate and the unemployment rate gap between Canada and the United States. We think that these two factors were largely responsible for the widening of the gaps in the relative rental price of capital and relative price of investment goods in Canada relative to the United States in the second half of the 1990s.

A large portion of capital, especially machinery and equipment, is imported from the United States. Therefore, the prices of investment goods are heavily influenced by the movements in the market value of the Canadian dollar relative to the American currency. In other words, the large increase in the PPP for the capital input since 1992 was largely due to the depreciation of the Canadian dollar vis-à-vis the U.S. dollar.[22] On the other hand, a large part of wages and salaries in Canada is paid in Canadian dollars. Consequently, the labour PPP is largely immune from movements in the market value of the Canadian dollar. In addition, the labour market in the United States in the 1990s was much tighter than in Canada, as evidenced by the large unemployment rate gap between the two countries. The tighter labour market in the United States contributed to the faster growth in the U.S. wage rate, hence a declining PPP for the labour input. The stronger economic growth and the tighter labour market in the United States were largely due to greater dynamism of ICT producing industries in the United States and a bigger share of these industries in the U.S. economy, and more efficient use of ICTs in U.S. service industries.

Conclusions

The main objective of this paper has been to analyse the role of capital accumulation in the Canada-U.S. labour productivity gap in the 1990s. The following are some of the key findings:

- M&E capital intensity is more important for labour productivity than structures capital intensity;

- The inter-industry variation in labour productivity levels in Canada is highly positively correlated with the inter-industry differences in M&E capital intensity;
- Similarly, the inter-industry variation in the Canada-U.S. labour productivity gap and the differences in the M&E capital intensity gap are also highly positively correlated:
- The capital intensity gap accounted for at least 12 per cent of the Canada-U.S. business sector labour productivity gap in 2000;
- More importantly, the widening of the labour productivity gap in the latter half of the 1990s was largely due to the widening of the capital intensity gap between the two countries;
- After controlling for industry-specific effects, the capital-to-labour cost in Canada relative to the United States has a significantly positive impact on the Canada-U.S. capital intensity gap;
- The depreciation of the Canadian dollar vis-à-vis the U.S. dollar and the unemployment rate gap between the two countries seem to have contributed significantly to the faster rate of increase in the relative price of capital in Canada in the 1990s, hence to the widening of the capital intensity gap between the two countries.

These findings point to an optimistic outlook for the Canada-U.S. labour productivity and real income gaps. The market value of the Canadian dollar vis-à-vis the American currency, despite the recent appreciation, is still somewhat below the purchasing power parity level, estimated to be around $0.85 U.S. by both Statistics Canada and the OECD. Therefore, there is potential for a further appreciation of the Canadian dollar over the medium term. The recent appreciation of the Canadian dollar in combination with a potential for further appreciation, and the possibility of closing some of the unemployment rate gap between the two countries would lower the relative price of investment in Canada compared to the U.S., a reversal of the trend in the last decade. These positive developments, other things being equal, would narrow the capital intensity and the labour productivity gaps over the next five years or so. Nevertheless, capital is highly footloose across countries, especially in North America. Hence, to attract and retain investments in machinery and equipment and structures, Canada needs to maintain highly competitive and flexible corporate tax and investment incentive systems vis-à-vis the United States.

Future research should analyse in some detail the reasons behind the considerable M&E capital intensity gap between Canada and the United States in many industries, especially in high-tech industries. We also need to do more in-depth research about the causes of the higher relative price of investment goods in Canada.

Notes

* We thank Andrew Sharpe of the CSLS for many valuable comments and suggestions. An earlier draft of the paper was presented at the annual meeting of the Canadian Economics Association at Carleton University in Ottawa in May 2003. The views expressed here are our own and do not necessarily reflect those of Industry Canada or the Government of Canada. The unabridged version of this article is posted at www.csls.ca under *International Productivity Monitor*. Email: someshwar.rao@ic.gc.ca.

1 The competitiveness of a country can be formally defined as the degree to which a country can, under free and fair market conditions, produce goods and services that meet the test of international markets while simultaneously maintaining and expanding the real incomes of its citizens (President's Commission on Industrial Competitiveness, 1985).

2 See Rao et al. (2001) for innovation, Rao, Tang and Wang (2002) for human capital, and Rao and Tang (2001) for the production and use of ICTs.

3 Lower investment intensity in Canada has been identified as one of the key factors responsible for the Canada-U.S. labour productivity gap by many studies, e.g. Lee and Tang (2001), Bernstein, Harris and Sharpe (2002), Nadeau and Rao (2002), Rao, Tang and Wang (2002), and Sharpe (2003).

4 The *OECD Economic Outlook* does not provide data on hours worked for productivity analysis and U.S. statistical agencies do not publish hours worked for detailed industries. To be consistent, the number of employed persons is used to define labour productivity (i.e. GDP per worker) and capital intensity (i.e. capital stock per worker) throughout the paper.

5 Labour productivity levels are defined as real GDP per worker at market prices in 1997 dollars (real GDP at basic prices is adjusted to real GDP at market prices).

6 Note that Canada's productivity decline relative to the United States started in the early 1980s.

7 It should be noted that differences in commodity composition between the two countries may partly explain the lower relative productivity levels in the Canadian electrical and electronic equipment and machinery industries.

8 For instance, Greenwood, Hercowitz and Krusell (1997) suggest that technical change is "embodied" in new M&E investment. Therefore, M&E is needed to realize fully the benefits of technological progress. According to Stiroh (2002), the investment-specific technical change is conceptually distinct from capital accumulation and disembodied technical change.

9 Preferably, one could measure capital in such a way that it is consistent with the concept of "constant quality" as used by Jorgenson and his associates, e.g. Jorgenson (1995), Jorgenson and Griliches (1995) and Jorgenson and Stiroh (2000). Under this framework, capital input is derived as quantity indices of capital stocks of different types of assets, using capital rental prices as weights. However, we do not have data for undertaking such an exercise.

10 Note, however, that total capital intensity in Canada was equal to or slightly higher than that in the United States briefly in the mid-1990s (Appendix Table 2).

11 For both countries, there are 15 manufacturing and 6 non-manufacturing industries. Each industry has 11 observations for Canada and 13 observations for the United States.

12 The estimates are White-heteroskedasticity consistent, which corrects for the presence of any heteroskedasticity across industries. These results are found in Table 4 of the unabridged version of this article posted under the *International Productivity Monitor* at www.csls.ca.

13 The growth accounting framework has been widely used by Jorgenson and his associates in economic growth and productivity studies, e.g. Jorgenson, Gollop and Fraumeni (1987), Jorgenson (1995), Jorgenson and Griliches (1995), Jorgenson and Stiroh (2000), Jorgenson and Lee (2001) and Jorgenson and Yun (2001).

14 This growth accounting framework is based on the assumptions of constant returns to scale and competitive product and factor markets.

15 Under this framework, MFP growth is calculated as a residual, equal to labour productivity growth minus the contribution of capital intensity growth. MFP growth is often referred to as technical progress. Nevertheless, it captures the influence of a variety of other factors, including innovation of all sorts, economies of scale and scope, market imperfections, worker management relations, resource re-allocation, measurement errors in both output and inputs, etc.

16 For instance, if total capital stock is replaced by M&E capital stock and 0.543 used as the capital income share in equation (2) for the Canadian manufacturing sector, as per the regression results in Table 4 of the unabridged version of this article, then the M&E capital intensity level gap will explain about 64 per cent of the Canada-U.S. manufacturing labour productivity gap in 2000.

17 We have data for 15 manufacturing and 6 non-manufacturing industries for 1987-1998 and thus have a pooled sample of 252 observations.

18 The estimates are White-heteroskedasticity consistent, which corrects for the presence of any heteroskedasticity across industries.

19 These results are found in Tables 7 and 8 of the unabridged version of this article posted under the *International Productivity Monitor* at www.csls.ca.

20 The relative rental price of capital in Canada relative to the United States dropped sharply over the 1987-92 period. One possible explanation for the significant decline is the reduction in the real interest rate spread in the two countries. The real interest rate in Canada was significantly above that in the United States in the late 1980s and early 1990s, and the spread reached 5.8 percentage points in 1990. The spread is the risk premium that Canadian firms paid for obtaining capital, and it affects the user cost of capital by influencing the rate of return on each asset. The spread gradually declined after 1990, and virtually disappeared after 1995. The reduction in the spread coincided with the sharp decline in the user cost of capital in Canada relative to the United States. This phenomenon has also been studied by McKenzie and Thompson (1997).

21 Besides the price of investment goods, the user cost of capital is also influenced by many tax related parameters such as the statutory tax rate, property taxes, and personal taxes. Many studies have documented that these taxes discourage investment (e.g. Mintz, 1995 and Jorgenson and Yun, 2001). McKenzie and Thompson (1997) provide excellent comparisons of the two tax systems and their impact on the cost of capital, also done more recently by Chen and Mintz (2003). They show that despite the tax reforms in both Canada and the United States in the mid-1980s, the overall impact of the tax system on the cost of capital has been higher in Canada than in the United States. However, the tax disadvantage more or less stabilized after 1989 (McKenzie and Thompson, 1997 and Jog and Tang, 2001).

22 Note, however, that the rental cost of capital increased at a slower pace than the exchange rate in the 1990s. This may be explained by the fact that prices of some assets such as structures are less affected by the exchange rate changes.

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Appendix Table 1
Capital Intensity[a] in Canadian Industries

Industry[b]	M&E			Structures			Total		
	1987	1995	2000	1987	1995	2000	1987	1995	2000
Primary industries	42.2	31.5	42.4	238.7	281.8	365.6	280.2	313.4	408.0
Construction	10.3	15.0	16.8	5.7	7.4	7.2	16.0	22.4	24.0
Manufacturing (total)	35.8	49.2	49.1	39.3	44.9	39.5	75.0	94.2	88.7
Food and beverage and tobacco	24.1	33.3	37.7	34.1	37.8	37.3	58.6	71.7	75.6
Rubber & plastics	21.3	30.4	34.9	19.8	19.8	17.2	41.2	50.2	52.1
Leather	5.6	12.1	13.1	12.9	22.8	25.7	18.5	34.9	38.8
Textiles[c]	9.6	12.2	14.5	13.4	14.4	14.7	22.9	26.6	29.2
Lumber & wood	33.7	45.7	42.5	27.1	29.1	25.7	60.8	74.7	68.1
Furniture & fixtures	3.5	5.8	7.9	9.4	11.3	9.5	12.8	17.1	17.4
Paper & allied	133.1	197.0	200.8	68.7	91.1	95.3	202.1	288.1	296.1
Printing & publishing	12.4	16.7	18.8	8.5	10.1	9.4	20.8	26.8	28.2
Primary metal	104.3	123.8	148.6	85.3	106.5	107.9	189.6	230.3	256.6
Fabricated metal	14.0	15.9	18.8	18.0	20.5	17.4	31.9	36.3	36.2
Machinery, electrical and electronics	11.7	18.6	22.7	18.7	23.7	18.8	30.2	42.3	41.2
Transportation equipment	36.6	56.9	52.1	30.2	33.8	28.9	66.8	90.7	81.0
Stone, clay & glass	44.5	52.4	60.6	44.9	46.9	41.7	89.6	99.3	102.3
Petroleum and coal prod.	67.3	115.4	132.5	561.6	743.7	641.3	625.8	859.0	773.7
Chemicals	85.7	95.7	95.7	103.0	109.4	102.6	188.6	205.1	198.2
Transportation & warehousing	30.7	38.5	47.5	143.3	149.6	141.6	173.5	188.0	189.1
Communications & utilities	155.2	211.9	276.9	543.1	642.8	709.6	695.5	854.7	985.0
Wholesale trade	4.5	10.3	17.3	17.6	21.0	19.9	21.1	31.1	37.0
Retail trade	2.4	4.7	6.7	11.2	13.5	15.0	13.3	18.2	21.6
Business Sector	20.7	26.1	30.9	67.7	74.7	72.1	88.1	100.8	102.9

Notes:

a Real net non-residential capital stock (machinery & equipment, and structures, in 1997 Canadian dollars) per worker.

b Industrial classifications for Canada are based on North American Industry Classification.

c Including primary textile mills, apparel and other textile products.

Sources: Statistics Canada.

