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What Explains the Canada-US ICT Investment Intensity Gap?

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Executive Summary

This report attempts to answer the question of why Canadian firms invest less in ICT, defined to include computers, communications, and software, than their US counterparts. Given the disappearance of labour productivity growth in the business sector in Canada in 2003 and 2004 and the large gap in labour productivity levels between Canada and the United States, lagging ICT investment has been identified as a possible cause of both this weak growth and large gap. In addition, higher rates of ICT adoption have been pointed to as means of improving Canada's productivity performance. An understanding of the causes of the Canada-US ICT investment gap is thus crucial for the correct diagnosis of Canada's productivity problem and the development of effective policies to reverse this situation.

This report is divided into two main parts. The first part provides an overview of trends in ICT investment in Canada, relative to the United States, and relative to OECD countries. Given that the United States is by far Canada's largest trading partner, a US-centric approach is appropriate. But it is also important to situate Canada within a broader international perspective. This section also discusses the consistency between ICT investment estimates and the actual use of ICT in this country.

The second part of the report provides a detailed discussion of possible causes of the Canada-US ICT investment gap. The explanations are divided into four main areas: statistical and methodological differences, differences in economic structure, cultural and behavioural differences, and macroeconomic differences. This part also includes a discussion of the literature on the factors influencing ICT adoption.

In terms of Canada's ICT performance, the main findings of the report are highlighted below.

- In 2004, current dollar ICT investment per worker in the Canadian business sector was 45.1 per cent of that of the United States. This low proportion applied to all three ICT asset types – software (43.5 per cent), communications equipment (44.1 per cent), and computers (54.1 per cent).

- The largest industry contributions to the Canada-US ICT investment per worker shortfall in 2004 were from professional, scientific and technical services, which accounted for 26 per cent of the gap, manufacturing (20 per cent), transportation and warehousing (11 per cent), and information and cultural industries (9 per cent).

- A second metric for Canada-US ICT investment intensity comparisons, because of productivity level differences between the two countries, is ICT investment as a share of GDP. On this criteria, ICT investment in the Canadian business sector in 2004 was 61.6 per cent of the US level. Again, all three ICT asset types were well below the US level – software (59.4 per cent), communications equipment (60.2 per cent), and computers (73.8 per cent).

- Canada's lower share of ICT investment in GDP was not accounted for by a lower overall investment share in GDP, but by a lower share of ICT investment in total business sector investment, 18.5 per cent versus 30.5 per cent in 2004.

- Both ICT per worker and ICT as a share of GDP in the Canadian business sector have been on a strong downward trend in Canada, relative to the United States, over the past 17 years. The former fell from 60.4 per cent in 1987 in 45.1 per cent in 2004, while the latter decreased from 74.0 per cent to 61.6 per cent.

- Given that ICT investment accounted for 30 per cent of total current dollar business sector machinery and equipment (M&E) investment in 2004, the shortfall in ICT spending by the Canadian firms relative to their US counterparts explains much of the lower M&E investment intensity in this country. Non-ICT M&E investment per worker in the Canadian business sector was 70.3 per cent of the US level in 2004 and non-ICT M&E investment as a share of GDP was 96.0 per cent.

- Although a poor performer in terms of ICT investment relative to the United States, Canada in 2001 ranked above the OECD average (eighth or ninth out of 19 OECD countries) for the share of ICT investment in total investment, the share of ICT investment in GDP, and ICT investment per worker.

- Data on computers in use in Canadian business support the finding based on computer investment data that Canadian workers have much less computer capital to work with than their US counterparts. However, data on telecom equipment use and telecom services availability appear similar in the two countries. This situation appears inconsistent with the reported large shortfall in communications investment in Canada relative to the United States.

The report investigated a large number of possible reasons for the Canada-US ICT investment intensity gap. The factors can be organized into four categories based on the evidence found during the course of the research:

- factors where there is strong, quantitative evidence that they contribute to the gap;

- factors that appear to contribute to the gap, although the evidence is weaker;

- factors where there is evidence that they do not contribute to the gap; and

- factors for which the evidence is inconclusive.

The report identified three factors that fall into the first category: industrial structure, the size distribution of employment, and ICT measurement. Canada has smaller employment shares than the United States in two ICT-intensive industries: the cultural and information industry, which includes telecommunications, finance, insurance and real estate. Equally, Canada has a larger share of employment in small- and medium-sized enterprises than the United States, and these firms spend less on ICT than larger firms. Simulations using 2003 data show that if Canada had the industrial structure and size distribution of employment of the United States, 7-8 points of the 38.4 percentage point gap in the Canada-US share of ICT investment in GDP would be eliminated. Thus these two factors together account for about 20 per cent of the gap.

Our research uncovered gaps in the measurement of ICT investment by Statistics Canada. The survey used to estimate investment ICT assets in the oil and gas industry does not identify ICT assets. There is no investment survey of either the construction or fishing industries so ICT investment for these industries is likely underestimated. Because the industries affected are relatively small, the effect of this underestimation of ICT assets on the Canada-US ICT gap is also small, around 1 percentage point.

In terms of the second category of factors, the report identified two factors. The first is the 20 per cent lower labour compensation costs in Canada relative to the United States. In surveys of factors influencing the adoption of advanced technologies, firms identify cost as the most important barrier. With ICT investment goods prices similar in both countries, the higher price of ICT investment goods relative to labour costs in Canada makes firms more reluctant to substitute capital for labour by adopting ICT than their US counterparts. The second factor is the much greater extent of foreign direct investment in Canada than in the United States. Multinationals often purchase ICT assets such as servers and software in the home country for use in the host countries, with the result that these investments are sometimes not recorded in the host country. The third factor, with the weakest evidence, is that the proportion of Canadian managers with a university education is less than in the United States. To the degree that university educated managers are more comfortable with ICT, and more able to appreciate the potential benefits, this educational attainment gap may contribute to the ICT intensity gap.

In terms of the third category of factors, the evidence indicates that differences in the definition of ICT assets by statistical agencies do not explain the ICT investment intensity differences between Canada and the United States. Equally, the marginal effective tax rate on ICT assets in 2005 is similar in Canada and the United States so therefore cannot account for current differences in ICT investment although, in the past, tax rates on ICT assets were somewhat higher in Canada than in the United States and may have played some role in explaining the gap.

There is much anecdotal evidence that there are cultural differences in the operation of businesses between Canada and the United States and that these differences account for the ICT investment gap. Unfortunately, this report found no hard data to support this view, although it may still be valid and may indeed account for part of the gap. Further research is needed that surveys managers in both countries on their attitudes to ICT. Lower ICT investment is Canada may also reflect the lower intensity of competition in this country, but again the evidence on this issue is inconclusive at this stage.

What Explains the Canada-US ICT Investment Gap?[1]

It is widely recognized that machinery and equipment (M&E) investment intensity is lower in Canada than in the United States (Sharpe, 2004). Indeed, the Minister of Industry highlighted this fact in a recent speech.[2] What is less well known is that it is the information and communications technology (ICT) component of M&E investment that largely accounts for the M&E investment gap. The objective of this study is to shed light on the factors that account for this gap in ICT investment between Canada and the United States.

Given the disappearance of labour productivity growth in the business sector in Canada in 2003 and 2004 (Rao, Sharpe and Smith, 2005) and the large gap in labour productivity levels between Canada and the United States,[3] lagging ICT investment has been identified as a possible cause of both this weak growth and large gap. Indeed, a recent study (Fuss and Waverman, 2005: 42) estimates that the lower ICT capital stock intensity explains for 56 per cent of the Canada-US labour productivity gap in 2003.[4]

In addition, higher rates of ICT adoption have been pointed to as means of improving Canada's productivity performance. An understanding of the causes of the

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[1] This report has been prepared by the Centre for the Study of Living Standards (CSLS) for the Information Technology Association of Canada (ITAC) and its consortium of funders (Bell Canada, Hewlett Packard, Industry Canada, Intel, Microsoft, Nortel, and SAP Canada). An abridged version of the paper is published in the Fall 2005 issue of the *International Productivity Monitor*. The CSLS would like to thank Lynda Leonard and Bernard Courtois from ITAC for their support of this project. The CSLS would like to thank the following people for their assistance in the preparation of the report: Richard Landry, Mychèle Gagnon, Gilbert Paquette, Michel Pascal, and John Foley of Statistics Canada; David Wasshausen fromthe US Bureau of Economic Analysis, and Gabriel Verret at the University of Ottawa and the following persons for useful comments: Lynda Leonard and Bernard Courtois from ITAC, Frank Lee, John Lester and Benoit Robidoux from Finance Canada, Richard Dion from the Bank of Canada and members of the consortium of funders. The report was written by Jean-Francois Arsenault, Elad Gafni, Peter Harrison, and Sharon Qiao and Andrew Sharpe.

[2] "As a proportion of GDP Canadian firms invest less in new machinery and equipment than their counterparts in any G7 country. We know that machinery and equipment investment is key to driving new technology deep into the economy, and we're falling short… Investments in, and applications of, information and communications technologies are a major source of productivity improvements. But here again, we're still falling short of the U.S." (Speech by the Honourable David L. Emerson, Minister of Industry to the Canadian Club, Ottawa, Ontario, November 3, 2005.)

[3] Accounting to the OECD (2005: Annex Table 2), business sector output per hour in Canada in 2004 was 76 percent of the US level, a gap of 24 percentage points. Canada in 2004 ranked 17th out of 30 OECD countries in terms of labour productivity levels, down from third in 1950 and fifth in 1973.

[4] Fuss and Waverman break down the 56 per cent contribution for 2003 into 12 per cent from capital deepening and 44 per cent from ICT spillovers. The spillovers are in turn disaggregated into 2 per cent from telecom penetration and 42 per cent from IT penetration. The IT penetration is further disaggregated into 31 per cent from PC penetration (computers per capita) and 11 per cent from digital/PC interaction. Similar results were obtained for 2000, although the overall ICT contribution to the productivity gap that year was somewhat higher at 60 per cent.

Canada-US ICT investment gap is thus crucial for the correct diagnosis of Canada's productivity problem and the development of effective policies to reverse this situation reduce of the Canada-US productivity gap.

While research has been conducted on difference in ICT capital growth between Canada and the United States up to 2000 (see the studies in Jorgenson, 2004), there has been much less research on the factors behind the lower ICT capital intensity level in Canada. The object of this report is to fill this gap.

This report is divided into two main parts. The first part provides an overview of trends in ICT investment in Canada, relative to the United States, and relative to OECD countries. Given that the United States is by far Canada's largest trading partner, a US-centric approach is appropriate. But it is also important to situate Canada within a broader international perspective. This section also discusses the consistency between ICT investment estimates and the actual use of ICT in this country.

The second part of the report provides a detailed discussion of possible causes of the Canada-US ICT investment gap. The explanations are divided into four main areas: statistical and methodological differences, differences in economic structure, cultural and behavioural differences, and macroeconomic differences. This part also includes a discussion of the literature on the factors influencing ICT adoption.

Part One: An Overview of ICT Investment Trends

This part of the report provides an overview of trends in ICT investment in Canada, relative to the United States, and relative to OECD countries. Given that the United States is by far Canada's largest trading partner, a US-centric approach is appropriate. But it is also important to situate Canada within a broader international perspective. This section also discusses the consistency between ICT investment estimates and the actual use of ICT in this country.

Basic Definitions, Concepts and Relationships

This report discusses a number of economic definitions, concepts and relationships that it is important for the reader to grasp for a full understanding of the discussion. The first key concept is investment itself, which is defined by economists as expenditures on new assets or capital goods used in the production process that last more than one year. It does not mean the purchase of a financial asset or claim and excludes the purchase of land. Fixed investment, which is the focus of this study, excludes inventories, which are a component of total investment. Fixed investment is undertaken by both the business and the non-business sector (i.e. government).