Appendix Table 2
Relative Capital Intensity[a] in Canadian Industries
(U.S. =100)

Industry[b]	M&E			Structures			Total		
	1987	1995	2000	1987	1995	2000	1987	1995	2000
Primary industries	0.43	0.34	0.40	0.90	1.22	1.52	0.78	0.96	1.16
Construction	0.82	1.08	1.01	0.93	1.17	1.39	0.95	1.23	1.25
Manufacturing (total)	0.62	0.71	0.60	1.21	1.29	1.05	0.91	1.00	0.83
Food and beverage and tobacco	0.37	0.44	0.43	0.79	0.85	0.80	0.58	0.65	0.61
Rubber & plastics	0.53	0.60	0.53	0.97	0.94	0.72	0.74	0.77	0.65
Leather	0.49	0.95	0.61	0.87	1.28	1.08	0.72	1.16	0.89
Textiles[c]	0.45	0.48	0.40	0.88	0.87	0.68	0.67	0.68	0.55
Lumber & wood	1.26	1.85	1.57	1.32	1.53	1.41	1.37	1.82	1.62
Furniture & fixtures	0.27	0.38	0.43	0.60	0.68	0.60	0.46	0.56	0.54
Paper & allied	1.01	1.26	1.15	1.84	2.25	2.20	1.36	1.67	1.56
Printing & publishing	0.43	0.54	0.47	0.51	0.55	0.50	0.50	0.59	0.53
Primary metal	0.62	0.72	0.85	1.11	1.49	1.57	0.86	1.06	1.17
Fabricated metal	0.26	0.29	0.33	0.83	0.97	0.85	0.48	0.53	0.52
Machinery, electrical and electronics	0.24	0.31	0.30	0.79	0.87	0.56	0.46	0.53	0.42
Transportation equipment	0.66	0.82	0.66	1.08	0.96	0.85	0.88	0.95	0.80
Stone, clay & glass	0.64	0.76	0.66	1.15	1.25	1.08	0.90	1.02	0.88
Petroleum and coal prod.	0.23	0.25	0.28	1.45	1.91	1.51	0.95	1.07	0.90
Chemicals	0.62	0.54	0.47	1.45	1.34	1.11	0.99	0.88	0.74
Transportation & warehousing	0.27	0.37	0.42	1.02	1.32	1.40	0.70	0.90	0.93
Communications & utilities	0.52	0.58	0.62	1.16	1.24	1.34	0.93	1.00	1.05
Wholesale trade	0.16	0.27	0.29	0.56	0.62	0.56	0.39	0.45	0.43
Retail trade	0.26	0.44	0.51	0.59	0.63	0.66	0.47	0.56	0.61
Business sector	0.51	0.57	0.55	1.20	1.31	1.26	0.93	1.01	0.95

Notes:

a Real net non-residential capital stock (machinery & equipment, and structures, in 1997 U.S. dollars) per worker. Canadian net capital stock is converted into U.S. dollars using purchasing power parity exchange rate for M&E and structure (Statistics Canada, 2002).

b Industrial classifications for Canada are based on North American Industry Classification System and those for the U.S. are based on U.S. 1987 Standard Industrial Classification.

c Including primary textile mills, apparel and other textile products.

Sources: Statistics Canada and U.S. Bureau of Economic Analysis.

Why Net Domestic Product Should Replace Gross Domestic Product as a Measure of Economic Growth

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Given the enormous amount of work that goes into producing statistics on economic growth, it is understandable that those who produce them are prone to defend their quality and to argue that alternative measures only marginally alter the overall picture. That may be true in many cases. But we must keep in mind that statistics are often used to compare countries or periods of time, e.g. the acceleration or deceleration of economic growth between two dates. With that type of comparison, different measurement techniques can have a decisive influence on results and conclusions, and may even affect policy recommendations.

My principal criticism of the growth measures that currently predominate has to do with the almost total fixation on Gross Domestic Product (GDP). In my view, there should be much less emphasis on GDP as the main yardstick of economic growth, and a much greater emphasis on Net Domestic Product (NDP).

The most basic measure of economic output is of course GDP, which includes all expenditures for investment, regardless of whether they are used to add to the capital stock, or simply to replace worn out or obsolete equipment and software. The portion of investment spending that is used to replace worn out and obsolete equipment — depreciation — while essential for maintaining the level of output, does not increase the economy's capacities in any way. If GDP were to grow simply as a result of the fact that more money was being spent to maintain the capital stock because of increased depreciation, it would not mean that anyone had been made better off. There would be no more resources available for consumption. Nor would there be any more output available in future periods, because the size of the capital stock would not have increased.

In such a scenario, since equipment is wearing out more quickly, it is necessary to run harder just to stay in the same place. The economy must devote more resources every year to replace worn out and obsolete equipment, just to keep the capital stock intact. The additional resources used to replace this equipment are recorded in the national accounts, but it does not imply that anyone is better off.

Take, for example, the December 2002 issue of the OECD *Economic Outlook*. A simple check with my word processor found 531 references to GDP. By comparison, employment was mentioned 218 times, and exports 293 times.

The measure preferred by me and many other economists as the best measure of economic

growth is Net National Product (NNP) and as a second best NDP. The difference between NDP and NNP is insignificant in a country with little foreign ownership but large in a country with high levels of foreign investment such as Ireland. In the OECD *Economic Outlook* there was not a single reference either to NNP or NDP.

The unrecognized importance of NDP does not of course mean that GDP may not still be a better yardstick for certain purposes. For example, GDP may be superior as a measure of overall production as depreciation is part of value added. In addition, aggregate demand is driven by gross investment, not net investment. Thus, for forecasting economic activity, including trends in output and employment, GDP may be the more relevant concept.

NDP as a Measure of Economic Welfare

Why GDP, and not NNP or NDP? The usual answer is that to correctly measure capital depreciation is said to be too problematic. But are we really interested only in GDP? Should economists, and especially economists at the OECD, not try instead to overcome the technical problems and place a greater emphasis on NNP and NDP?

NDP is calculated by deducting capital depreciation from GDP. In recent years, NDP has become a more relevant measure for tracking the variables that are usually associated with "the new economy," such as potential output and prospects for non-inflationary growth. For the same reason, NDP is a more appropriate measure of general welfare than GDP. NNP is an even better measure of welfare because it captures the level of net income created by and available to the individuals living in a country.[1]

One of my duties as chief economist of a Swedish labour federation is to estimate the potential for increases in real wages on the basis of macro data for my own country and for the world at large. Most of my colleagues in unions and employer organizations around the world face the same problem. Among the most important resources for this task is, of course, information about output and productivity trends. But in today's new economy, that is not enough. Due to changes in capital intensity and the need to write off capital stock, GDP has become less useful. The most appropriate measure for calculating the potential for increases of real wages and real profits is NNP or NDP, not GDP.

The pioneer of growth accounting, Edward Denison, used net product or income measures in his many studies of the sources of economic growth (e.g. Denison, 1985). Charles Hulten (1992) has demonstrated that net measures are appropriate for welfare-related approaches while gross measures are appropriate for production analysis. And recently Steven Landefeld and Barbara Fraumeni, senior officials at the U.S. Department of Commerce's Bureau of Economic Analysis (BEA), are among those who have highlighted the issue of greater depreciation and role of NDP as a measure of sustainable growth. They write:

> An interesting and related issue is the impact of the increasingly short-lived equipment and software on real GDP growth verses net domestic product (NDP) growth. NDP is often used as a measure of sustainable growth, in the sense that it subtracts depreciation from GDP to indicate the amount of current product/income that should be set aside for the using up of capital stock in production during the current period (Landefeld and Fraumeni, 2001:31).

In recent years, growing investment in, and the increasingly efficient use of, information and communications technologies (ICT) has made a major contribution to higher potential growth. The increasing significance of new technologies, along with the rapid rate of depreciation for

both hardware and software because of short service lives, should be reflected in measures of economic growth.

Empirical Differences

ICT investment has come to represent a growing portion of total investment. Consequently, capital depreciation has grown much faster than GDP. For example, in the United States there has been a large increase in ICT investment as a proportion of total investment, and depreciation as a share of GDP, leading to a widening gap between economic growth rates as measured by GDP and NDP. The share of ICT investment in total non-residential investment in the United States in 2000 was 30 per cent, compared to 27 per cent in Finland and around 15 per cent in France, Japan, the United Kingdom, Germany and Italy (OECD, 2002). ICT accounts for an increasing share of investment in all sectors. During the 1990s investment growth has increasingly been driven by ICT investment, but to different degrees in different countries.

This growing importance of ICT is a result of many factors, including the rapid price declines for ICT and growing demand for ICT applications. This has created challenges for national accountants. One example is provided by the altered definition of investment that the U.S. BEA adopted in 1999. The previous practice had been to treat purchases of software by both the private and public sectors as intermediate inputs. But starting in 1999 such purchases were classified as investments. This had the effect of increasing total nominal investment in current dollars in 1999 by an estimated 95 billion dollars in the private sector and by 20 billion dollars in the public sector. Taken together, it increased recorded nominal and real GDP by around 1.5 per cent. But because of the corresponding increase in depreciation, this change increased NDP only marginally. As a result the gap between GDP and NDP is widening, and the value of GDP as a measure of general welfare is declining.

The U.S. BEA does produce an estimate of NDP. During the 1960s and 1970s, the difference between the average annual growth rates of GDP and NDP in the United States was only 0.1 percentage points according to BEA estimates (Baker, 2001). This marginal difference was explained by the fact that the service lives for capital stock were relatively long at that time, and stable. During the 1980s and continuing into the mid-1990s, the difference between GDP and NDP growth rates increased to an average of 0.2 percentage points per year. In the second half of the 1990s the difference between the two measures of economic growth increased significantly to around half a percentage point per year.

Estimates of GDP and NDP for OECD countries are available from the national accounts data maintained by the OECD . Unfortunately, estimates of capital depreciation are not available for a number of OECD countries, especially for earlier years. For the period 1995- 2001, estimates for both real GDP and real NDP growth are available for 16 countries, including all G-7 countries except Japan (Table 1).

In the post-1995 period, a period when the new economy has flourished, NDP growth has been lower than GDP growth in 14 of the 16 countries for which estimates are available (Finland and the United Kingdom were the exceptions), with an annual (unweighted) average gap of 0.15 percentage points. This reflected the rise in the average (unweighted) depreciation share of real GDP by 0.75 points from 13.86 per cent in 1995 to 14.60 per cent in 2001. The difference in growth rates was especially large in Iceland (0.52 points) and the United States (0.48 points).

Finland, although a leader in the ICT field, actually experienced considerably stronger NDP

Table 1
GDP Growth versus NDP Growth and Changes in the Importance of Depreciation in 16 OECD Countries

	Compound Average Annual Growth Rates for 1995-2001		Difference: GDP growth-NDP growth	Real Depreciation as a percentage of Real GDP		Difference: 2001-1995
	Real GDP	Real NDP		1995	2001	
Australia	3.87	3.59	0.27	15.63	16.95	1.33
Austria	2.40	2.26	0.15	14.05	14.78	0.73
Belgium	2.41	2.22	0.19	14.22	15.17	0.95
Canada	3.56	3.41	0.15	13.16	13.90	0.74
Denmark	2.48	2.05	0.43	15.98	18.07	2.09
Finland	4.11	4.67	-0.56	18.17	15.48	-2.69
France	2.48*	2.42*	0.06	13.74	13.98**	0.24
Germany	1.60	1.38	0.21	14.79	15.87	1.07
Greece	3.54	3.50	0.04	9.07	9.28	0.22
Iceland	4.60	4.09	0.52	14.69	17.18	2.49
Italy	1.92	1.80	0.12	13.10	13.69	0.59
Netherlands	3.29	3.20	0.10	15.12	15.60	0.48
Spain	3.64	3.52	0.12	13.00	13.61	0.60
Sweden	2.90	2.68	0.22	13.34	14.44	1.10
United Kingdom	2.76	2.85	-0.09	12.09	11.65	-0.45
United States	3.42	2.93	0.48	11.58	14.03	2.45
Unweighted 16-country average	3.06	2.91	0.15	13.86	14.60	0.75

* 1995-2000 for France.

** 2000 for France.

Note: A complete set of tables providing the underlying data on GDP, depreciation, NDP and the share of depreciation in GDP, expressed in both nominal and real prices, is available as an appendix to this paper. It is posted at www.csls.ca under *International Productivity Monitor*.

Source: OECD National Accounts, available at http://www.oecd.org/document/28/0,2340,en_2825_495684_2750044_1_1_1_1,00.html.

growth than GDP growth. However, these numbers should be treated with great caution as it seems unlikely that depreciation as a percentage of GDP fell strongly in the 1990s, as the official data indicate. Given the dominant role of GDP and low interest in NDP, it is very possible that the current estimates of depreciation for certain countries are not based on up-to-date estimates of the service lives of capital assets and hence may not be capturing true changes in depreciation patterns. Therefore, we must be very careful in interpreting OECD estimates for NDP. The Finnish and UK cases are warning examples. Is it really possible that the relative importance of depreciation can be falling in economies undergoing enormous structural changes and where the role of long-term infrastructure investments is reduced and the growth in investment shifting to ICT assets?

In the United States, it has become fairly common for economists to monitor the NDP trend as an indicator of the economy's long term growth potential. This has been made possible by the availability of NDP figures from as far back as the 1930s.

The rapid development during recent years of software and equipment with short life cycles (e.g. computers and accessories), and the increasing share of the total capital stock which they represent, suggests that depreciation assumptions and rules should be continually reviewed and updated in order to provide a more solid basis for measuring NDP, among other things.

Assuming that it is possible to assess capital stock within various sectors of the economy on a continual basis, while at the same time making necessary adjustments to write off periods, NDP could become a useful measure of the moderately long term potential for output growth.

Conclusion

GDP was an acceptable measure of economic growth as long as capital depreciation as a share of GDP was fairly constant over time. Under this condition, GDP and NDP developed in tandem with each other. But under current conditions where the composition of investment is shifting toward shorter-lived assets, the implications of placing almost all emphasis on GDP and neglecting NDP is to overestimate:

- the real rate of economic growth;
- productivity increases;
- the potential for increasing wages without inflationary risks to the labour market;
- gross business profits, thus increasing the risk of stock market bubbles; and
- differences in growth rates between countries (e.g. between the United States and Europe).

The OECD should play a leading role in producing reliable estimates of depreciation and NDP on a regular basis for all OECD countries and incorporating these estimates into projections in the *Economic Outlook*. My recommendation to the OECD is to start with estimates of income per capita based on Purchasing Power Parities (PPP). At present per capita volume indices based on PPPs reflect only differences in the gross volume of goods and services produced. No consideration is given to depreciation, which has implications for living standards comparisons.

Notes

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1 If for example a large part of the capital stock is owned by foreigners, both GDP and NDP can dramatically overstate the living standard of the individuals living in a country. Extreme cases here are Ireland and Luxembourg, two European tax heavens for American and European citizens and companies.

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Symposium on Future Productivity Growth in Canada: An Introduction

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Centre for the Study of Living Standards

No issue is more important for the future prospects of the Canadian economy than trend labour productivity growth. Greater productivity growth boosts potential income gains, gains that Canadian society can choose to take in the form of more consumer goods, additional public services, or less work time. To examine the issue of future productivity growth in Canada, the Centre for the Study of Living Standards organized a panel on this topic at the annual meeting of the Canadian Economics Association in June 2003 at Carleton University.

The three panelists, Thomas Wilson from the University of Toronto, Tiff Macklem from the Bank of Canada, and Benoît Robidoux from Finance Canada have since written up their presentations, which are published in this symposium. The purpose of this introduction is to provide the context for their discussion by highlighting certain issues related to the topic not directly addressed in the contributions. Brief summaries of the three contributions to the symposium are found in the Editor's Overview at the beginning of the issue. The key message that emerges from the symposium is a very positive one. There is a consensus among the contributors that total economy labour productivity growth in Canada is likely to be around 2 per cent per year over the next two decades, almost double the pace of the 1973-96 period.

Choice of Measure of Aggregate Labour Productivity

Aggregate labour productivity can be defined in a number of ways: on the basis of the total economy or the business sector, and in terms of persons employed or hours worked and growth rates differ among measures. Labour input is used as a measure of output in the non-business sector, which by definition results in no recorded productivity growth. This means that output in the total economy, which includes the non-business sector, tends to grow at a slower pace than the output of the business sector (see Table 1). An important reason for choosing the total economy as the appropriate measure of aggregate labour productivity is that the potential for real income gains is determined by economy-wide aggregate productivity increases, but the business sector accounts for only around three quarters of total economy output.

Total hours worked is a more accurate measure of labour input than persons employed because hours exhibit both cyclical and secular movements. Total economy output per hour has grown significantly faster than output per worker since 1961 (Table 1). When data on hours are available, an hours-based aggregate labour productivity measure is preferable to a worker-based measure.

Productivity and the Sustainability of Social Programs

Small increases in productivity and real income over long periods can greatly affect fiscal balances and the sustainability of social programs. A movement from an environment of 1 per cent productivity growth, which characterized the 1973-96 period, to an environment of 2 per cent productivity growth, which the contributors to this symposium believe will be realized in coming years, has extremely favourable consequences for the affordability of social programs. Indeed, according to William Robson (2003:20) from the C.D. Howe Institute,

> Growth in output per working age population of 1.9 per cent annually would essentially cause the net national demographically driven liability to disappear.

With 2 per cent annual labour productivity growth, this would imply growth in output per working age person of 1.7 per cent, assuming that the working age population grows 0.3 percentage points per year faster than the labour force following Dungan and Murphy (2003). This is very close to the figure given by Robson required to guarantee sustainability of social programs. Many would argue alternatively that 2 per cent productivity growth removes basically any threat to the financial solvency of social programs related to demographic developments.

Table 1
Productivity Growth Rates in Canada, 1961-2001
(Compound average annual rates of change)

	Total Economy		Business Sector	
	Output per Worker	Output per Hour	Output per Worker	Output per Hour
1961-2001	1.48	1.85	1.79	2.13
1961-1973	2.69	3.42	3.06	3.74
1973-1989	0.75	1.06	1.07	1.38
1989-1996	1.03	1.17	1.08	1.22
1996-2001	1.56	1.61	2.03	2.02

Source: Statistics Canada, Aggregate Productivity Measures. CANSIM table 383-0003. Released August 1, 2002.

Other Projections of Aggregate Labour Productivity

Long-term productivity forecasts are also produced by Global Insight, Informetrica, and the Conference Board of Canada. These projections are somewhat lower than the consensus of around 2 per cent total economy labour productivity growth that emerges from the three contributions to this symposium. Global Insight projects aggregate labour productivity growth of 1.9 per cent over the 2002-26 period. Informetrica sees aggregate labour productivity rising at only a 1.6 per cent average annual rate over the 2002-26 period, while the Conference Board of Canada projects an even lower 1.46 per cent per year over the 2002-15 period.

These projections show that, despite the consensus of the three contributions to the symposium, there is no overall consensus in the economics profession in Canada. Labour productivity growth in Canada may be lower than 2 per cent as certain projections would indicate. On the other hand, given the degree to which the extremely strong productivity growth recently experienced in the United States spills over to Canada, it may be well above 2 per cent. In any case, future productivity trends are of the utmost importance for the living standards of Canadians and will be followed very closely by economists and policymakers.

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A Perspective on Future Productivity Growth in Canada

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University of Toronto

This article considers the issue of Canada's future productivity growth in the context of a long-term projection (or base case projection) of the Canadian economy prepared by my colleagues Peter Dungan and Steve Murphy[1] of the Policy and Economic Analysis Program (PEAP) at the University of Toronto. This projection was developed with the FOCUS macroeconometric model of the Canadian economy.[2] An overview of this projection is provided in Table 1.

The essential feature of this projection is a convergence towards equilibrium growth. With the economy not fully recovered from the recent growth recession, above potential growth is required to move the economy back to its potential. In this projection, convergence to potential output is attained by 2008, and growth at potential occurs thereafter. The unemployment rate settles down to 6.2 per cent, with inflation in the 1.8-1.9 per cent range (Table 1 and Chart 1).

The fiscal picture is of modest federal and provincial surpluses on a National Accounts basis, but with a larger consolidated government sector surplus because of the cash surpluses of the Canada and Quebec Pension Plan (CPP/QPP) accounts. Debt ratios of both the federal and provincial government sectors continue to decline (Chart 2).[3]

Projected actual output growth and two alternative potential output growth projections (based on different total factor productivity (TFP) assumptions) are shown in Chart 3. As is clear, the base case output projection is consistent with the higher potential growth with TFP growth averaging 1 per cent per year.

However, potential growth is projected to decline in the future. This is primarily due to the decline in the growth of the labour supply based

Chart 1
Canada: Main Indicators

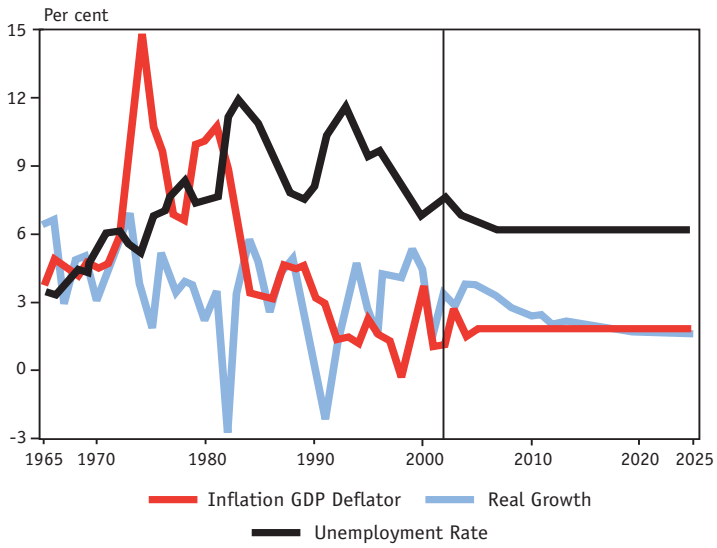


Table 1
Overview of PEAP Projection*
(Average annual rate of growth unless otherwise specified)

	2002-2008	2008-2015	2015-2025
Real GDP	3.4	2.3	1.7
Inflation (CPI)	1.9	1.9	1.9
Unemployment Rate period average (%)	6.6	6.2	6.2
Labour Productivity	1.9	1.7	1.7

* Projection released on April 24, 2003 prepared by Peter Dungan and Steve Murphy.

on demographic developments, and secondarily to a more modest decline in the rate of capital formation, as shown in Chart 4.

Measured labour productivity will deviate from its trend rate of growth over the business cycle. Historically, labour productivity growth has tended to decline during recessions (or growth recessions) and accelerate during recovery periods.

In the PEAP projection, labour productivity is above trend over the 2003-2008 period as the economy recovers from the growth recession of 2001-2. Labour productivity growth averages 1.9 per cent per year over that period. When the economy arrives at its equilibrium growth path in 2008, labour productivity is projected to grow by 1.7 per cent per year thereafter (See Chart 5).[4]

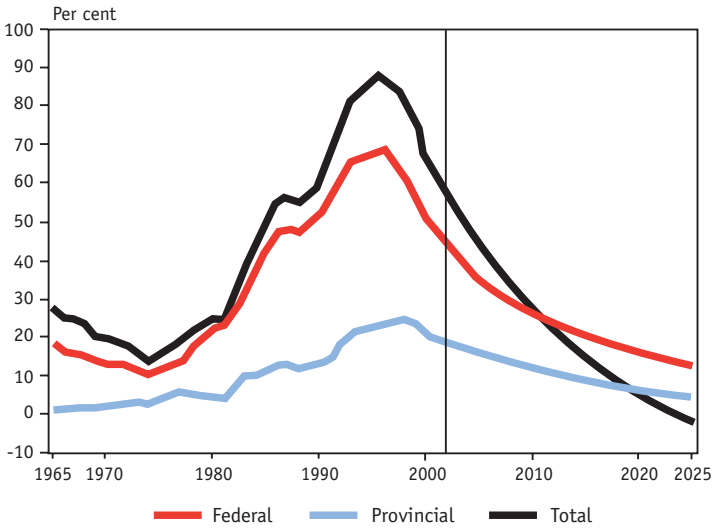
Although future productivity growth in the PEAP projection is higher than the average over the past twenty years, I view this projection as being on the conservative side for several reasons. First, the slowing growth of the labour force is accompanied by increased capital deepening. Over the projection period, the rate of capital formation will be 2 per cent higher than the growth of employment (Chart 4). This capital deepening should boost labour productivity (as occurred over the 1998-2000 period when substantial capital deepening was accompanied by labour productivity growth of 2 per cent per year).[5]

Second, the recent (1995-2000) acceleration of TFP growth in the business sector may continue over the medium term, as the fruits of past investments in information and communication technology (ICT) are realized. However, for the reasons explained in Dungan and Wilson (2002) and in the companion papers in this symposium by Tiff Macklem (2003) and Benoit Robidoux (2003), the gains from ICT investments will likely be lower in Canada than in the United States.