The capital stock is the quantity of fixed capital that exists at a point in time and represents the accumulated flow of investment minus depreciation. Although the Centre for the Study of Living Standards has constructed estimates of ICT capital stock for Canada and the United States, which can be found in the ICT database on the CSLS website, this study will not discuss trends in ICT capital stock and instead focus exclusively on ICT investment. Since it is investment flows that determine the capital stock, trends in Canada-US ICT capital stock intensity are similar to the ICT investment intensity and their inclusion adds little. In addition, different depreciation rates and patterns and service life assumptions used in the estimation of the capital stock between Canada and the United States may account for differences in capital intensity between the two countries, differences which do not affect investment estimates.

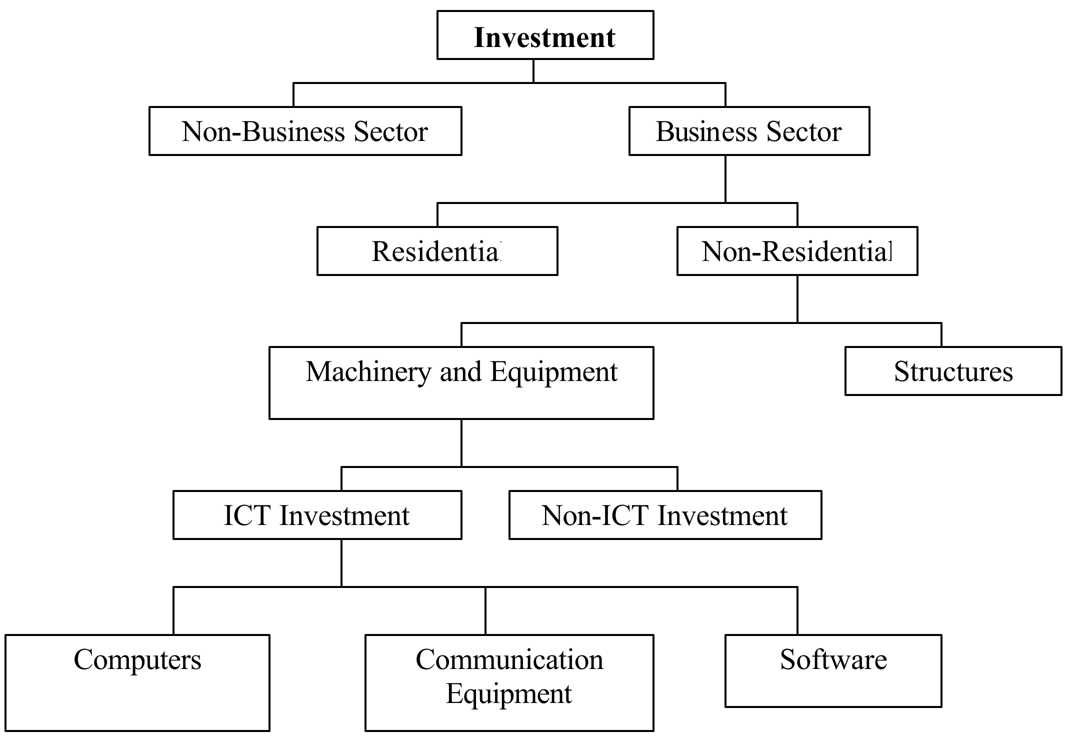
Total fixed investment is divided into residential investment (housing) and non-residential investment (Exhibit 1). Since residential investment is not used in the production process and hence does not contribute to productivity growth, it is of less interest from a productivity perspective and will not be discussed in this report.

Non-residential investment can in turn be divided into structures and machinery and equipment (M&E), with the latter sub-divided into ICT and non-ICT M&E. ICT has three components: computers, communication equipment, and software. It should be noted that software, until recently, was not part of fixed investment as defined by the national accounts. While firms continue to expense software, it is now considered a capital asset from the point of view of the official investment estimates prepared by statistical agencies because of the enlargement of the definition of investment to encompass software.

There are two measures of investment intensity: investment per worker and investment as a share of GDP. Both will be used in this report. While the former is easier to understand, the latter is more relevant for international comparisons because investment per worker is affected by a country's productivity and real income per capita level. Rich countries have much higher levels of investment per worker than poor countries, but may not have a higher share of investment in GDP.

ICT investment as a share of GDP is determined by both the overall share of investment in GDP and the share of ICT in total investment. A country might have a low level of ICT investment in GDP, because it fails to invest in all types of investment goods, or because it devotes a lower proportion of its total investment to ICT. We will see that this latter situation accounts for Canada's relatively weak ICT investment relative to the United States.

Exhibit 1. The Structure of Investment



The Centre for the Study of Living Standards ICT Database

The Centre for the Study of Living Standards (CSLS) has compiled an extensive and up-to-date database containing information on ICT investment and capital stock in Canada and the United States for use in this project. This database is publicly available on the CSLS website[5] and is composed of 29 charts and 45 summary tables comparing Canada and the United States. There are also 34 detailed tables with country-specific data on Canada and the United States. Information is available on investment and capital stock for total ICT and its three components, computers, communication equipment and software, in current and real US dollars, in most cases from 1987 to 2004.

ICT comparisons between Canada and the United States are available by four measures: relative levels of ICT investment per worker, relative levels of ICT capital stock per worker, relative levels of ICT investment as a share of GDP, and relative levels of ICT investment as a share of total investment. Estimates of ICT investment and capital stock are also available by industry[6] for Canada and the United States. Finally, information is provided on business sector non-residential total investment, business sector non-residential structures investment, and business sector machinery and equipment investment, since these components of investment are used in comparisons of ICT investment between Canada and the United States.

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[5] Website address: http://www.csls.ca/data/ict.asp.
[6] Two-digit North American Industry Classification System (NAICS) industries.

Trends in ICT Investment, Canada and the United States, 1987-2004

Trends over Time

How much has investment in ICT (expenditure on ICT investment goods) grown in recent years? To answer this question is not a trivial exercise. Simply looking at the amount of money spent on ICT investment in any given year and comparing that amount with money spent in previous years is misleading for two reasons. First, the quality of goods changes over time. A typical computer today is a very different good from a typical computer in 1988. It is clear that $1,000 spent on a computer then, would have bought much less computing power than $1,000 spent on a computer today. As a result, it is difficult to compare in a meaningful way dollar expenditures over time, and the comparison typically becomes less meaningful over longer periods. The other factor that must be accounted for when analyzing time trends in investment is that even if the quality of goods remains the same, their prices still tend to change over time. This change can be upward, in which case it is known as inflation, or downward, which case it is known as deflation. This phenomenon affects all prices in the economy and its causes lie in both supply- and demand-side factors.[7]

Trends in Current-Dollar ICT Investment

Charts 1, 2, and 3 show changes in ICT investment and its components over time in the business sector in Canada and the United States. Chart 1 shows average annual growth rates in ICT investment in current dollars, that is, not adjusted for quality and price change, 1987-2004. In this case total ICT investment increased on average 6.3 per cent per year in Canada and 7.7 per cent in the United States. In both countries software investment grew at more than twice the rate of growth in computers and communications equipment investment—at an average annual rate of 9.8 per cent in Canada and 11.6 per cent in the United States. Investment in computers grew at an average annual rate of 3.9 per cent in Canada and 5.5 per cent in the United States. Finally, average annual rate of growth of investment in communications equipment was almost the same in Canada and the United States—4.9 and 5.1 per cent respectively.

Table 1 shows average annual growth rates for ICT investment and its components for sub-periods 1987-1995, 1995-2000, and 2000-2004. Such a periodization paints a richer picture of investment trends than a simple 1987-2004 average. From 1987 to 1995 in the United States the rate of growth in ICT investment and all of its components was higher than in Canada. However, between 1995 and 2000 the growth rate of computer and communications investment in Canada was approximately twice the US rate. From 1995 to 2000 the growth rate of US software investment continued to outpace the Canadian growth rate. This discrepancy was enough to give the United States

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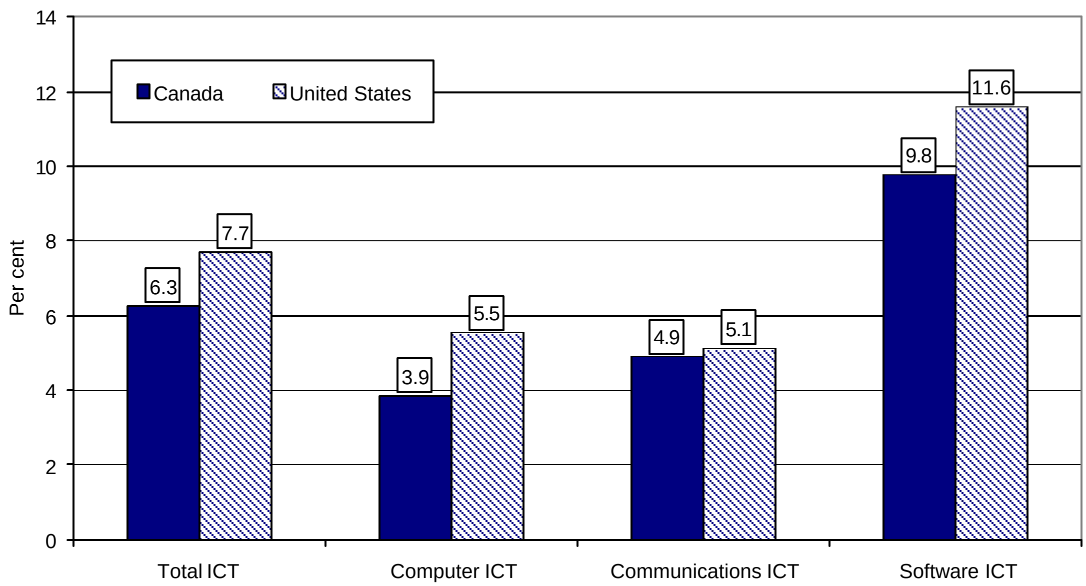
[7] For example, if the demand for a good greatly exceeds the supply, which can be common with newly introduced ICT goods, then producers have an incentive to increase prices. On the supply side input costs can impact on output prices. For example, an increase in the price of oil can increase the cost of many inputs, or a decrease in the price of microprocessors can lead to a decrease in the price of computers.

a lead overall in ICT investment growth in the period 1995-2000. The 2000-2004 period saw a slowing of the average annual rate of growth in ICT investment and its components in relation to the rapid pace of the 1995-2000 period. Overall, there was in fact a net nominal disinvestment in ICT, with US ICT investment at an average annual rate of -2.15 per cent and Canada at -1.45 per cent. Computer ICT investment was also negative in this period; the average annual rates of investment in computers in Canada and the United States were respectively -5.99 per cent and -3.05 per cent. Average annual communications ICT investment rates in Canada exhibited a -5.41 per cent change and the United States a -7.31 per cent change. Finally, in terms of average annual growth rates, software investment was 4.88 per cent in Canada and 1.51 per cent in the United States.

Chart 1: Total ICT Investment by Component, Average Annual Growth in the Business Sector in Canada and the United States, Current Dollars, per cent, 1987-2004



Source: CSLS ICT Database Table S9-S12

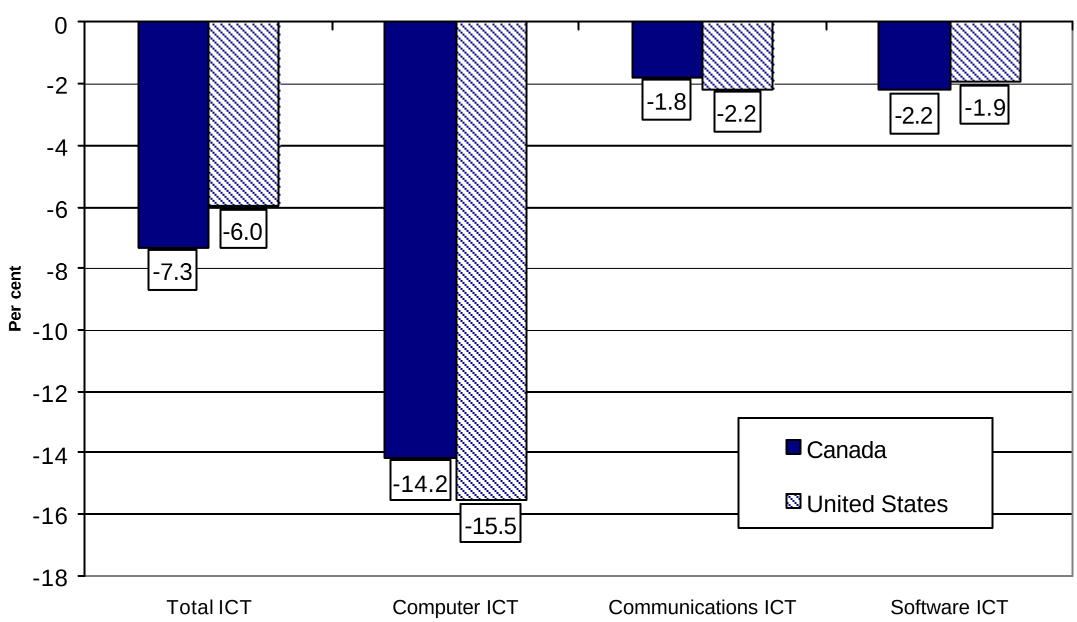
Table 1: ICT investment by component, average annual growth rate in the business sector in Canada and the United States, 1987-2004, current dollars, per cent

	Total ICT		Computer ICT		Communications ICT		Software ICT	
	Canada	United States	Canada	United States	Canada	United States	Canada	United States
1987-2004	6.26	7.72	3.86	5.53	4.90	5.12	9.76	11.59
1987-1995	6.13	8.76	3.46	7.84	3.13	6.22	11.75	12.54
1995-2000	13.07	14.55	13.20	9.09	17.11	14.34	10.60	18.76
2000-2004	-1.45	-2.15	-5.99	-3.05	-5.41	-7.31	4.88	1.51
Source: CSLS ICT database Tables	S9		S10		S11		S12	

Trends in ICT Investment Prices

Chart 2 shows deflator growth. The deflator is the index by which current-dollar estimates are divided to obtain real (*i.e.* quality- and price-change adjusted) estimates. Overall, Chart 2 shows that the prices of ICT goods decreased at an average annual rate of 7.3 per cent in Canada and 6.0 per cent in the United States between 1987 and 2004. Computers show by far the greatest average annual decrease in prices, 14.2 per cent in Canada and 15.5 per cent in the United States. Deflation of communications ICT prices was much more modest, declining 1.8 per cent in Canada and 2.2 per cent in the United States between 1987 and 2004. Software prices exhibited similar small average annual declines of 2.2 per cent in Canada and 1.9 per cent in the United States. Over time, if all else had remained the same, the cumulative difference in deflation rates, that is the fact that prices were falling on average faster in Canada than in the United States, would have led to higher real ICT investment intensity in Canada relative to the United States. Simply put, had Canada and the United States had equal levels of ICT investment per worker (or as a share of GDP) in 1987 and all else remained the same, the deflator growth pattern in Chart 2 implies that Canada should have a higher real level of ICT investment per worker (or as a share of GDP) than the United States in 2004. The conclusion is that the ICT investment gap has widened over this period, in spite, and not because of, differences in deflator growth rates.

Chart 2: ICT Investment by Component, Average Annual Deflator Growth in the Business Sector in Canada and the United States, per cent, 1987-2004

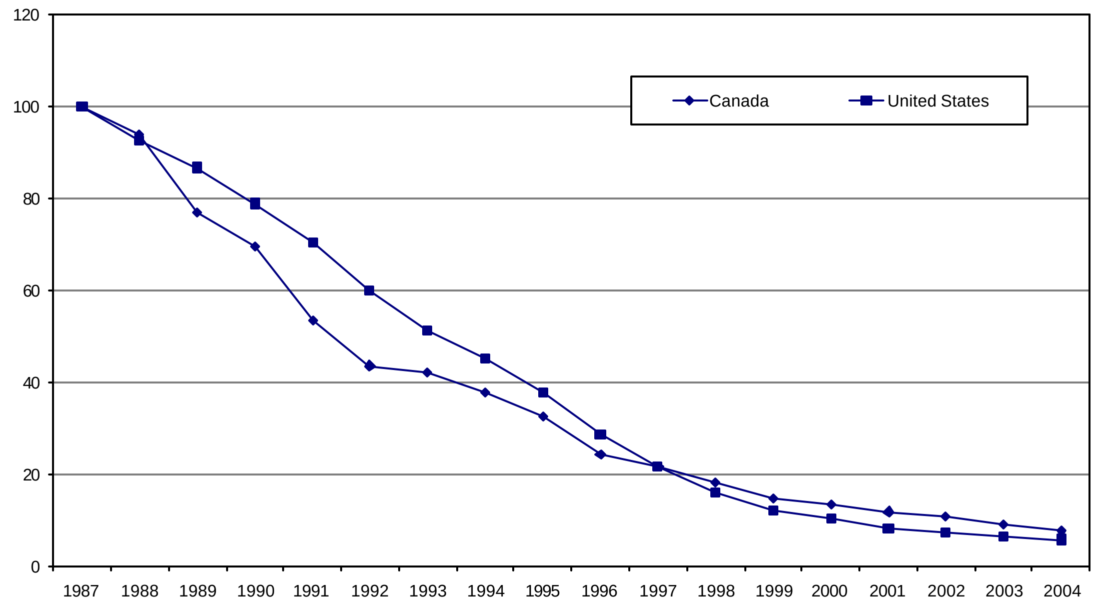


Source: CSLS ICT Database Table S29

While average annual rates of change in the deflators for ICT investment provide a summary of price movements for computers, communication equipment and software

(Chart 2), it is also informative to look at how the prices of each of these components of ICT changed over the same period, 1987-2004.[8]

Chart 3: Computer Investment Deflator, Canada and the United States, (1987 = 100), 1987-2004



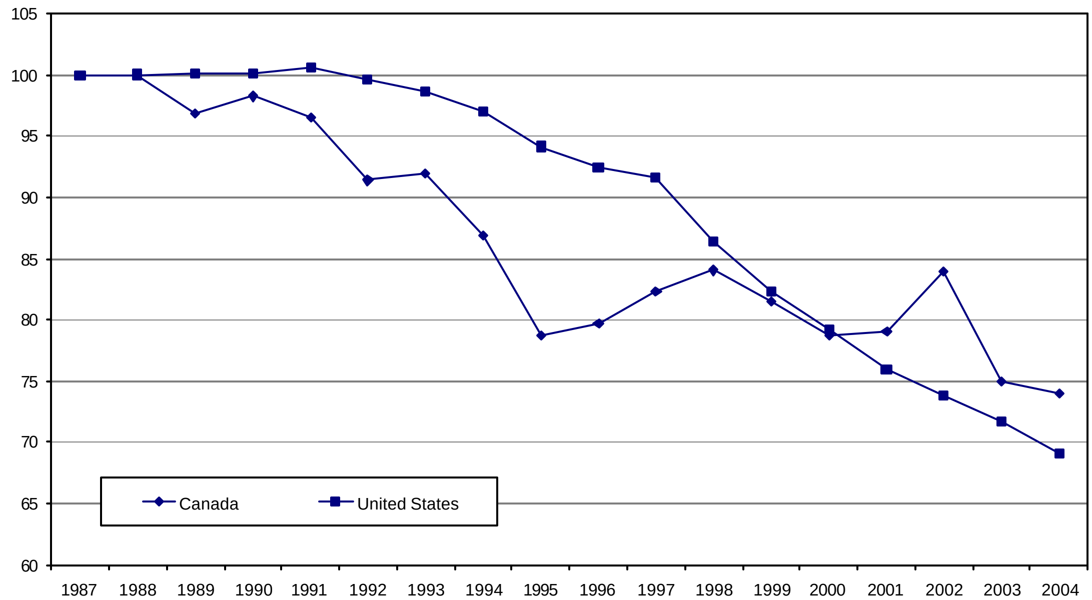
Source: CSLS ICT Database

Computer investment prices exhibited the greatest fall of the three components between 1987 and 2004 (Chart 3). Relative to 1987, Canadian computer prices fell more rapidly than US computer prices between 1988 and 1992. After 1992, Canadian and US computer prices fell in an essentially similar pattern. In 2004, computer prices in Canada and the United States were at 7.47 per cent and 5.67 per cent of their 1987 levels respectively.

The decline of communication equipment prices (Chart 4) was much less dramatic than that observed in computer prices. In Canada, communication equipment prices fell much more rapidly than in the United States between 1987 and 1992. By 1992, Canadian prices were at 79 per cent of their 1987 level, while US prices were at 94 per cent of their 1987 level. This gap in relative price decline subsequently narrowed, and in 2000, both Canadian and US communication equipment prices had fallen to 79 per cent of their 1987 levels. From 2000 to 2004, prices fell more rapidly in the United States than in Canada. In 2004, US communications equipment prices reached 69 per cent of their 1987 level, while Canadian prices fell to 74 per cent of their 1987 level.

[8] Because of the method used to construct deflators in the United States (implicit price deflator based chain-Fisher series), computers, communication equipment, and software deflators cannot be added together to produce a deflator for ICT equipment. Since no independent deflator for total ICT is available, it is omitted from this discussion.

Chart 4: Communication Equipment Investment Deflator, Canada and the United States, (1987 = 100), 1987-2004

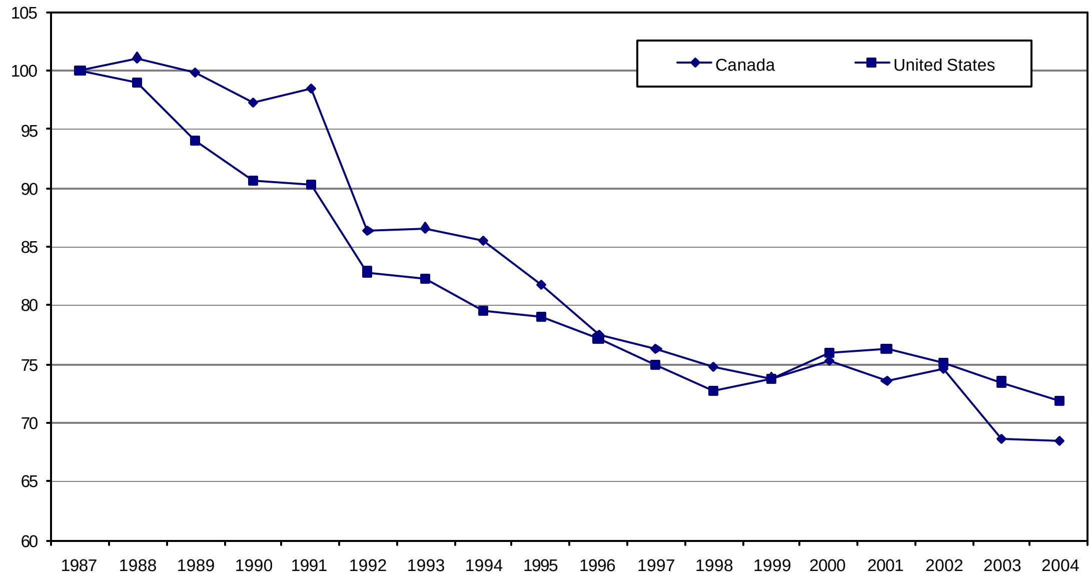


Source: CSLS ICT Database

Software prices in Canada and the United States fell between 1987 and 2004 and tracked one another relatively closely in comparison with computer and communication equipment prices (Chart 5). Relative to 1987, US prices fell more than Canadian prices from 1987 to 1999. By 2004, Canadian software prices had fallen to 68 per cent of their 1987 level, while US software prices had fallen to 72 per cent of their 1987 level.