Third, the PEAP projection envisions continuation of the stable policy environment established through inflation targeting and prudent fiscal policies in recent years. With monetary as well as fiscal policies acting as "automatic stabilizers," future business cycles should be mitigated (barring adverse supply price shocks).[6]

Fourth, the benefits of trade liberalization should continue to be realized, provided that recent security concerns do not generate new barriers to trade. There is some evidence at the industry and plant level that indicates that trade liberalization has had significant effects in produc-

Chart 2
Government Debt as a per cent of GDP*



* In the FOCUS model government debt is on a National Accounts basis which differs somewhat from debt on a Public Accounts basis. Total government sector net debt includes the debt of municipalities and is reduced by the net assets held by the CPP and QPP systems.

Chart 3
Potential and Projected Growth

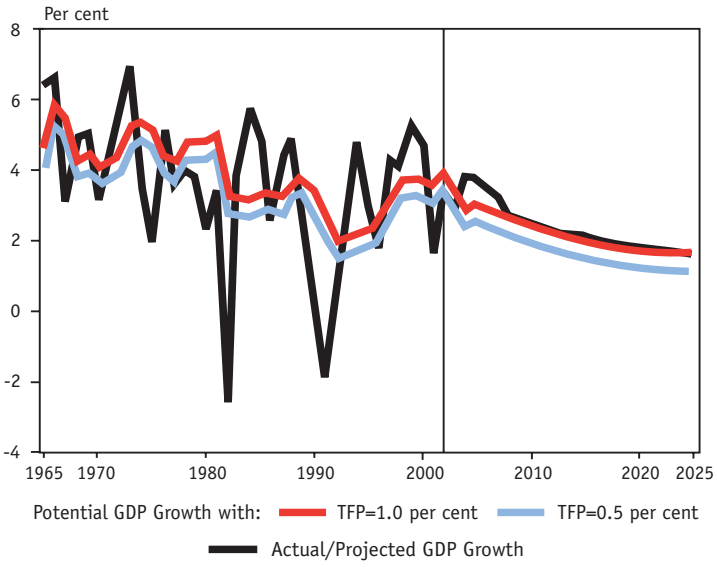
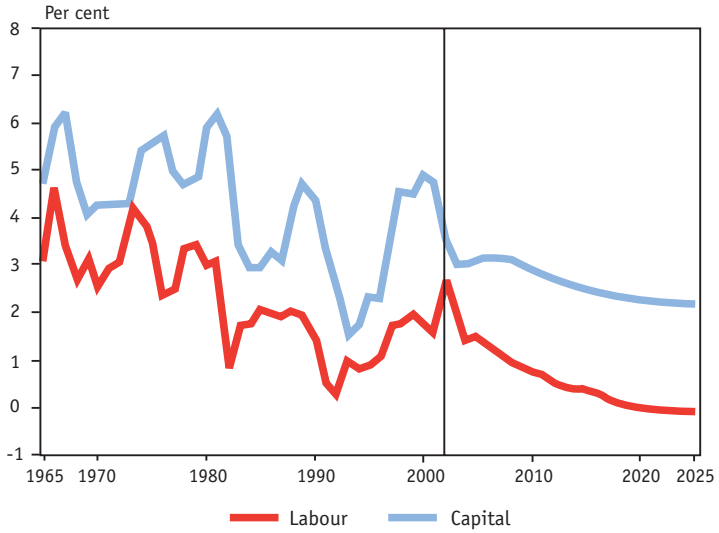


Chart 4

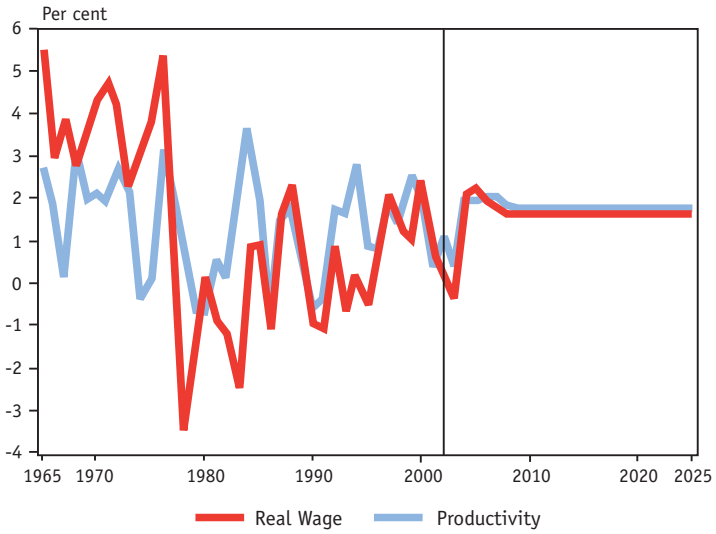
Growth Rates of Capital and Labour*



* In the FOCUS model, labour is defined as employment.

Chart 5

Real Wage Gains and Labour Productivity Growth*



* In the FOCUS model, labour productivity is measured by real GDP per worker.

tivity growth.[7] However, it is doubtful that the significant aggregate TFP gains from Canada-U.S. free trade, originally estimated by Cox and Harris (1985), have yet been fully realized.[8]

Finally, I want to point out that the productivity picture is improved somewhat if we use Gross *National* Product (GNP) rather than Gross *Domestic* Product (GDP) as the measure of growth. Clearly, GNP growth is the better measure of potential improvement in living standards.

In recent years, Canada's net foreign indebtedness has declined, and this continues in the PEAP projection (Chart 6). Indeed, after about 2010, Canada is projected to become a net lender, gradually building up a net asset position relative to the rest of the world.

The cumulative effects of these developments over the period of the projection are that GNP will increase by 3 per cent more than GDP. The average annual growth rate for GNP will be 0.15 per cent above that of GDP over the projection period.

Note that the opposite picture holds for the United States. In recent years, the U.S. economy has moved from a net asset to net debtor position, and with larger current account deficits, the net foreign debt in the United States will continue to increase relative to U.S. GDP. Canada/U.S. differences in projected productivity growth would therefore be 0.2 to 0.3 per cent lower if GNP rather than GDP were used as the measure of output.

It is difficult to derive quantitative estimates for the first four factors listed above. It is also even more difficult to determine the timing of effects: How long will the productivity gains from past ICT investments last? When will the gains from trade liberalization be fully realized?

On balance, it is my judgment that aggregate labour productivity growth (on a GDP basis) will likely average about 2 per cent per year over the next ten to fifteen years, provided that there are no adverse supply shocks, no reversal of trade liberalization, and no rude policy shocks. I may therefore perhaps be viewed as a cautious optimist on this issue.

Notes

* The author is Professor Emeritus of Economics and Senior Advisor, Institute for Policy Analysis at the University of Toronto. This article is based on a presentation given at the CSLS session on *Perspectives on Future Productivity Growth in Canada* at the 2003 Canadian Economics Association meetings at Carleton University, Ottawa, Ontario, May 31-June 2. Email: twilson@chass.utoronto.ca.

1 This projection was released on April 24, 2003. An updated projection as of July 17, 2003 is published in Dungan and Murphy (2003).

2 For a description of the FOCUS model, see Dungan, Jump, and Murphy (2002).

3 For an examination of the impact of productivity growth on the fiscal position of governments, see Dungan (2002).

4 This projection is slightly above the long-term productivity growth of 1.6 per cent per year presented by Denton and Spencer (2003).

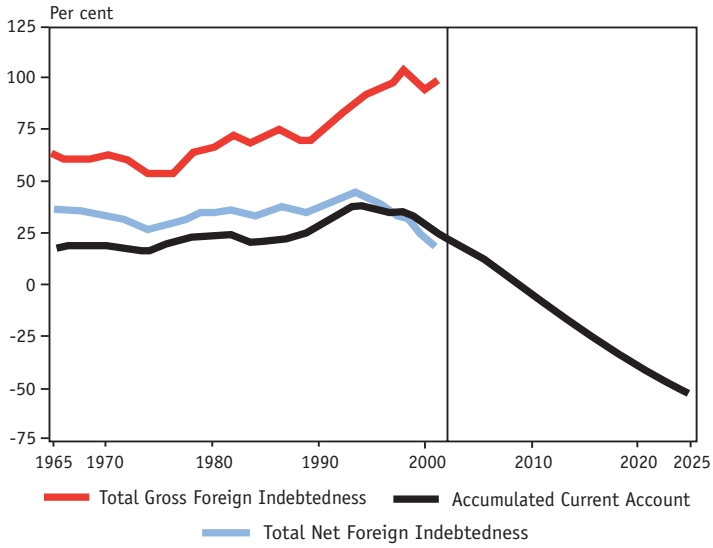
5 The PEAP projection incorporates normal capital-labour substitution, but does not include technology embodiment effects.

6 Although monetary policy actions remain discretionary, under inflation targeting the central bank will tend to offset the effects of real demand shocks.

7 See Baldwin and Gu (2003), Sawchuk and Trefler (2002), and Trefler (1999).

8 See also the papers by Harris (1991) and Dungan and Wilson (1991) in the "Symposium on Canada-US FTA" in the *Journal of Policy Modeling*.

Chart 6
Canadian External Debt as a per cent of GDP



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Future Productivity Growth in Canada: Comparing to the United States

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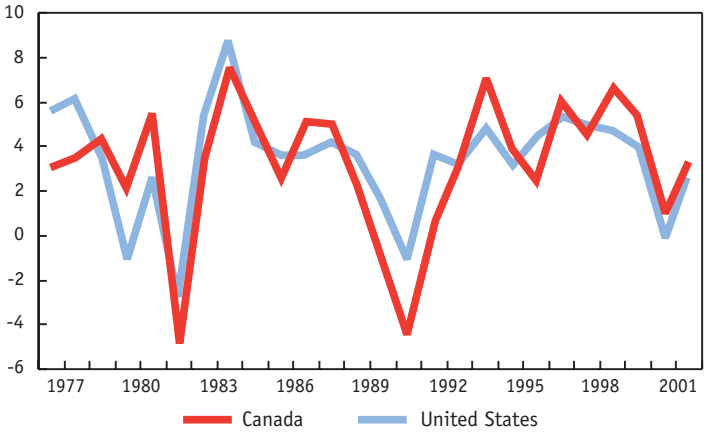
Bank of Canada

The growth resurgence in the United States in the second half of the 1990s has attracted a great deal of interest among leading productivity experts. From their research we have learned a great deal about what is driving productivity growth in the United States. There has also been some very good research done on the Canadian experience using similar methodologies to the U.S. studies. As Canada's neighbour and largest trading partner, the United States provides the obvious benchmark of comparison.

This commentary begins by quickly reviewing some facts about the sources of growth in the United States and Canada in the second half of the 1990s, with particular emphasis on the role of productivity growth. The second section takes a closer look at productivity growth in the United States and Canada through the window of growth accounting studies. The third section reviews some of the broader determinants of productivity growth, and compares Canada to the United States along these dimensions. Finally, the conclusion provides an assessment of the prospects for future productivity growth in Canada.

Chart 1
Business Sector Output Growth in the United States and Canada: 1977-2002



Sources: Statistics Canada and U.S. Department of Labour, Bureau of Labour Statistics.