One important caveat is worth keeping in mind when looking at the trends presented in Charts 3, 4, and 5. Deflator series are indexes. They are relative price series; in this case they show prices relative to 1987. The charts should not be interpreted as absolute price levels. For example, the fact that in 2004 Canadian software prices were at 68 per cent of their 1987 level, while US software prices were relatively higher at 72 per cent of their 1987 level, does not imply that Canadian software prices were absolutely lower than US software prices when expressed in a common currency. Nonetheless, deflator series can be very useful for explaining when an economic event occurs. For example, if Canadian computer prices fell more rapidly than US prices over a given period, then it might be the case that computer investment in Canada would increase relative to computer investment in the United States over that period. Charts 3, 4, and 5 show that over the 1987-2004 period prices of ICT goods tended to move, with few exceptions, in a similar pattern. As noted above with reference to Chart 2, this conclusion means that relative price movements tended to increase real investment in ICT in Canada relative to the United States, thus leaving even more of the ICT investment intensity gap to be explained by other factors.

Chart 5: Software Investment Deflator, Canada and the United States, (1987 = 100), 1987-2004

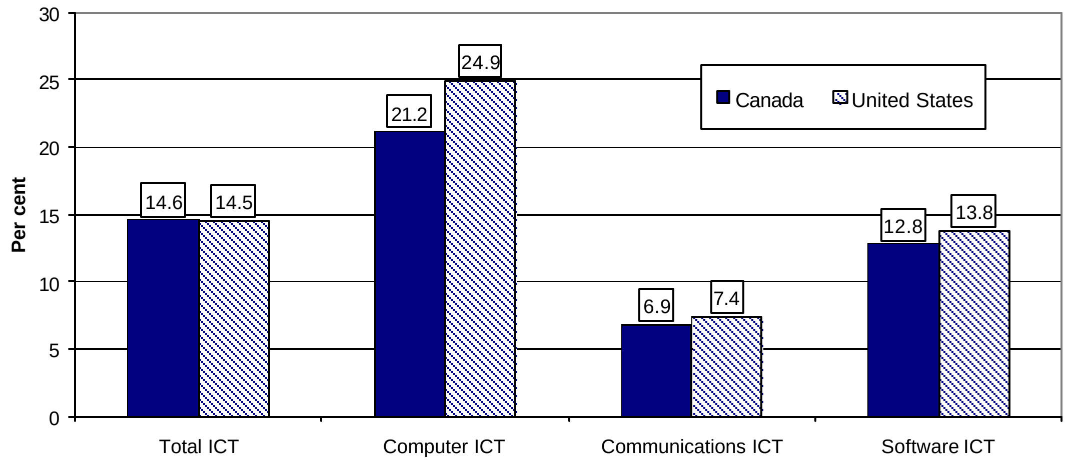


Source: CSLS ICT Database

Trends in Real ICT Investment

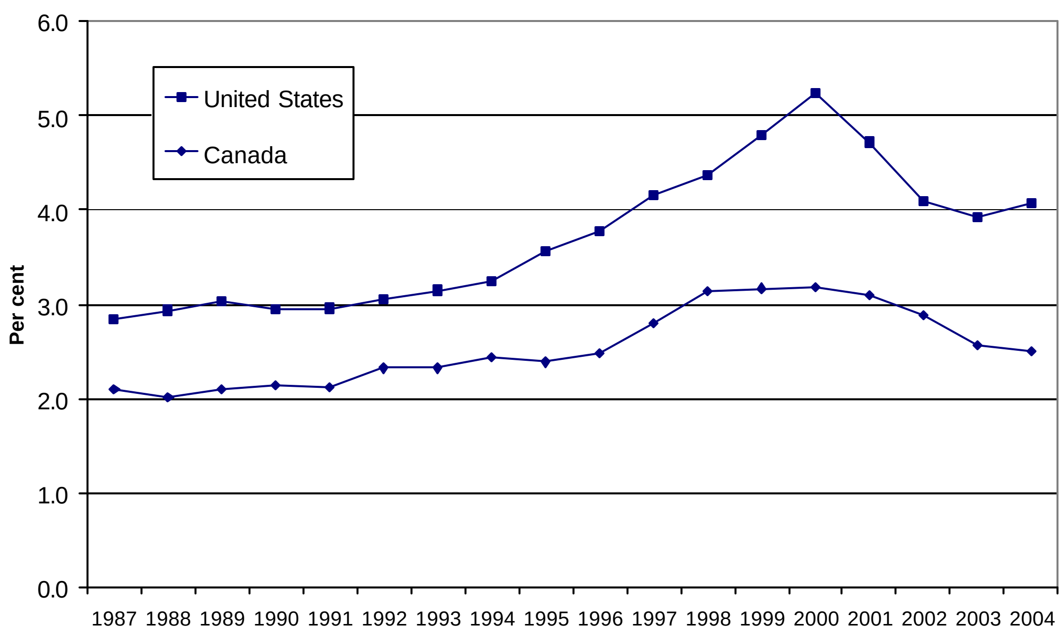
Chart 6 shows the average annual growth rate of ICT investment adjusted for quality improvement and price deflation using Fisher dollars. These adjusted figures are commonly referred to as real growth rates. The real average annual total ICT investment growth rate was very similar in Canada and the United States at 14.6 per cent and 14.5 per cent respectively. Computer ICT investment showed the greatest real average annual growth over the period, 21.0 per cent in Canada and 24.9 per cent in the United States. The United States, at 7.4 per cent, also outpaced Canada, at 6.8 per cent, in real average annual growth in communications investment. In computer investment, the US average annual growth rate was 13.8 per cent compared to 12.2 per cent in Canada.

Chart 6: ICT Investment by Component, Average Annual Growth Rate in the Business Sector in Canada and the United States, Fisher Dollars, per cent, 1987-2004



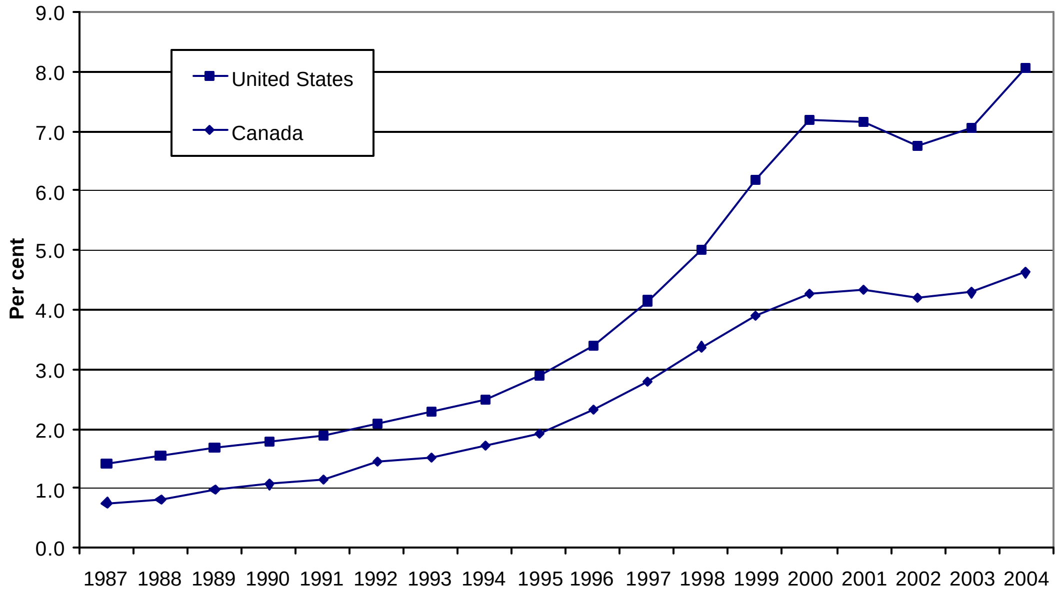
Source: CSLS ICT Database Tables 13v, 14v, 15v, 16v, 30v, 31v, 32v, and 33v based on Fisher dollars.
Note: The definition of the business sector for the three components (computers, communication equipment and software) in Canada differs from the aggregate data on total ICT investment. U.S. total ICT estimates are the summation of the Fisher dollar series for the three components as no estimates of total ICT in Fisher dollars are available for the United States. As a result, the total ICT investment growth rate for the United States is an approximation.

Chart 7: Total ICT Investment as a Share of Business Sector GDP in Canada and the United States, current dollars, per cent, 1987-2004



Source: CSLS ICT Database Table S9.

Chart 8: Total ICT Investment as a Proportion of Business Sector GDP in Canada and the United States, Fisher Dollars, Per Cent 1987-2004

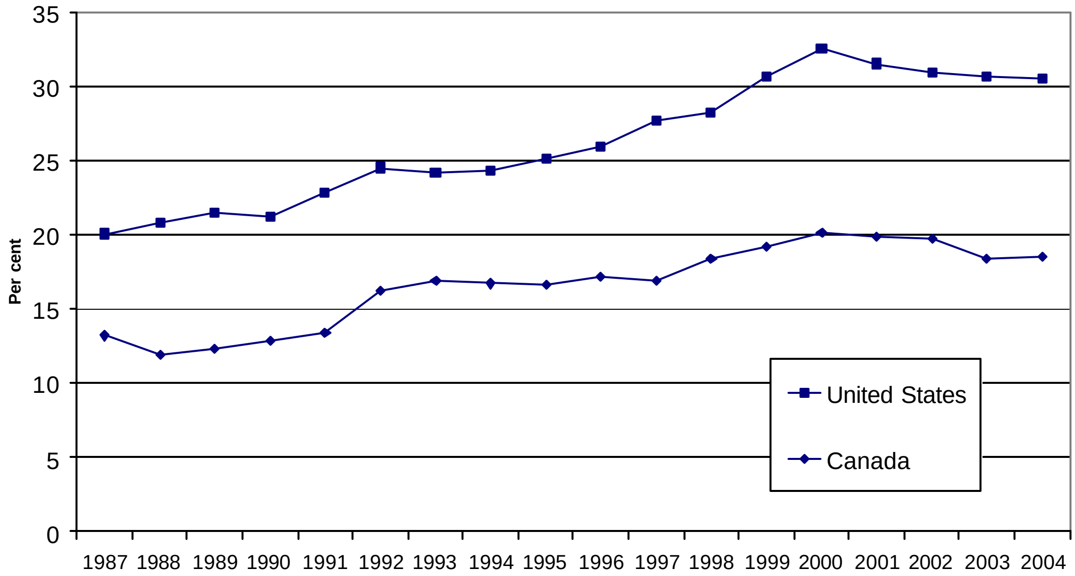


Source: CSLS ICT Database Tables 5v and 22v
Note: Fisher dollars: United States 2000 base year and Canada 1997 base year. Trends are approximate, because Fisher-dollar series are not additive.

Charts 7 and 8 show total ICT investment as a proportion of business sector GDP in Canada and United States in current and in Fisher dollars respectively. An upward trend in both series is apparent from 1987 to 2000 (United States) or 2001 (Canada), at which point there is a downturn in both countries. Not surprisingly, given that deflation has been accounted for, the upward trend is much more pronounced in the Fisher-dollar series in Chart 8 than in the current-dollar series in Chart 7. Furthermore, the downturn which began in 2000-2001 is much smaller in the Fisher-dollar series. In Chart 7 there is a slight increase in ICT investment share in 2003 and 2004 for the United States and none for Canada. Between 2002 and 2004, Chart 8 shows an upturn in ICT investment share in Canada and a significantly more visible upturn in the United States relative to the current-dollar series.

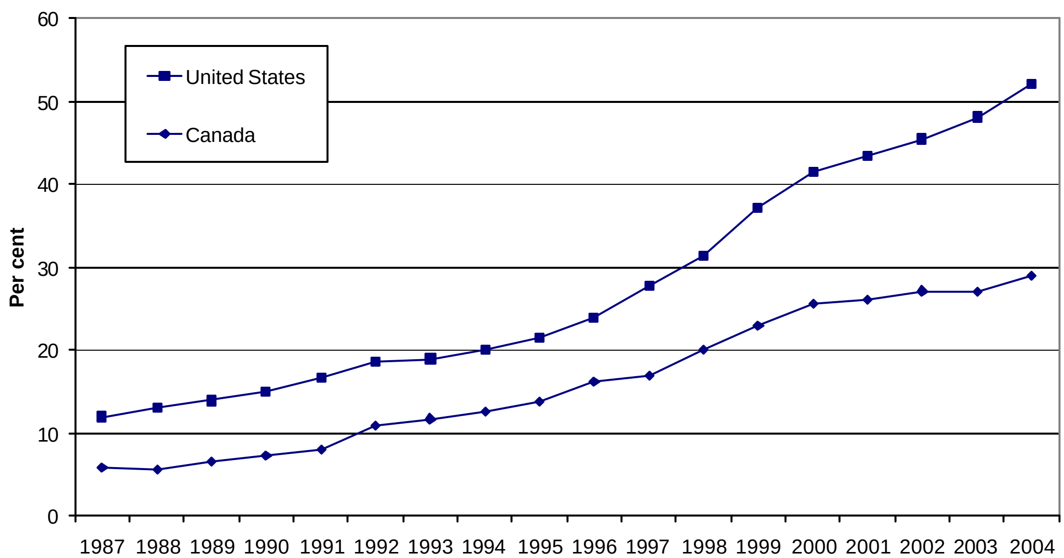
Charts 9 and 10 show total ICT investment as share of business sector non-residential investment in Canada and the United States in current and Fisher dollars respectively. In current dollars the share of ICT investment in US business sector non-residential investment increased from 20 per cent to more than 30 per cent between 1987 and 2004. In Canada the increase was from 13.2 to 18.5 per cent. In Fisher dollars ICT investment in the United States increased in real terms to approximately more than 50 per cent of total business sector investment in 2004 from just over 10 per cent in 1987. In Canada Chart 10 shows a similar, yet less dramatic, increase in the proportion of ICT investment from approximately 6 per cent in 1987 to almost 30 per cent in 2004.

Chart 9: Total ICT Investment as a Share of Total Business Sector Non-Residential Investment in Canada and the United States, current dollars, per cent, 1987-2004



Source: CSLS ICT Database Table S13

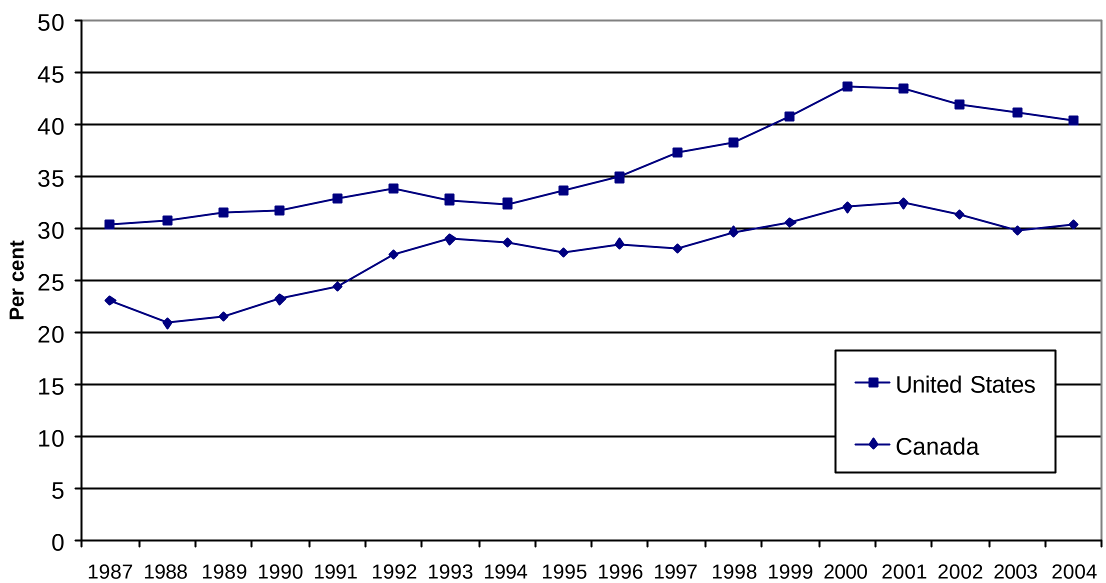
Chart 10: Total ICT Investment as a Proportion of Total Business Sector Non-Residential Investment in Canada and the United States, Fisher Dollars, per cent, 1987-2004



Source: CSLS ICT Database Tables 5v and 22v
Note: Fisher dollars: United States 2000 base year and Canada 1997 base year. Trends are approximate, because Fisher-dollar series are not additive.

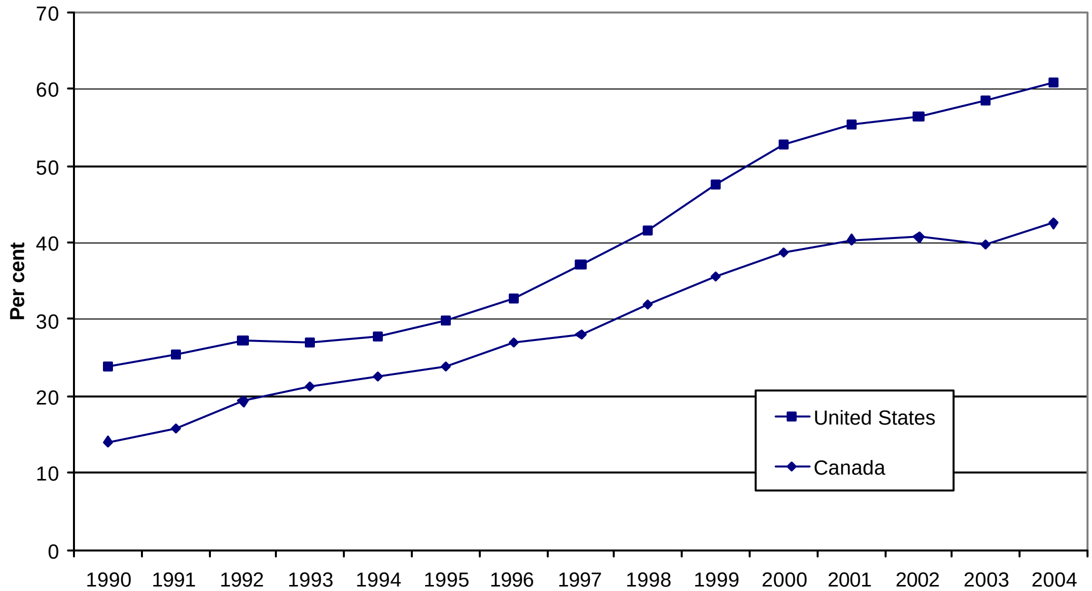
Charts 11 and 12 present the shares of ICT investment in total business sector investment in machinery and equipment (M&E) between 1987 and 2004 and 1990 and 2004 respectively in Canada and the United States. In this case the differences between the current-dollar (Chart 11) and Fisher-dollar (Chart 12) series are immediately apparent. The primary difference is the upward trend of total ICT investment as a share of business sector M&E investment in Canada and the United States in Chart 12. The upward trend is much less pronounced in the current-dollar Chart 11. In Chart 11, US ICT investment as a share of business sector M&E investment, rose from just over 30 per cent to just over 40 per cent. In Canada, the rise was from 23 per cent to more than 30 per cent. In Chart 12, US ICT investment as a share of M&E investment rose from less than 25 per cent to more than 60 per cent over the 1990-2004 period. In Canada, the share rose less dramatically from below 15 per cent to more than 40 per cent.

Chart 11: Total ICT Investment as a Share of Business Sector Machinery and Equipment Investment in Canada and the United States, current dollars, per cent, 1987-2004



Source: CSLS ICT Database Tables S9 and S40

Chart 12: Total ICT Investment as a Proportion of Business Sector Machinery and Equipment Investment in Canada and the United States, Fisher Dollars, per cent, 1990-2004

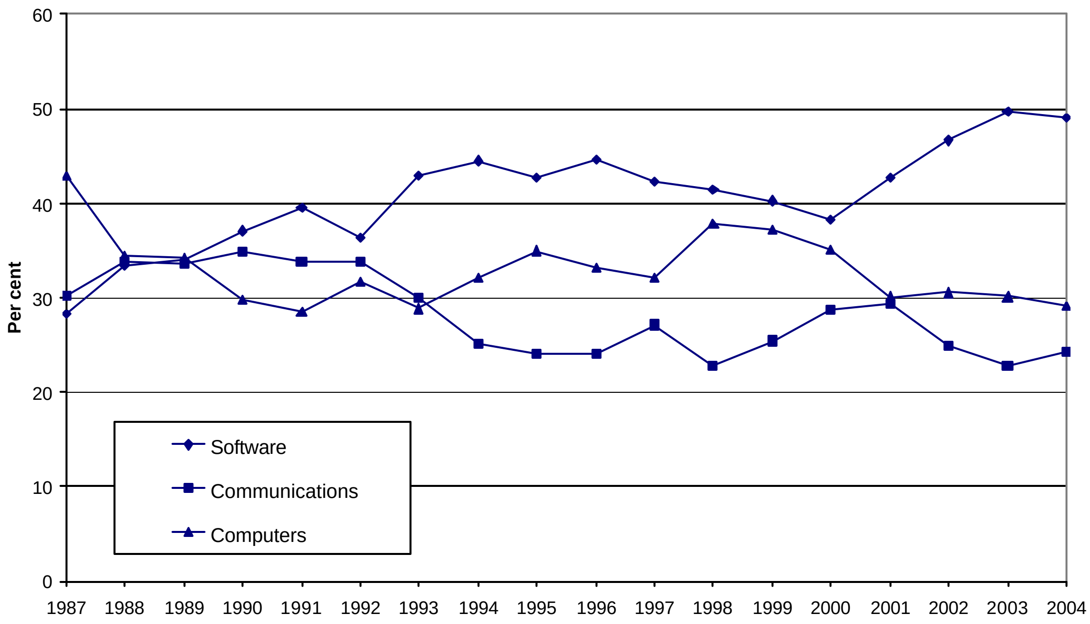


Source: CSLS ICT Database Tables 5v and 30v, CANSIM II Table 310002, and BEA NIPA Table 9.3
Note: Fisher dollars: United States 2000 base year and Canada 1997 base year. Trends are approximate, because Fisher-dollar series are not additive.