Some Facts

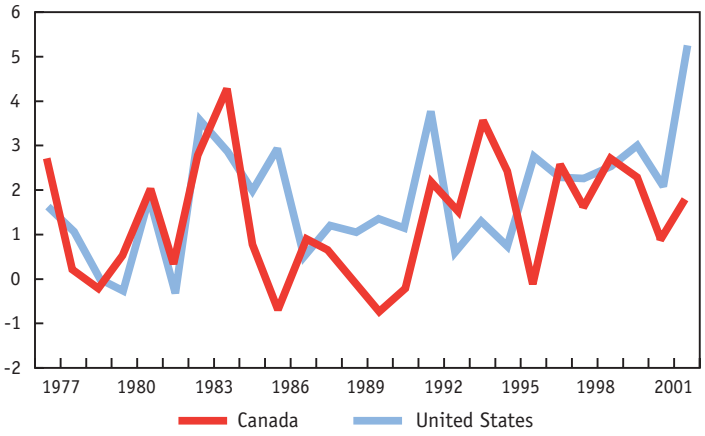
Output growth surged in both the United States and Canada in the second half of the 1990s. Over the 1995 to 2000 period, growth in business-sector output averaged 4.7 per cent in the United States and 5.0 per cent in Canada.[1] Chart 1 plots business-sector output growth in Canada and the United States and reveals that growth picked up a little later in Canada than in the United States, but in recent years it has been stronger in Canada than in the United States. Indeed, over the period 1996 to 2002, growth in

Canada was almost a full percentage point higher on average — 4.5 per cent in Canada compared to 3.6 per cent in the United States.

Output growth can be divided into two sources — growth in labour inputs and growth in labour productivity. Charts 2 and 3 compare the growth in labour productivity and labour inputs in the United States and Canada. Through the second half of the 1990s, labour productivity and labour inputs both grew strongly in the United States and Canada. Comparing the United States and Canada we see also that productivity growth made a larger contribution to higher output growth in the United States, whereas strong growth in labour inputs was more important in Canada. Indeed, from 1995 to 2000, labour productivity in the business sector averaged 2.6 per cent in the United States compared to 1.8 per cent in Canada. Over the same period, hours worked in the business sector grew at an average rate of 2.0 per cent in the United States compared with 3.1 per cent in Canada.

In summary, there are different ways to grow. Growth in the United States and Canada came from both growth in labour inputs and growth in labour productivity, but productivity growth was relatively more important in the United States and growth in hours worked was relatively more important in Canada. Next let us dig deeper on productivity growth.

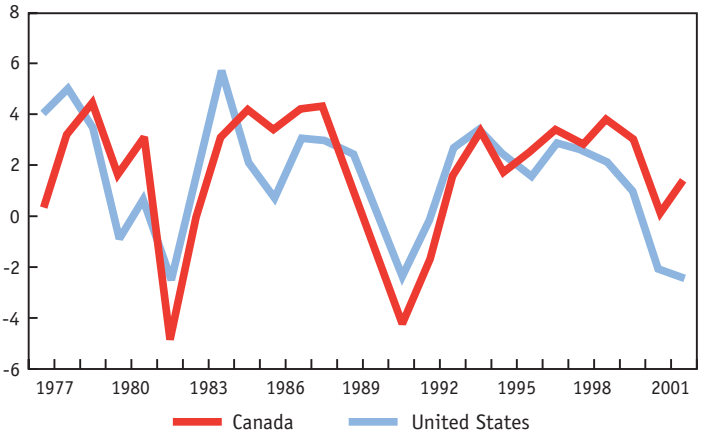
Chart 2
Business Sector Labour Productivity[a] Growth in the United States and Canada: 1977-2002



Note: a Labour productivity is defined as output per hour worked.

Sources: Statistics Canada and U.S. Department of Labour, Bureau of Labour Statistics.

Chart 3
Growth in Hours Worked in the United States and Canada: 1977-2002



Sources: Statistics Canada and U.S. Department of Labour, Bureau of Labour Statistics.

Productivity Growth in the United States and Canada Compared

As the above figures reveal, labour productivity is highly cyclical. The typical cyclical pattern is for productivity growth to rebound sharply early in a recovery (e.g. 1983 and 1992), and then to weaken as the expansion matures (e.g., 1987-1990). The usual story is that labour productivity declines late in the cycle as the unemployment rate falls and labour quality declines. In the most recent U.S. expansion, productivity growth increased late in the cycle. So the question is how did the U.S. economy escape the usual cyclical pattern of declining productivity growth as the expansion matured?

The consensus that has emerged in the literature, based on both aggregate growth accounting studies and more disaggregated evidence, is that the effects of declining labour quality on productivity were more than offset by an acceleration in the productivity gains in the *production* of infor-

Table 1
Alternative U.S. Growth-Accounting Studies

	Jorgenson, Ho and Stiroh[a] (1995-2001)	Oliner and Sichel[b] (1995-2001)	Armstrong et al.[c] (1995-2000)
Average labour productivity growth	2.02	2.43	2.7
Contributions from:[d]			
Capital Deepening	1.39	1.19	1.1
ICT capital deepening	0.85	1.02	1.0
Other capital deepening	0.54	0.17	0.1
Labour quality	0.22	0.25	0.3
TFP growth	0.40	0.99	1.4
ICT-producers	0.41	0.77	
Other	- 0.01	0.23	
Total contribution from ICT (capital deepening + TFP)	1.26	1.79	

Notes:

a Jorgenson et al. use a broader measure of output than other studies.

b Non-farm business sector.

c Business sector (Source: *The Daily*, Statistics Canada (12 July 2002)).

d Contributions are reported in percentage points. The separate contributions may not add to total due to rounding.

Table 2
U.S. — Canada Differences in Sources of Business-Sector Productivity Growth (1995-2000)[a]

	U.S.	Canada	Difference: U.S. less Canada
Average labour productivity growth	2.7	**1.8**	0.9
Contributions from:[d]			
Capital Deepening	1.1	**0.5**	0.6
ICT capital deepening	1.0	**0.5**	0.5
Other capital deepening	0.1	**0.0**	0.1
Labour quality	0.3	**0.3**	0.0
TFP growth	1.4	**1.1**	0.3
ICT-producers	0.6	**0.2**	0.4
Total contribution from ICT (capital deepening + TFP)	1.6	**0.7**	0.9

Notes:

a Calculated from *The Daily*, Statistics Canada (July 12, 2002).

b Numbers may not add to total due to rounding.

c Estimates of TFP growth in the ICT-producing sector are taken from Oliner and Sichel (2002) and Muir and Robidoux (2001). For comparability with the Muir-Robidoux number for Canada, the U.S. estimate excludes computer software and telecom equipment.

mation and communications technology (ICT) and increased investment in and *use* of new ICT in the rest of the economy. Dale Jorgenson (2001) has stressed that this was driven by an acceleration in the rate of price decline of computers from about 15 per cent a year to 25 per cent a year which was the result of shortening the product cycle for semi-conductors from 3 years to 2 years.

Table 1 reports the results of three growth accounting studies on U.S. data — Jorgenson, Ho and Stiroh (2003), Oliner and Sichel (2002) and a study conducted by Armstrong, Harchaoui, Jackson and Tarkhani (2002) at Statistics Canada.[2] The numbers differ somewhat due to different concepts of output and different vintages of data revisions, but the message is the same. The two biggest contributors to labour productivity growth from 1995 to 2000 were capital deepening in ICT, and growth in total factor productivity (TFP) in the ICT-producing sector. Moreover, as shown in these studies, together these two contributors explain most if not all of the *increase* in labour productivity growth in the United States relative to the previous 20 years.

Table 2 reports comparable results for the United States and Canada based on the study by Armstrong et al.[3] Focusing first on Canada, three conclusions emerge. First, the main sources of productivity growth in Canada over the 1995 to 2000 period were capital deepening, which contributed 0.5 percentage points, and TFP growth which contributed 1.1 percentage points. Second, capital deepening was all in ICT. So as in the United States, investment in ICT played an important role in labour productivity growth over this period. Third, TFP growth in ICT-producing sectors is only a small part of total TFP growth — 0.2 points of the 1.1 percentage points.[4]

Comparing Canada to the United States points out that ICT played a much larger role in the productivity growth in the United States. The contribution of ICT-capital deepening to

productivity growth in Canada from 1995 to 2000 is half that in the United States. Similarly, more TFP growth came from ICT-producing sectors in the United States than in Canada.[5] This greater role of ICT in the United States may be related in part to structural differences between the Canadian and U.S. economies.

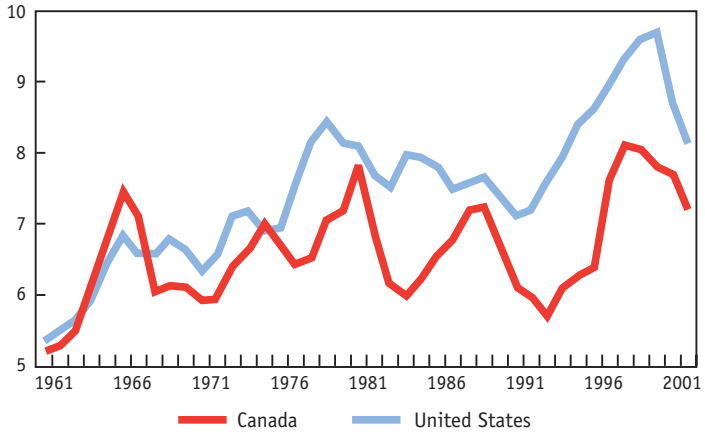
One structural factor may be the greater importance of small firms in Canada. Baldwin and Sabourin (1998) examine plant-level data in the manufacturing sector and find a significant positive relationship between the use of computer-based technologies and labour productivity growth in the Canadian manufacturing sector. They also find that small firms have been slower to adopt new technologies than large firms. When combined with the fact that small firms account for a larger share of manufacturing output in Canada than in the United States, this may be one structural reason why investment in ICT, while an important contributor to productivity growth in Canada, has not been as important as in the United States.

The smaller contribution of the ICT-producing sector to TFP growth in Canada appears to reflect two additional structural factors. First, industries producing ICT goods account for a smaller share of output in Canada than in the United States. Second, while rates of productivity growth in ICT-manufacturing are high in Canada, they are not as high as in the United States. This appears to reflect differences in the types of ICT goods produced in the two countries. In particular, the biggest productivity gains in ICT have been in the production of semi-conductors which is concentrated in the United States.

Beyond ICT — Broader Determinants of Productivity Growth Compared

While the recent U.S. experience has thrown the spot light on ICT, the broader productivity literature highlights a number of determinants. Three of these stand out as critical factors for Canada's continued productivity performance.

Chart 4
Nominal Business Investment in Machinery and Equipment as Share of Nominal GDP
(per cent)

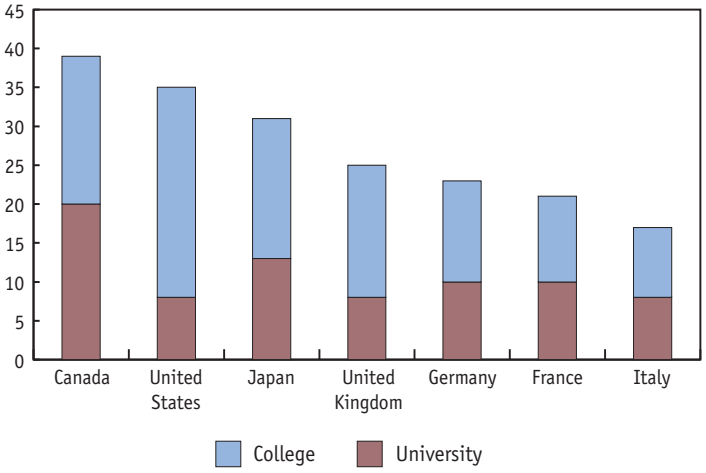


Sources: Statistics Canada and U.S. Department of Commerce, Bureau of Economic Analysis, "Survey of Current Business".

Investment in Machinery and Equipment

The ratio of business investment in machinery and equipment (M&E) to GDP tends to be an important determinant of productivity growth in cross-country studies. As shown in Chart 4, investment in M&E began rising as a share of output in the United States in 1992. Four years later in 1996 (Chart 2), productivity growth in the United States began to increase. In Canada, investment in M&E as a share of output has also risen, but the increase started later and has not been as pronounced. The later start in Canada appears to reflect the fact that the Canadian economy was weaker in the mid-1990s than the U.S. economy and is consistent with the fact that productivity was slower to pick-up in Canada. The later start may also suggest there is more productivity payoff to come in the near term if the lags between investment and productivity growth in the United States can be

Chart 5
Percentage of the Population Aged 25 to 64 with Completed Post-Secondary Education, 1999



Source: OECD.

used as a guide for Canada (see Macklem and Yetman, 2001).