The Changing Relative Importance of the Components of ICT Investment, 1987-2004

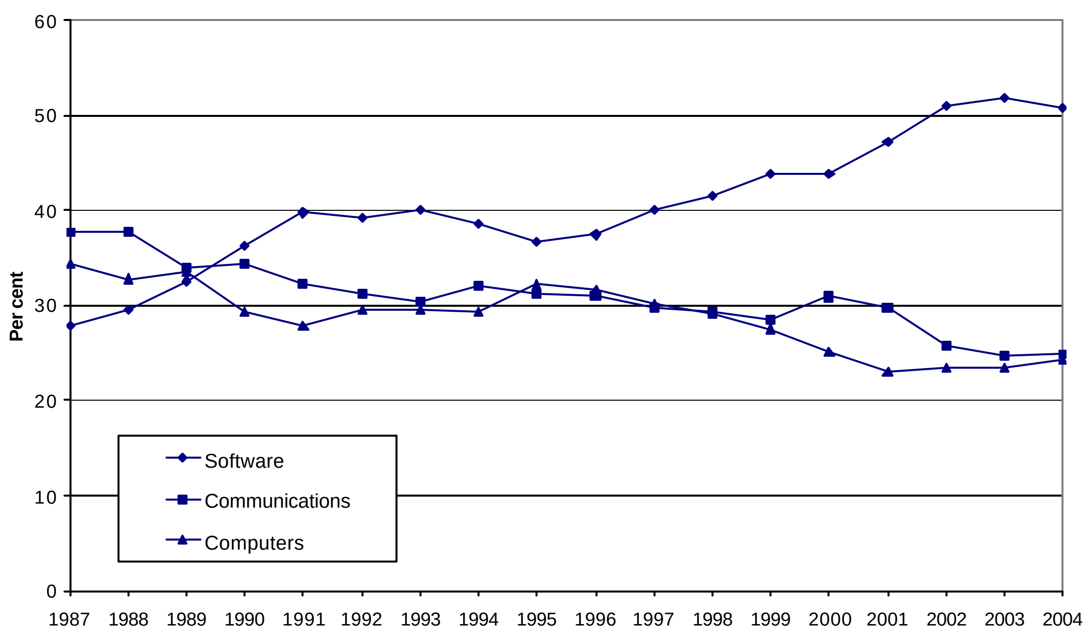
Charts 13 and 14 show the percentage contribution of each component of ICT investment to total business sector ICT investment in Canada and the United States respectively. In both countries the composition of ICT investment followed a similar pattern. In 1989, each component made up approximately one-third of total ICT investment; and, after this point software unambiguously became the most important component of ICT investment. Software investment rose to slightly more than 50 per cent of total ICT investment in the United States in 2004 and slightly less than 50 per cent in Canada. As software grew in importance throughout the 1990s, both computers and communications investment made up a progressively smaller share of total ICT investment. In the United States these series tracked each other fairly closely and in 2004 each constituted approximately 25 per cent of total ICT investment in the business sector. In Canada, computers and communications did not track each other as a closely as in the United States and in 2004 were slightly less than 30 per cent and 25 per cent of total business sector ICT investment respectively.

Chart 13: Canada, Components of ICT Investment as a Percentage of Total ICT Investment, current dollars, 1987-2004



Source: CSLS ICT database Tables S1-S4

Chart 14: United States, Components of ICT Investment as a Percentage of Total ICT Investment, current dollars, 1987-2004



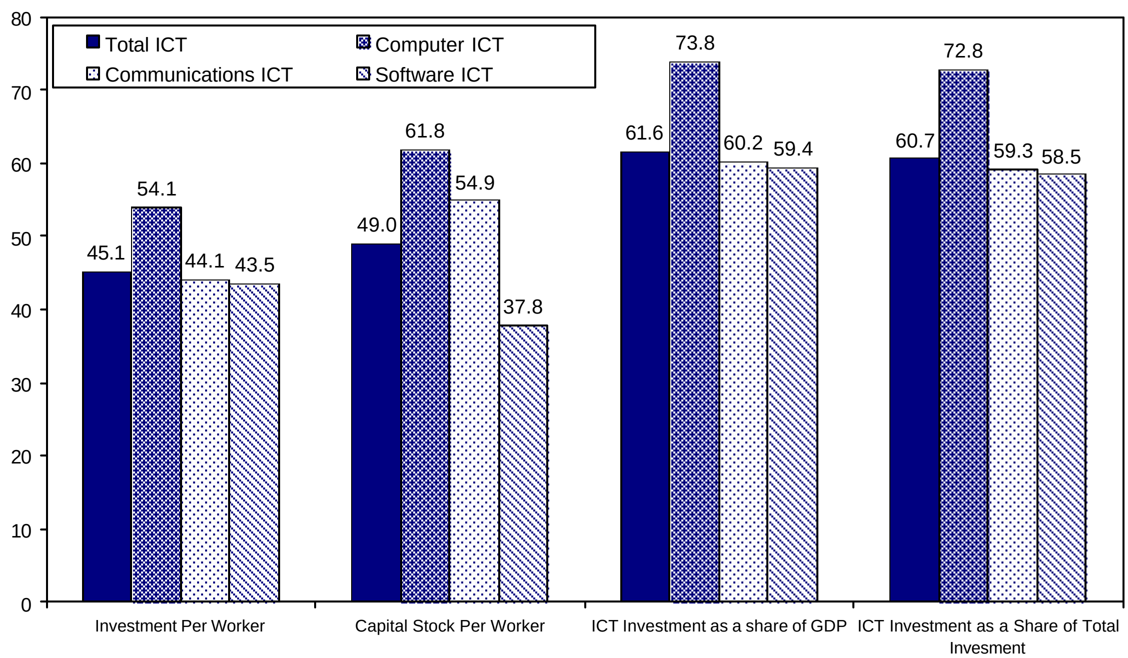
Source: CSLS ICT database Tables S1-S4

The ICT Investment Gap

The ICT Investment Gap in 2004

The gap in ICT investment between Canada and the United States can be measured in several different ways, yet by any measure the gap is significant. Chart 15 shows the ICT investment gap between Canada and the United States on the basis of ICT investment per worker, ICT capital stock per worker, ICT investment as a share of business sector GDP, and ICT investment as a share of total business sector non-residential investment. In each case the Canadian level of investment or capital stock is expressed as a percentage of the US level.

Chart 15: The Canada-US ICT Gap, Canada as a Percentage of the United States, 2004



Source : CSLS ICT Database Tables S1 to S16

ICT Investment per Worker

In terms of ICT investment per worker Canada invested only 45.1 per cent of the US level. By components, ICT investment in Canada as a proportion of the United States for computers, communications and software was respectively 54.1 per cent, 44.1 per cent and 43.5 per cent in 2004.

ICT Capital Stock per Worker[9]

As mentioned above, ICT capital stock per worker is not generally used in this report because of differences in methodologies used in different countries to depreciate ICT assets. Investment is easier to measure, and exhibits broadly similar trends to ICT capital stock, although it is more variable. Nonetheless, it is worthwhile to note that in 2004 ICT capital stock per worker in Canada was 49 per cent of US level. Canadian stocks of computers, communication equipment and software were respectively 61.8, 54.9 and 37.8 per cent of the US level.

ICT Investment as a Share of Business Sector GDP

Due to differences in labour productivity between Canada and the United States and differences in the ratio of the purchasing power parity for ICT investment to purchasing power parity for GDP, the gap in terms of ICT investment as a share of GDP differs from the gap in terms of ICT investment per worker (see Appendix 2 for mathematical discussion). Overall ICT investment as a share of business sector GDP in Canada was only 61.6 per cent of the US level in 2004. Computer investment was 73.8 per cent of the US level; communications investment was 60.2 per cent of the US level; and software investment was 59.4 per cent of the US level.

ICT Investment as a Share of Business Sector Non-Residential Investment

The picture by this metric is almost identical to that presented in terms of ICT investment as a share of total business sector GDP. Overall, Canada's level of ICT investment as a share of business sector non-residential investment was 60.7 per cent in 2004. Again, computer investment Canada was closest to the US level at 72.8 per cent. Following behind were communications at 59.3 per cent of the US level and software at 58.5 per cent of the US level.

Trends in the ICT Investment Gap, 1987-2004

The ICT investment gap between Canada and the United States has not remained constant over the period from 1987 to 2004. In the case of overall ICT investment and each of its three components, computer, communications, and software, the trend has been for the gap to widen.

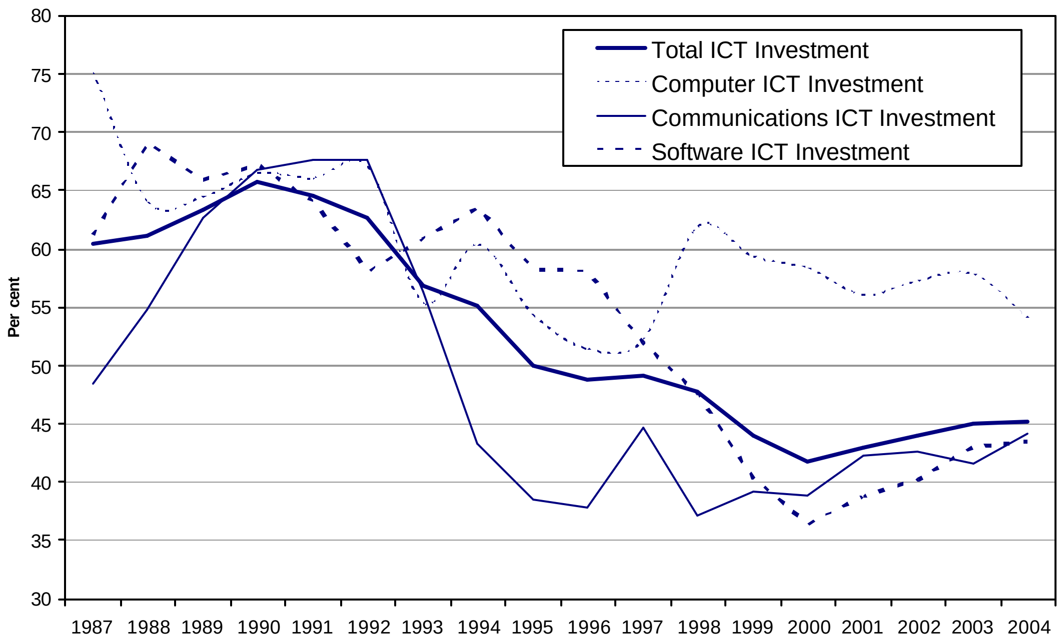
[9] Whereas capital stock is a stock variable, *i.e.* a variable representing a quantity which exists at a fixed point in time, investment is a flow. Investment is not defined at a fixed point in time, but rather over a period of time, usually a year. For example, investment might be $10 billion in 2004, whereas capital stock might be $140 billion as of Dec. 31, 2004. Investment contributes to capital stock. The capital stock is nothing more than the sum of all previous investment, after the wearing-out of old capital is accounted for. This process of wearing-out is known as depreciation. It is in the calculation of depreciation that countries tend to differ in statistical methodologies. For this reason, investment data are generally speaking more comparable across countries than capital stock data.

Trends in the ICT Investment Gap per Worker

Chart 16 shows trends in the ICT investment gap between Canada and the United States on a per-worker basis. In 1990, ICT investment per worker in Canada was around 65 per cent of the US level in all of its components. Over the decade the level of ICT investment in Canada relative to ICT investment in the United States fell significantly.

Total ICT investment per worker in Canada relative to the United States rose from 1987 to 1990. It then declined throughout the 1990s and began a slow recovery in 2000. Computer ICT investment per worker in Canada fell from a high of around 75 per cent of the US level to almost 50 per cent in 1996 then rebounded somewhat in the late 1990s before falling again through 2004. Communications ICT investment per worker in Canada was less than 50 per cent of the US level in 1987. It then rose rapidly to more than 65 per cent of the US level in the early 1990s before declining steeply through 1996. There was an increase in communications investment per worker in Canada relative to the United States in 1997, but this was followed by a sharp fall in 1998 and a slow recovery since then. Finally, software ICT investment per worker in Canada in 1987 was just over 60 per cent of the US level. It rose briefly then declined throughout the 1990s only to begin a slow rise in 2000.