Human Capital

Human capital or the average skill level of workers has been increasing over time. By most measures, the average skill level of workers is very comparable in the United States and Canada. In particular, the average number of years of formal education has been very similar in the United States and Canada. By some measures Canada may have an edge, but by others the United States is ahead. As shown in Chart 5, almost 40 per cent of Canadians aged 25 to 64 have completed some form of post-secondary education. This is the highest proportion among the OECD countries. There are also some compositional differences between Canada and the United States. A considerably higher percentage of Canadians have a non-university post-secondary education, and a lower percentage have a university degree. Canada also has a lower proportion of people with advanced research degrees, and, once at work, Canadian workers receive less employer-sponsored training than do their American counterparts.

Openness to Trade and Investment

Openness to trade contributes to productivity growth by facilitating the diffusion of technologies and is typically found to be an important determinant of productivity growth in cross-country studies. Low trade and regulatory barriers also promote a more efficient allocation of resources and the achievement of economies of scale in production.

By any standard, Canada is a very open economy and has become more open in the last decade and a half. Following the Free Trade Agreement (FTA) with the United States and subsequently the extension to include Mexico under the North American Free Trade Agreement (NAFTA), trade as a share of GDP in Canada rose from about 50 per cent in 1990 to about 80 per cent in recent years.[6]

At the micro level, there is also compelling evidence of the importance of trade to productivity growth. In his study of the effects of the FTA, Trefler (1999) finds that tariff reductions increased labour productivity in the manufacturing sector. Baldwin and Gu (2003) report that productivity growth in Canada has been stronger in export-oriented manufacturing plants. In addition, Baldwin and Dhaliwal (2001) report that productivity growth has been stronger in foreign controlled establishments in the manufacturing sector suggesting that trade and foreign direct investment are important sources of technology transfer. Using industry data, Gera, Gu and Lee (1999) find that spillovers from foreign R&D spending that are embodied in imported intermediate inputs are a positive contributor to productivity growth in Canada. This likely provides some offset to the relatively low level of domestic R&D spending in Canada.

Summary and Conclusions

There are a number of reasons to be optimistic about productivity growth in Canada. There are also some reasons to be cautious. Needless to say, predictions about productivity growth are subject to considerable uncertainty.

On the positive side:

- Investment in machinery and equipment increased as a share of GDP over the 1990s. Given the lags between the timing of investment and the realization of productivity gains, this increased investment should continue to support higher trend productivity growth in the near term.
- Canada has a high exposure to international trade and investment. Empirical evidence indicates that this openness promotes the diffusion of knowledge and new technologies.
- Canada's macro-policy framework of low, stable inflation and improved fiscal positions provides a good supporting environment for efficient decision-making by firms.
- U.S. productivity growth was surprisingly strong through 2001 and 2002, despite the cyclical downturn in economic activity, and has grown strongly through the first half of 2003. This suggests that a significant part of the increase in U.S. productivity growth will be sustained. The longer the productivity resurgence lasts in the United States, the greater are likely to be the spillovers to Canada.
- Sharpe (2003) estimates the level gap between productivity in Canada and the United States to be somewhere between 10 and 20 per cent. This suggests that Canada can grow by adopting state of the art technologies and processes that already exist. Canada is, therefore, less reliant than the productivity-leading United States on the product cycle for semi-conductors.

There are also some reasons to take a more cautious perspective on future trend productivity growth in Canada relative to the United States:

- ICT-producing industries, which have made major contributions to the high productivity growth in the U.S. manufacturing sector, account for a smaller share of Canadian output. Moreover, although productivity gains in ICT production have also been strong in Canada, they have been significantly lower than in the United States. Some of this difference in growth rates appears to reflect structural differences in the composition of ICT output.
- Canada has a larger proportion of small firms and small firms tend to adopt new technology more slowly than larger firms.
- Canada has a relatively low rate of domestic R&D spending.

Overall, the Bank of Canada's projection is that trend output in Canada — what we usually call potential output — is growing at about 3 per cent. This can be roughly divided into 1 per cent growth in trend labour inputs with the remaining 2 per cent coming from trend labour productivity growth. This rate of trend labour productivity growth is somewhat above the average productivity growth experienced in Canada from 1975 to 1995, but in line with the experience in recent years.

Looking ahead, growth in potential output of about 3 per cent is a reasonable forecast through to roughly the end of the current decade. Thereafter, growth in labour inputs is expected to decline as the baby-boom generation moves into retirement and is replaced with a smaller cohort of workers entering the labour force. Thus, potential output growth is likely to decline unless productivity growth picks up or immigration increases.

Public policy has an important role to play and considerable progress has already been made with both macro and micro policies. Going forward, public policy can support productivity growth by reinforcing and enhancing the factors discussed above that have contributed to produc-

tivity growth. This includes continued progress on multilateral trade liberalization, secure and enhanced access to U.S. markets, low inflation, prudent fiscal management, renewed efforts to reduce structural rigidities in the economy and improve flexibility, effective capital market regulation that enhances the efficient provision and allocation of capital, good corporate governance, strong primary and secondary school systems that develop life-long learning skills, a post-secondary system that provides well-trained graduates and a home base for advanced research, and employer-sponsored training to maintain and improve skills while working.

Notes

* I am very grateful to my colleague Allan Crawford for many helpful discussions on this topic. This commentary draws heavily on previous work by myself and James Yetman (Macklem and Yetman, 2001) as well as recent articles by Allan Crawford (2002, 2003). This paper is based on a presentation at the CSLS session on Perspectives on Future Productivity Growth in Canada at the 2003 Canadian Economics Association meetings at Carleton University, Ottawa, Ontario, May 31-June 2. Email: tmacklem@bank-banque-canada.ca.

1 The focus on the business sector facilitates Canada-U.S. comparability based on published sources. Throughout this commentary, growth over the period A to B refers to the level in period B over the level in period A, all divided by the number of years from A to B. Labour inputs are measured as hours worked and labour productivity is measured as output per unit of labour input. Data sources are provided in the accompanying figures.

2 The Jorgenson, Ho and Stiroh study reported is the latest available update of their on-going work in this area — see also Jorgenson, Ho and Stiroh (2002). Similarly, the numbers reported in Table 1 for Armstrong et al. are drawn from an update to the original article. This update is published in Statistics Canada's *Daily*, July 12, 2002.

3 Khan and Santos (2002) also provide a Canada-U.S. comparison of the contribution of ICT to productivity growth and come to similar conclusions.

4 The estimate of TFP growth in the ICT-producing sector is drawn from Muir and Robidoux (2001) since Armstrong et al. do not separate out TFP growth in the ICT-producing sector from overall TFP growth.

5 In his commentary on future productivity growth in this issue, Robidoux (2003) also makes this point, but puts the emphasis on the improvement in TFP growth in Canada in the non-ICT-producing sector with particular focus on the service sector.

6 The trade share is defined as the sum of exports and imports divided by GDP.

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Future Productivity Growth in Canada: The Role of the Service Sector

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Finance Canada

Productivity growth has increased markedly in Canada since 1996. What will be the productivity performance of Canada over the coming decades? Instead of turning to a crystal ball, one may want to look back and carefully examine recent data and analyses to obtain some insight on likely future developments. This is the approach used in this paper. We examine recent empirical evidence on productivity growth emerging from aggregate and industry data for Canada and the United States. We also examine briefly the evidence for other OECD countries.

A survey of the available evidence suggests that the productivity resurgence in Canada and the United States during the second half of the 1990s resulted to a large extent from improved performance of the service sector — mainly wholesale and retail trade. The service sector invested heavily in information and communication technologies (ICT) over many years, leading to a pick-up in total factor productivity growth. While there is no evidence of a similar adjustment in other G-7 countries, productivity growth increased in ICT-intensive service industries in many smaller OECD countries.

While this leads us to conclude that the increase in Canada's labour productivity growth reflects structural changes, the continuation of this performance will depend to a large extent on the ability of the service sector to continue to use and efficiently embody ICT, and machinery and equipment more generally, in their production and management processes. We argue that, in the long run, the role of the service sector in determining the productivity performance of the economy in Canada, and elsewhere, will only grow given historical trends and population ageing.

Evidence from Aggregate and Industry Data in Canada and the United States

It is well known that labour productivity growth has increased significantly in the United States starting in 1995. A similar acceleration also occurred in Canada starting in 1996. As a matter of fact, data up to 2001 suggest that the pick-up in labour productivity growth has been as remarkable in Canada as in the United States (Table 1).[1] For the whole economy, labour productivity growth, defined as GDP per hour, increased to about 2 per cent per year, an acceleration of almost 1 percentage point from the post-1973 performance in both countries.

Is this improvement cyclical or structural? While there have been debates on this issue,

there is now a consensus emerging in the literature according to which the U.S. productivity resurgence is to a large extent structural.[2] While there is much less literature that has examined Canadian data, results reported in Robidoux and Wong (2003) also point in that direction.

What is the source of this structural improvement in productivity growth? This is an important question because it may help in the assessment of whether the increase in productivity growth is sustainable. For example, while an increase in capital deepening may be difficult to sustain, a higher rate of total factor productivity (TFP) growth may bode better for productivity prospects despite the higher degree of ignorance concerning the determinants of this source of growth.[3]

A number of studies have examined the source of the acceleration in productivity growth in the United States using the growth accounting framework at the *aggregate level* — i.e. for the overall business sector. They concluded that a large increase in TFP growth in ICT-producing industries, together with an increased use of ICT capital in the rest of the economy accounts for most of the U.S. productivity resurgence. However, these studies did not find much evidence of a pick-up in TFP growth outside the ICT sector. This was particularly the case for a recent paper by Stephen Oliner and Daniel Sichel that looks at the 1995-2001 period.[4]

In Canada, the evidence emerging from aggregate growth accounting exercises suggests a rather different story where ICT plays a more muted role — both because the ICT sector is smaller and the run-up in ICT use has been less prevalent — and TFP growth (outside of the ICT-producing sector) is the major source of the improved productivity performance.[5]

However, aggregate growth accounting studies have their limitations, one of which is their lack of industry detail. A recent analysis by Faruqui et al. (2003) fills some of that gap by calculating labour productivity growth at the *industry level* for both Canada and the United States in a consistent manner. The results show that labour productivity growth increased in the manufacturing sector in the United States after 1995, essentially reflecting productivity improvement in the ICT sector, while it remained roughly unchanged in Canada. However, the more striking result from that study is the large acceleration in labour productivity growth in the service sector.[6] In both countries, productivity growth in the service sector increased from about 1 per cent in the early 1990s to almost 2.5 per cent in the late 1990s (Table 2). Since the service sector is much larger than the manufacturing sector, this means that the service sector accounted for most (about 80 per cent) of the productivity resurgence since the mid-1990s in Canada as well as in the United States.

Are service sector productivity gains widespread or concentrated in a small number of industries within the sector? Data suggest that in the United States most of the gains originate in the wholesale and retail trade sectors and, to a lesser extent, in finance, insurance and real estate

Table 1
Labour Productivity Growth
(average annual rate of change)

	(1) 1973-1989	(2) 1989-1996	(3) 1996-2001	(3)-(2) Change
Canada				
Business Sector	1.3	1.2	2.3	1.1
Total Economy	1.4	1.2	2.0	0.8
	(1) 1973-1989	(2) 1989-1995	(3) 1995-2001	(3)-(2) Change
United States				
Business Sector	1.5	1.4	2.4	1.0
Total Economy	1.2	1.1	1.8	0.7

Sources: Labour productivity corresponds to real GDP per hour. For the business sector: Statistics Canada and Bureau of Labor Statistics labour productivity series. For the total economy: real GDP from National Accounts divided by hours from Statistics Canada (LFS) and BLS (unpublished). The BLS hours series is constructed from both the Current Population Survey and Current Establishment Survey.

Table 2

Sectoral Labour Productivity Growth, Canada and the United States

(average annual rate of change)

	Canada			United States		
	1987-1996	1996-2000	Change*	1987-1996	1996-2000	Change*
Business Sector	1.0	2.2	1.2	1.5	2.6	1.1
Sectoral Breakdown						
Primary	3.1	5.2	2.1	2.7	3.9	1.2
Construction	-0.7	0.4	1.1	0.2	-1.0	-1.2
Manufacturing	2.1	1.9	-0.2	2.6	4.6	2.0
Services	0.7	2.3	1.6	1.1	2.3	1.2

* Percentage points.

Source: Faruqui et al. (2003), U.S. figures are adjusted for statistical discrepancies. Labour productivity is defined as real GDP per hour.

Table 3

Labour Productivity Growth in the Service Sector, Canada and the United States

(average annual rate of change)

	Canada			United States		
	1987-1996	1997-2000	Change*	1987-1995	1995-2000	Change*
Service	0.7	2.1	1.4	0.9	2.4	1.5
Transportation	1.7	1.7	0.0	1.3	1.9	0.6
Communication	3.3	-	-	4.8	2.1	-2.7
Other Utilities	-0.8	-	-	2.5	2.5	0.0
Wholesale Trade	1.7	3.5	1.8	2.7	5.8	3.2
Retail Trade	0.5	3.0	1.5	1.6	5.3	3.7
FIRE	1.2	3.3	2.1	1.8	2.9	1.1
Other Services	-0.4	-	-	-0.6	0.0	0.5

* Percentage points.

Sources: Annex tables from unpublished and unabridged version of Faruqui et al. (2003), except for detailed service sectors over the 1997-2000 period for Canada that are from Statistics Canada and correspond to GDP at basic prices per hour worked.

(FIRE).[7] While consistent time-series productivity data by industry are still not available for Canada at that level of detail, available output and hours data suggest that a very similar story holds true for Canada as well (Table 3).

Are service sector productivity gains linked to ICT use? One may suspect so since the industries that use ICT most intensively are located in the service sector. As a matter of fact, there is now widespread evidence that the acceleration in productivity growth has been primarily located in industries that use more intensively ICT, namely service industries. This view is supported by raw data presented in Table 4 as well as by a number of empirical analyses (Stiroh, 2002; van Ark et al., 2002, 2003; Gu and Wang, 2003).

One important point, however, is that these analyses differ from the aggregate growth accounting studies noted above because they look at the effect of the (past) level — not the growth — of ICT capital on labour productivity growth. So, these studies are implicitly testing the impact of ICT on productivity growth in an endogenous growth framework rather than in the exogenous growth framework and hence tend to support the view that ICT is more a general-purpose technology rather than just another type of capital.[8]

Table 4
Labour Productivity Growth by Industry and ICT Intensity, Canada and the United States[9]
(Average annual rate of change)

	Canada			United States		
	1987-1996	1997-2000	Change	1987-1995	1995-2000	Change
Business Sector	1.1	1.8	0.8	1.0	2.1	1.1
ICT-intensive	1.9	3.5	1.7	1.8	3.8	2.0
Less ICT-intensive	0.5	0.5	0.0	0.0	0.0	-0.1
Manufacturing Sector	2.7	1.7	-1.0	3.2	3.4	0.2
ICT-intensive	4.8	10.7	5.9	4.5	6.9	2.3
Less ICT-intensive	2.6	0.7	-1.8	2.2	0.3	-1.9
Service Sector	0.7	1.8	1.1	0.4	2.0	1.6
ICT-intensive	1.7	3.2	1.5	1.1	3.4	2.1
Less ICT-intensive	-0.5	-0.4	0.1	-1.0	0.1	1.0

Sources: Labour productivity corresponds to real GDP at basic prices per worker (Statistics Canada) and gross product originating per full-time equivalent employees (Bureau of Economic Analysis). See footnote 9 for more details.

So, after all, is the impact of ICT on service sector productivity growth the result of a faster accumulation of ICT capital in the late 1990s or an improvement in total factor productivity growth caused by a successful incorporation of ICT in the production and management processes in the 1980s and early 1990s? No direct industry growth accounting evidence is available for Canada but all indirect evidence noted above points in the direction of the latter explanation. For the United States, a recent study by Jack Triplett and Barry Bosworth concludes that most of the improvement in service sector productivity growth came from a pick-up in TFP growth: "*With respect to the post-1995 acceleration of labour productivity, however, MFP is the dominant factor in the acceleration, because IT capital deepening was as prominent a source of labour productivity growth before 1995 as after.*"[10] Moreover, industry details provided in their analysis indicate that the improvement has been particularly important in large service sectors such as wholesale trade, retail trade and finance.[11]

Overall, this suggests that the productivity resurgence in Canada and the United States has similar roots: service sectors that have invested heavily in ICT over many years, leading to a pick-up in total factor productivity growth during the second half of the 1990s. This also suggests that the marked fall in ICT investment in the last downturn and the modest recovery since then may not lead to a fall in productivity growth as suggested implicitly by aggregate growth accounting studies. In this respect, the continued solid productivity performance in 2002 supports the view that TFP growth in the service sector has increased during the 1990s both in the United States and Canada.

International Evidence

If ICT were effectively a "general purpose technology" that could be used to improve productivity growth, in the service sector in particular, one would expect an increase in productivity growth not only in Canada and the United States, but also in other countries. This is, after all, what happened in the early 1970s when the productivity growth slowdown was widespread

Table 5
International Evidence on Labour Productivity Growth
(Average annual rate of change)

	Total Economy			Business Service Sector		
	1973-1989	1996-2001	Change*	1973-1989	1996-2001	Change*
United States	1.2	1.8	0.5	0.7	3.4	2.7
Australia	1.5	1.9	0.5	0.8	2.7	1.9
Canada	1.4	2.0	0.7	0.6	2.4	1.8
Norway	3.3	1.9	-1.4	1.2	2.8	1.6
United Kingdom	2.1	1.6	-0.5	1.3	2.3	1.0
Denmark	2.4	1.8	-0.6	0.8	1.6	0.7
Sweden	1.5	1.7	0.3	1.0	1.6	0.6
Belgium	2.8	1.6	-0.5	1.7	1.3	-0.4
Spain	3.3	-0.5	-3.8	0.9	0.3	-0.6
Finland	2.4	2.5	0.2	2.3	1.6	-0.8
Germany	2.3	1.3	-1.0	1.9	1.1	-0.8
Italy	2.8	0.9	-1.9	1.0	0.2	-0.9
France	3.0	1.8	-1.2	2.4	-0.0	-2.4
Japan	3.1	1.5	-1.6	4.4	1.4	-3.1

* Percentage points.

Note: Australia (1974-1989), France (1978-1989), Japan (1981-1989), Spain (1980-1989), Sweden (1980-1989 and 1996-2000) and United States (1977-1989).

Sources: OECD Economic Outlook and STAN database, Statistics Canada, BEA and BLS. For the total economy, labour productivity corresponds to GDP per hour. For the business service sector, labour productivity corresponds to value-added per worker.

among industrialized countries, perhaps as the application to the production process of previous general purpose technologies matured.

However, when looking at other countries there is not much evidence of a pick-up in productivity growth similar to that experienced in Canada and the United States. While productivity growth picked up significantly in Australia,[12] and probably earlier than it did in the United States, it slowed or remained unchanged in many European countries in the second half of the 1990s.[13] However, this aggregate picture hides productivity improvement in ICT-intensive service sectors in some European countries. Van Ark et al. (2002) find that labour productivity growth in ICT-intensive service sectors increased significantly in six European countries between the first and second half of the 1990s.[14]

Most recent data on labour productivity growth from the OECD database presented in Table 5 are in line with the results of van Ark et al. (2002). Productivity growth in the service sector, and in some cases in the overall economy, increased in a number of small European countries in the late 1990s compared to the 1973-1989 period. The most striking result from these data, however, is the lack of any evidence of a pick-up in productivity growth in the service sector or the overall economy in large European countries as well as in Japan. Among the G7 countries, the United Kingdom is the only country aside from Canada and the United States where productivity growth in the service sector increased, but its overall productivity growth performance deteriorated. Overall, this suggests, albeit tentatively, that the successful incorporation of ICT in the production of services is also underway in other countries, which may lead to better productivity growth performance in coming years.[15]

Concluding Remarks

Using aggregate growth accounting technique, Robidoux and Wong (2003) concluded that total-economy trend labour productivity (GDP per hour) growth for Canada increased steadily in the 1990s, reaching about 2 per cent per year in recent years. The examination of the broader empirical evidence discussed above supports this conjecture.[16] But, it also suggests that Canada's productivity performance will depend to a large extent on the ability of the service sector to continue to use and efficiently incorporate ICT, and machinery and equipment more generally, in production and management processes.

Furthermore, the role of the service sector in determining the aggregate productivity performance of the economy in Canada and elsewhere in the world will not abate but rather grow in importance. Despite the rise in the prices of services relative to those of goods, aggregate demand has shifted towards services in recent decades and is likely to continue to do so in coming decades.[17] This process is indeed likely to accelerate with population ageing over the coming decades. In effect, an increase in the proportion of elderly in the population is likely to shift aggregate demand towards services, such as health services.

Although the positive impact that ageing may have on physical and human capital deepening is well documented,[18] the impact changes in the composition of aggregate demand may have on TFP growth seems to have been neglected in the literature. On the positive side, research and development and ensuing innovations are probably endogenous to the composition of final demand and will surely adjust over time to this new reality. However, bumps in the road have to be expected given the non-linear processes behind research and innovation. And, this does not account for the possibility that certain innovations may lead service-sector industries to experience productivity gains that are not accurately measured.

Notes

* I thank Max Baylor, Anthony Fisher, Jeanne Lafortune and Frank Lee for comments and suggestions. The views expressed in this paper are my own and should not be attributed to the Department of Finance. This paper is based on a presentation at the CSLS session on Perspectives on Future Productivity Growth in Canada at the 2003 Canadian Economics Association meetings at Carleton University, Ottawa, Ontario, May 31-June 2. Email: robidoux.benoit@fin.gc.ca.

1 Following Robidoux and Wong (2003) who advocate that each country should be examined according to its own breakpoint, we consider the change in labour productivity growth starting in 1995 in the United States, but 1996 in Canada. We also exclude data available for 2002 and the first half of 2003 because productivity data tend to be revised significantly. More importantly, in recent years revisions were not white noises on both sides of the border: most of the time productivity growth was revised downward in the United States, while the opposite occurred in Canada. In any event, including 2002 would not change significantly the relative Canada-U.S. picture provided in Table 1 as long as the total economy is used as benchmark.

2 See Gordon (2002, 2003), Basu et al. (2001), Stiroh (2002) and Oliner and Sichel (2002).

3 This is to say that, unlike labour productivity growth attributable to capital deepening, TFP growth reflects a not particularly well-understood process that combines the influence and interaction of many factors.

4 Oliner and Sichel (2002). See also Jorgenson and Stiroh (2000), and Oliner and Sichel (2000).

5 See Robidoux and Wong (2003), Armstrong et al. (2002), Khan and Santos (2002) and Muir and Robidoux (2001).

6 The key role of the service sector in the U.S. productivity revival has been first mentioned by Sharpe (2000) and Baily and Lawrence (2001).

7 This is based on results from Faruqui et al. (2003) that are reproduced in Table 3. Similar but more detailed results were reported earlier by Baily and Lawrence (2001). These more detailed results show that the improvement in FIRE mainly originated from the finance sector, while some notable increases in productivity growth occurred within "other services" for personal, business, and health services.

8 While the differences between endogenous and exogenous growth models is often exaggerated (Temple, 2003), the former type of model assumes that the level of capital affects the level of productivity contemporaneously, while the latter type of models assume that the level of growth drivers, which may include physical capital, affect, often

with lags, not the level but the rate of growth of productivity.

9 We thank Julie Turcotte and Yves Fontaine for kindly providing these data. For Canada, productivity growth by industry is constructed from Statistics Canada's data on output and employment. Within a sample of 13 industries, ICT-intensive industries are defined as industries that have an ICT capital stock to non-residential capital stock ratio greater than the private sector ratio. For the United States, labour productivity is defined as gross product originating divided by full-time equivalent employment from the BEA. A total of 57 industries were divided according to their ICT investment-to-output ratio in 1996 such that about 50 per cent of output originates from ICT-intensive industries. Stiroh (2002) and van Ark et al. (2002) show that the general results are not sensitive to the measure used to define the ICT-intensive industries. Note that the results for the manufacturing sector should be interpreted carefully since ICT-intensive industries include ICT-producing industries.

10 Triplett and Bosworth (2002: 25). See Triplett and Bosworth (2003) for a shorter version. Basu et al. (2003) obtain similar results, while Jorgenson et al. (2002) used a different data set and find a larger role for ICT capital deepening. Note, however, that labour productivity growth *fall*s in the second half of the 1990s in the wholesale trade sector in Jorgenson et al. (2002), while it increases in Basu et al. and Triplett and Bosworth.