Chart 16: ICT Investment per Worker in the Business Sector in Canada, as a proportion of the United States, current US dollars, 1987-2004



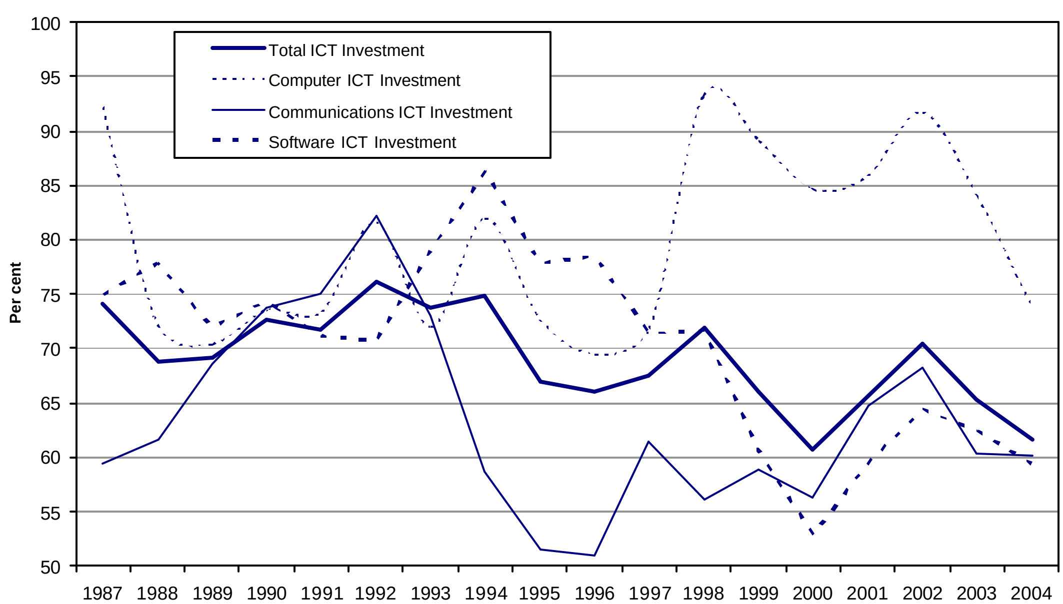
Source : Table S1 to S4

Trends in the ICT Investment as a Proportion of GDP Gap

Chart 17 shows the evolution of the Canada-US gap in ICT investment and its three components between 1987 and 2004 on the basis of ICT investment as a proportion of business sector GDP.

Relative to the US level, Canadian ICT investment as a proportion of business sector GDP exhibited a downward trend over the period. From a starting point of just below 75 per cent of the US level in 1987, it reached a peak of just over 75 per cent in 1992 before falling throughout the 1990s to just over 60 per cent of the US level in 2004. Computer investment exhibited no strong trend over the period, although it was quite variable. In 1987, 1998 and 2003, Canadian computer investment was more than 90 per cent of the US level, however, it also regularly fell below 75 per cent of the US level, as was the case in 2004. Canadian communications investment, as a share of business sector GDP relative to the United States, rose from below 60 per cent in 1987 to a high of more than 80 per cent in 1992. It then fell precipitously to just above 50 per cent in 1995-1996, then rose exhibited an upward trend to 2004. Finally, software investment, as a share of business sector GDP in Canada relative to the United States, rose from approximately 75 per cent of the US level in 1987 to peak at more than 85 per cent in 1994, but then fell to below 55 per cent of the US level in 2000. It reached approximately 60 per cent of the US level in 2004.

Chart 17: ICT Investment as a Share of GDP in the Business Sector in Canada, as a Proportion of the United States, current dollars, 1987-2004



Source : Table S9 to S12

Decomposition: Canada-U.S. ICT Investment per Worker Gap, 1987-2004

Introduction to Decomposition

For the decomposition of the Canada-US ICT investment per worker gap, four indicators are used: total non-residential investment as a share of GDP, ICT investment as a share of total non-residential investment, productivity and price adjustments. In the following part, the relation between these four factors and the Canada-US ICT investment per worker gap will be briefly explained (see Appendix 2 for more detailed mathematical discussion).

The first sub-indicator, total non-residential investment as a share of GDP, represents the portion of the economy allocated to investment rather than to consumption. When this ratio is higher in Canada than in the United States, it means that Canada is investing more. Thus, a Canada-US ratio under 100 means that Canada is investing less in relative term than the United States. Of course, all else equal, less investment translates into less ICT investment per worker.

The second sub-indicator is ICT investment as a share of total non-residential investment. Because we focus on ICT investment, it is important to know what portion of total investment is specifically allocated to ICT. The first and second indicators, when combined, give the Canada-US ratio of ICT investment as a share of GDP and represent the relative importance of ICT investment in each country. Of course, if the ICT investment share of total investment increases more in Canada than in the US, this contributes to closing the Canada-US ICT investment per worker gap.

The third indicator, which is a ratio of Canada's GDP per worker to US GDP per worker, is essential to compute the ICT investment per worker gap. Indeed, if Canadians are less productive than their US counterparts, even if they allocate the same share of their economic output to ICT investment, their absolute level of ICT investment per worker will still fall short of the US level. A lower productivity level is pervasive and affects the whole economy. Thus, all else equal, a Canada-US productivity ratio under 100 will increase the ICT investment per worker gap.

Finally, the last component captures price adjustments necessary to make the ICT investment per worker levels comparable in both countries. To do this, one needs to adjust both ICT investment and GDP. However, because we adjust the ICT investment data using the market exchange rate and the GDP data using purchasing power parity values, the price adjustment introduces a bias. When the market exchange rate is higher than the GDP purchasing power parity adjustment, ICT investment in Canada is overvalued and it contributes to closing the gap. However, the reverse is generally true, meaning that Canada's ICT gap is widened by price adjustments.

Analysis of Gap over Time

Between 1987 and 2004, the Canada-US business sector ICT investment per-worker gap increased from 39.6 percentage points to 54.9 percentage points, a 15.3 percentage-point expansion. To explain the gap, one can break it down in to four components, *i.e.* total non-residential business sector investment as a share of GDP, ICT investment as a share of total investment, GDP per worker and the ratio of ICT purchasing power parity to GDP purchasing power parity.

The Canada-US ratio of total non-residential business sector investment as a share of GDP fell from 112.7 in 1987 to 101.5 in 2004. Consequently, its contribution to the gap increased from a negative contribution of 9.4 percentage points to a much lower negative contribution of 1.0 percentage points. In other words, if the Canada-US ratio of investment as a share of GDP had remained at its 1987 level, the 2004 gap would be 8.4 percentage points lower. Thus, approximately 48 per cent of the gap widening between 1987 and 2004 is due to that factor.

Over the 1987-2004 period, however, the lagging Canadian ICT investment share of total non-residential investment was consistently the main contributor to the gap. Interestingly, the Canada-US ratio for this component was relatively stable over 1987-2004, staying in the 60 to 66 percent range during most of the period. This ratio suggests that ICT investment in Canada and the United States reacted similarly to changes in the level of investment. Thus, it seems that Canadian under-investment in ICT is structural, always representing a similar share of total investment compared to the United States. For this reason, the contribution of ICT investment as a share of total non-residential investment did not increase significantly during the 1987-2004 period, increasing only slightly from 33.0 percentage points in 1987 to 34.4 percentage points in 2004 and accounting for only 9 percent of the 15.3 percentage points widening of the gap.

The third component is GDP per worker. Over the 1987-2004 period, the Canada-US labour productivity gap did expand, particularly over the last four years. While Canada's labour productivity was 87.3 per cent of the United States in 1987, this ratio fell to 79.6 per cent, a 7.7 percentage-point decrease. This translated in to a 5 percentage-point increase in the contribution to the gap, from 10.7 percentage points in 1987 to 15.7 percentage points in 2004. Thus, this factor accounted for 33 per cent of the increase in the gap.

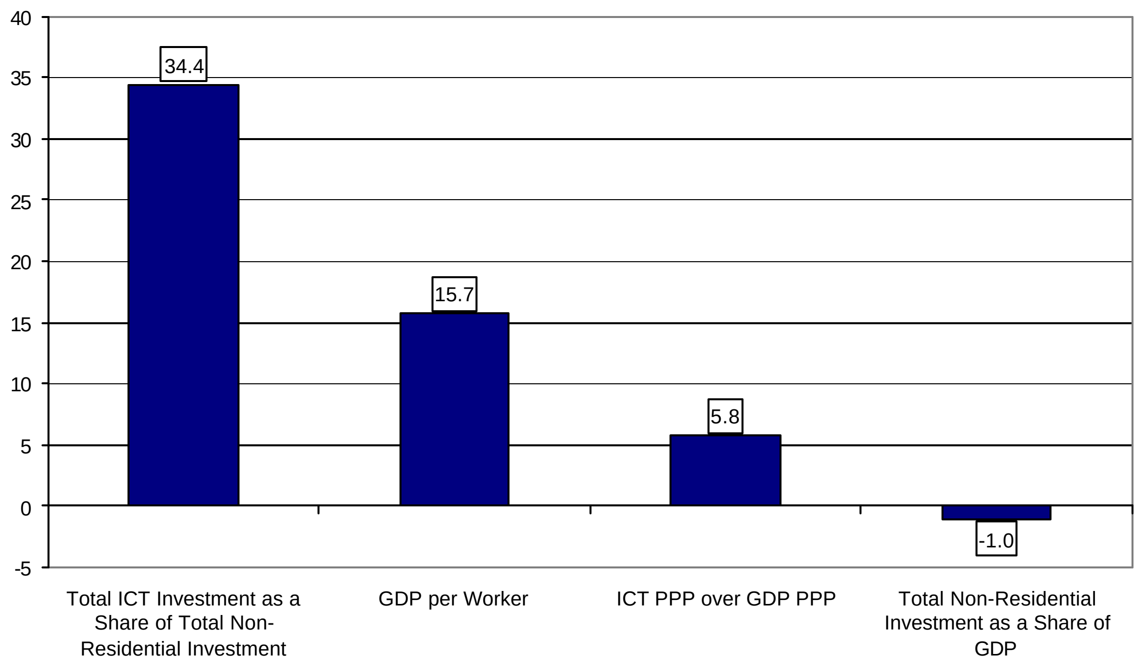
Finally, the last component is the ICT purchasing power parity to GDP purchasing power parity ratio. This ratio captures the difference in price adjustments made to the ICT investment per worker measure and the labour productivity measure to make it comparable with the United States. A ratio below one hundred means that the price of ICT goods relative to all other goods in Canada is higher than the relative price of U.S. ICT goods. However, because data on the purchasing power parity for ICT goods are not readily available, and because ICT goods are internationally traded, we used the market exchange rate to represent the ICT purchasing power parity.

The contribution to the gap of different relative prices did fluctuate considerably during the period, ranging between a negative contribution of 6.8 percentage points in 1991 and a positive contribution of 20 percentage points in 2002. However, over the whole 1987-2004 period, the contribution increased only slightly, from 5.3 percentage points in 1987 to 5.8 percentage points in 2004 and accounted for only 3 per cent of the increase in the gap during the period.

Apart from its direct impact on the gap through currency conversion, the relative prices of ICT and other goods also has an impact on the ratio of ICT investment as a share of total non-residential investment. Total non-residential investment includes both traded goods (such as most machinery and equipment, including ICT) and non-traded goods (structures). However, ICT investment is made up strictly of traded goods. Thus, when there is a change in the currency level, the level of ICT investment changes more than the level of total non-residential investment.

In general, economists distinguish between two effects, the price effect and the volume effect. Assuming an increase in the exchange rate, in the short-term the level of ICT investment will fall, because the same volume is bought at a lower price. However, as time goes by, the volume of ICT investment will increase and might compensate for the lower price of ICT goods, leading to increased ICT investment. The final effect depends on what economists call the price elasticity of ICT goods. A price elasticity of 1 means that the price effect and the volume effect cancel each other out, leaving ICT investment at its previous level.