11 Gross output instead of value-added is used when calculating labour productivity. Triplett and Bosworth have also some concerns about data quality in the security, commodity brokers and service industry, which shows the largest increase in productivity among all service industries, but their results are not qualitatively changed when this industry is removed from the sample.

12 See Parham (2002) for a discussion of the Australian productivity revival.

13 Ireland is a notable exception.

14 These countries are Denmark, Finland, Ireland, the Netherlands, Sweden and Switzerland.

15 See Basu et al. (2003) and van Ark et al. (2002) for analyses that support that optimistic view for the United Kingdom and Europe, respectively.

16 A similar conclusion is reached by Macklem (2003).

17 See Mohnen and ten Raa (2000) for an analysis of trends in the Canadian service sector.

18 See Mérette (2002) and Scarth (2002) for a general exposition of the potential impacts of ageing on labour productivity.

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The Sources of Economic Growth in OECD Countries: A Review Article

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In early 2003 the OECD published a major report entitled *The Sources of Economic Growth in OECD Countries*[1] that summarized the main findings of the OECD growth project initiated in 1999. The objective of the project had been to explain the reasons for different growth experiences across OECD countries and to identify policies, institutions and other factors that could contribute to enhancing long-term growth prospects. This review article provides an overview of the report and comments on the key findings.

The first broad conclusion is that there have been widening disparities across the OECD countries in rates of growth in GDP per capita in the 1990s. Some of this is due to the continued catch-up of low-income countries in the sample. But beyond this the disparities were the result of high growth rates in some already affluent countries such as the United States, Canada, Australia, the Netherlands and Norway, together with low growth rates in much of continental Europe.[2]

The OECD study also notes that disparities in growth have arisen largely from differences in labour utilization, with low growth countries experiencing slow growth or declines in employment and hours. Further, where there was weakness in labour utilization, this was not offset by faster productivity growth. The study finds that some fraction of overall growth was the result of "labour upskilling" (a shift to a more experienced or better educated workforce), but notes that in the slow-growing countries this was partially due to the fact that the low-skilled were kept out of work.

Sources of Economic Growth

The study turns next to an analysis of the sources of economic growth based upon aggregate data and using cross-country regression analysis, with a particular emphasis on the ways in which policies affect outcomes. The study argues that the causal variables looked at are able to explain much of the observed growth differences over time and across countries. It was found that investment in physical and in human capital were important to growth; that sound macro policies yield higher growth; and that the overall size of government in the economy may hinder growth if it becomes too large, although the pattern was mixed. Some government spending was found conducive to growth, while high levels of direct taxation (taxes on wages and profits) discouraged growth. R&D activities by the business sector had high social returns, and hence contributed to growth, but there was no evidence in this analysis of positive effects from government R&D. The study found some evidence that financial markets are important to growth, helping to channel resources towards the most rewarding activities, and encouraging investment.[3]

A very interesting and surprising result from the aggregate regression analysis is that "exposure to international trade" is an important determinant of output per working age person. The analysis concludes that an increase of 10 percentage points in trade exposure (an adjusted average of exports and imports as percentages of GDP)[4] raises output per person by 4 percentage points.[5] This result is not surprising in terms of the direction of the effect, but is remarkable in the magnitude — the report states that between the 1980s and 1990s trade exposure on average increased by about 10 percentage points. This result, if taken at face value, gives strong support to the view that increased globalization improves economic performance. It suggests that all OECD countries should move aggressively to remove remaining barriers to trade, and do so for their own advantage.

The OECD study does not highlight this conclusion in its main report, perhaps because of the difficulty of interpretation. There may be an issue as to whether trade leads to stronger growth or whether stronger growth leads to more trade. And since trade is so concentrated in manufacturing, which is only a modest fraction of GDP, the implied impact on manufacturing would have to be four or five times as large as the impact on GDP — a result that may be hard to swallow. Nevertheless, the fact that this result comes through in the regression analysis so strongly is reassuring to those of us who believe trade and other forms of globalization are an important factor in improving productivity. It is easier to think of scaling back an effect that looks too big than trying to rationalize why an effect that is said to be important does not show up in the regression.

Some of the limitations that apply to the coefficient on trade exposure also apply to other aggregate findings. There is always the possibility that correlations at the aggregate level are not getting at the underlying causal structure. For example, it is not surprising that rapid growth in a country will require fairly high levels of capital investment and will benefit if there is an ample supply of educated workers. But it is just as plausible that a high rate of, say, capital investment is more the result of rapid growth than the underlying cause. An increase in business opportunities in an economy will spur both growth and investment.

Industry Dynamics

Acknowledging the limitations of aggregate regression analyses, the OECD study then turns to a more micro focus, looking both at growth by industry and at firm dynamics. The industry analysis starts by asking what fraction of productivity growth within the OECD countries is the result of shifts among industries. Historically this has been important, as workers move from low productivity jobs in agriculture to much higher productivity jobs in industry and services. Many years ago Edward Denison argued that this accounted for an important part of the rapid growth in Europe and Japan after WWII. In the 1990s, however, industry shifts were not that important for the high-income countries like France, Germany, Italy, the United Kingdom, the United States or Japan. Almost all of the difference in overall growth rates is accounted for by differences in productivity performance within industries. The industry analysis also revealed that productivity growth differences across countries *within* manufacturing industries were not large. However, the fact that the high-tech sector in the United States was larger than in Europe gave it an advantage in productivity growth in the manufacturing sector as a whole.

The OECD regression analysis of industry productivity starts by estimating multifactor productivity (MFP) for each industry in each country in each year over the period 1984-98 — a huge data exercise. MFP growth in a given year/industry/country then depends on how fast

MFP is growing in the productivity leader (a measure of how fast the frontier is moving out); how far the level of MFP is behind the leader (a measure of the potential for catch-up); and a set of policy variables. Tests are made for the impact of industry and country dummy variables and additional regressions are run to assess the role of R&D, corporate structure and industrial relations systems.

The conclusions, and particularly the implications that emerge for policy, from this effort are as follows. The finding judged most important is that "stringent regulatory settings in the product market, as well as strict employment legislation, have a negative bearing on productivity at the industry — and, therefore, macro — levels."[6] This broad finding is qualified, however, by the argument that the impact of regulation varies depending on the nature or position of an industry. In particular, the impact of product market regulation on productivity is greater when industries are far away from the productivity frontier. That result makes sense, since the structural changes needed to reach the frontier will be larger in those cases and presumably more sensitive to barriers to change created by regulation.

The impact of labour market regulation also varies by industry situation. Hiring and firing restrictions have a negative effect on productivity performance when they are not offset by lower wages or by internal training. Thus the adverse effect of labour market rigidity is mitigated, according to these findings, if workers are willing to pay for it, through lower wages, or if firms respond to it by providing additional worker training.

The study does find some support for the view that R&D contributes to growth, but the results are qualified in ways that I do not find intuitive. I end up concluding that this data set does not provide very clear guidance as to the role or importance of R&D to growth. There is one intuitive result that is linked to innovation, however. The study finds that a German-style company structure does well in making incremental innovations in industries with a stable dominant technology (one thinks of the success of German capital goods producers). A more relaxed structure without institutionalized labour relations does better at innovating in rapidly evolving technologies (one thinks of IT and Silicon Valley).

This finding may explain, in part, the problems with job creation in Europe. Innovation in large firms with established technologies will often result in productivity growth that reduces employment. This is the picture one sees in industries such as steel and autos. Innovation in new firms or new establishments is more likely to involve new products and services.

Firm Dynamics

The final step of the study is to incorporate findings from a large volume of new work based on individual firms or establishments. Data at this level has revealed a very large degree of heterogeneity among firms in productivity growth rates and levels. This is consistent with a "creative destruction" view of the economy in which new firms enter, weak firms exit and incumbent firms struggle for market share and profits. There is also, of course, the problem that data errors introduce spurious differences across firms or over time. It is easy to see the heterogeneity, but discerning clear patterns in the data is much harder. The OECD and the academics that were part of the study worked at length to clean the data and capture its insights. The study included Finland, France, West Germany, Italy, the Netherlands, Portugal, the United Kingdom and the United States, and the productivity growth calculations were based on two five-year intervals, 1987-92 and 1992-97. The results for manufacturing are

much more extensive than for services, but there are some service sector findings also.

The first insight is that for these OECD countries, the bulk of labour productivity growth comes from improvements within firms rather than from reallocation of output or inputs among firms. The entry and exit of firms is important however, accounting for 20 to 40 per cent of total growth. For most of the countries the entry of new firms adds to productivity growth, but the United States is different. Entrants in the United States start with productivity levels well below the average and grow from there. The positive contribution in the United States comes from the exit of low productivity firms. Inevitably, the contribution of entry to growth is greater over longer periods of time.

The findings for MFP are a bit different, in that within-firm productivity growth is a smaller part of the total and the impact of entry and exit and reallocation are larger. Tentatively, therefore, the conclusion is that incumbent firms, which are generally larger, are able to invest and raise labour productivity, while new firms bring more innovative technology or new business processes.

An important and very surprising finding is that entry and exit rates are not greatly different between the United States and European countries. Despite the similarity in average turnover rates across countries, the regression analysis does tease out a negative effect of both product and labour market regulation on firm entry rates. Controlling for other determinants of entry and exit, the impact of regulation does show up in the data.

There is an argument made, indeed I have often made it myself, that rigidities in Europe discourage the entry of new firms and restrict the exit of old firms. If this is correct, it is very surprising that it does not show up as lower overall entry and exit rates in Europe, relative to the United States, either in manufacturing or in the broader business sector. I am not ready to discard old views just on the basis of this finding, and indeed neither is the OECD study, so how can this puzzle be resolved? One possibility is that rigidities in Europe *delay* adjustment and delay the exit of firms, but over time they cannot override the market forces that force uneconomic firms to leave. For example, if real wages are stuck at too high a level in Europe, then the economic pressure on firms to exit, over this period, may have been even higher than in the United States.

The most dramatic difference between the United States and Europe that shows up in this firm-level analysis occurs in the extent to which entering firms add to their employment over time. This finding has received a good deal of attention, understandably so. It shows that entering firms in the United States have dramatically increased their employment after 2, 4 or 7 years relative to their initial size. Entrants in the United States overall are smaller than in most of the other countries, have an above average probability of survival and grow employment much more than entrants in the other countries.

In summary, the firm level analysis does provide some intriguing insights, if not yet, complete answers. The study stresses, correctly, the high degree of churning in all countries. The importance of the creative destruction process and market experimentation is clear. Compared to Europe, entering firms in the United States are smaller and of lower relative productivity. If successful, however, they grow employment much more rapidly than entrants in the other countries.

In the policy arena this part of the research supports the idea that excessively stringent regulation in both product and labour markets will hinder growth. It illustrates vividly the constant churning that goes on in markets and shows that even though many European countries have barriers to economic change, the change happens anyway. There is an irresistible force of economic change and industry evolution. These barriers, however, may slow down the pace of innovation and the creation of new employment opportunities.

Conclusion

Overall, therefore, the OECD growth study provides important new understanding of economic growth in the 1990s and how policy differences have resulted in different outcomes (Truth in advertising: during my time as Chairman of the Council of Economic Advisers I was a strong supporter of this project). The diversity of performance within Europe in particular is notable. There is not just a U.S.-E.U. split in growth performance; some European economies and other OECD economies besides the United States have performed well over this period. Aside from the comments and criticisms given above, the main omission from the study is of ways to improve employment growth, especially in Europe. Combining full employment with high productivity is the challenge for policymakers and this report says very little about the need for labour market reform.

Notes

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1 The report can be downloaded at no cost in PDF e-book format or purchased for $40 U.S. from the OECD online bookshop (see www.oecd.org).

2 See page 51 in the report.

3 See pages 89-90 in the report.

4 The variable is described as a weighted average of export intensity and import penetration. In the empirical analysis this measure was adjusted for country size by regressing the crude trade exposure variable on population size and taking the estimated residuals from this exercise as the adjusted trade exposure. See Box 2.3 on page 78 of the report.

5 Table 1 in OECD, *The Policy Agenda for Growth,* 2003, a summary of the larger report.

6 See page 121 in the report.