Chart 18: Decomposition of the Canada-U.S Business ICT Investment per Worker Gap, current dollars, percentage points, 2004



In Canada's case, the recent decrease in ICT investment as a share of total non-residential investment relative to the United States, which fell from 63.6 per cent in 2002 to 60.1 per cent in 2003, could be explained by the increasing exchange rate during the period. This would have reduced the price of ICT for Canadians firms and lowered the value of their ICT investment at equal volume. However, one could expect this ratio to climb back up as the long-term volume effect kicks in. However, for the moment, the positive impact of a higher ICT purchasing power parity to GDP purchasing power parity ratio seems to be partially offset by the falling ICT value of ICT investment by Canadian firms.

Role of Relative Machinery and Equipment Investment Levels Between Canada and the United States in the ICT Investment Gap

Table 2 presents data on relative levels of business sector non-residential investment in Canada and the United States. The top panel presents data on a per worker basis, while the bottom panel presents figures on the ratio of Canadian to US non-residential investment as a percentage of business sector GDP. Both sets of data provide important information about the gap in ICT investment between Canada and the United States.[10]

[10]On a per-worker basis Canada did decline relative to the United in ICT investment (Table 2). This result may appear inconsistent with the broad declines in investment in the Table below. However, ICT investment per worker is sensitive to the exchange rate, and the increasing value of the Canadian dollar relative to the US dollar in 2004 contributed to maintaining stability of relative Canada-US ICT investment per worker (see Appendix 2 for mathematical background material).

As a share of GDP, nominal ICT investment actually fell in Canada in 2004, as was seen in Table 2 with the fall from 65.3 per cent of the US level in 2003 to 61.6 per cent of the US level in 2004. The table below shows the reason for this drop; nominal investment as a share of GDP declined by 2.14 per cent in Canada, while it advanced by 3.73 per cent in the United States. As the Table below shows, this decline in Canadian ICT investment as a share of GDP was part of a broader decline in both machinery and equipment investment and total investment as a share of GDP in 2004.

Table 2: Business Sector Non-Residential Investment					
Year	Proportion Canada/US (percent)				
	Total	Structures	Machinery and Equipment		
			Total M&E	ICT	Non-ICT M&E
per worker (current USD)					
1987	95.9	127.0	79.8	60.4	88.3
2000	79.6	146.7	57.0	41.8	68.6
2001	83.1	151.1	57.5	42.9	68.7
2002	85.4	163.7	58.6	44.0	69.5
2003	87.7	174.6	60.4	45.0	73.9
2004	**85.1**	**162.4**	**60.1**	**45.1**	**70.3**
1987-2004 Average*	**91.0**	**150.4**	**69.2**	**52.7**	**78.4**
as a share of business sector GDP (percent; current dollars)					
1987	112.7	141.4	97.9	74.0	108.3
2000	98.3	144.7	82.6	60.7	99.5
2001	104.4	147.9	88.1	65.7	105.2
2002	110.6	157.3	94.1	70.4	111.2
2003	108.6	162.7	90.1	65.3	107.3
2004	**101.5**	**161.5**	**82.1**	**61.6**	**96.0**
1987-2004 Average	**109.8**	**161.4**	**90.5**	**69.1**	**102.8**

* PPP adjustments for Canadian structures were extrapolated for years 1987-1991 and 2002-2004 based on Canadian and U.S. non-residential structures deflators.
Source: CSLS ICT database tables S33, S34, S36, S38, S40, S42, S44

Per-Worker Basis

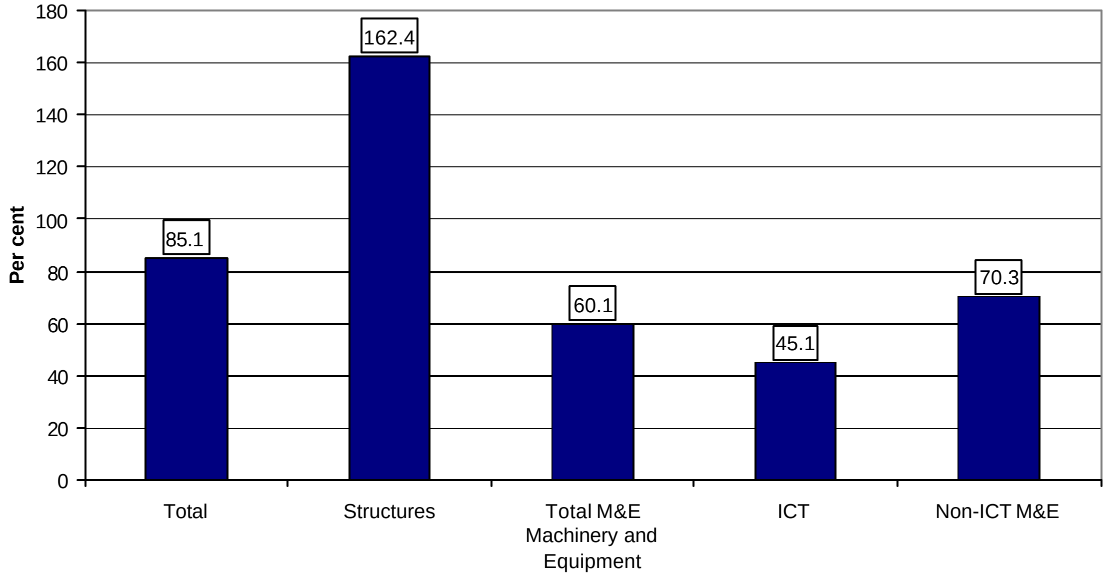
On a per-worker basis, Canadian non-residential business sector investment was only 85.1 per cent of the U.S. level in 2004 and averaged 91.0 per cent of the US level over the 1987-2004 period. (Table 2 and Chart 19) However, these aggregate figures mask a more complicated picture. Canadian investment in structures was 162.4 per cent of the US level in 2004 and averaged 150.4 per cent of the US level over the 1987-2004 period. In contrast, Canadian investment in machinery and equipment was substantially lower than the US level at 60.1 per cent in 2004 and averaging 69.2 per cent over the 1987-2004 period. Finally, when machinery and equipment is decomposed into ICT investment and non-ICT investment, Canadian ICT investment in 2004 was only 45.1 percent of the US level and averaged only 52.7 percent over the 1987-2004 period. Canadian non-ICT investment was much higher averaging 78.4 per cent over 1987-2004 and reaching 70.3 per cent in 2004.

Proportion-of-Business-Sector-GDP basis

When business sector non-residential investment is examined as a share of total business sector GDP, a distinct picture emerges of the ICT investment intensity gap.

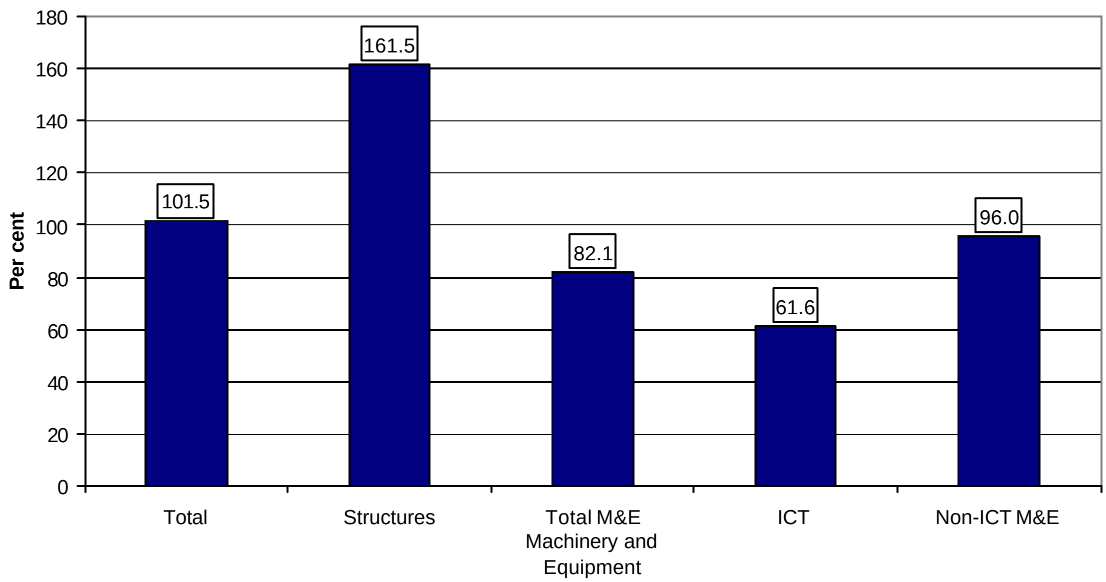
(Table 2 and Chart 20) Overall, investment in Canada was 101.5 per cent of the US level in 2004 and averaged 109.8 per cent of the US level between 1987 and 2004. As above, Canadian investment in structures was substantially greater than US structures investment, 161.5 per cent of the US level in 2004 and on average 161.4 of the US level 1987-2004. While total machinery and equipment investment was 82.1 per cent of the US level, ICT investment substantially lagged non-ICT investment. In fact, over 1987-2004, Canadian levels of non-ICT investment machinery and equipment investment were on average 102.8 per cent of the US level and 96.0 per cent of the US level in 2004. ICT investment was a different story. Perhaps the most interesting point made by Table 2 is that the Canada-US gap in machinery and equipment investment was entirely the result of the ICT investment gap. In 2004, Canadian ICT investment was 61.6 percent of the US level and averaged only 69.1 percent of the U.S. level over the entire 1987-2004 period.

Chart 19: Business Sector Non-Residential Investment per Worker, Canada as a Percentage of the United States, current US dollars, 2004



Source: CSLS ICT database tables S33, S34, S36, S38, S40, S42, S44

Chart 20: Non-Residential Investment as a Share of Business Sector GDP, Canada as a Percentage of the United States, current dollars, 2004



Source: CSLS ICT database tables S33, S34, S36, S38, S40, S42, S44

Box: Recent Developments in Business Sector Non-Residential Investment

In 2004 the United States experienced very strong growth in total non-residential business sector investment relative to Canada in both nominal and real terms. In real terms total investment grew at 10.6 per cent in the United States compared with 4.3 per cent in Canada. Real ICT investment grew at 11.7 per cent in Canada, but at 19.5 per cent in the United States. In per-worker terms real ICT investment grew at 9.6 per cent in Canada and 18.0 per cent in the United States.

Table Box: Real Trends in Business Non-Residential Investment, Canada and the United States, 2004

	Canada (CAD)		United States (USD)	
	Nominal	Real	Nominal	Real
Total				
Total Investment	3.63	7.32	11.58	10.57
Structures	5.59	2.30	7.12	2.11
M&E	2.42	10.90	13.10	13.52
ICT	4.28	11.66	11.28	19.48
Computer	0.84	18.71	15.50	25.84
Communications	10.88	11.99	11.98	16.38
Software	2.99	2.55	9.03	11.48
Per-Worker				
Total Investment	1.75	5.38	10.20	9.20
Structures	3.67	0.44	5.80	0.85
M&E	0.56	8.89	11.70	12.12
ICT	2.38	9.64	9.90	18.00
Computer	-0.99	16.56	14.08	24.28
Communications	8.87	9.96	10.60	14.94
Software	1.12	0.69	7.69	10.10

Source: Nominal data from CSLS ICT Database. Real data from CANSIM II Table 031-0002 for Canada and from Bureau of Economic Analysis Fixed Assets Standard Tables 4.7 and 4.8.

The Canada-US ICT Investment Gap by Industry[11]

[11] Some industries are omitted due to lack of Canadian data, usually resulting from confidentiality requirements in industries with small numbers of firms. As is standard practice in this report, for reasons of comparability between Canadian and US data, the health care and social assistance and education services sectors are omitted.

Per-Worker Gap by Industry 2004

This section presents data on the Canada-US ICT investment gap on a per-worker basis by industry. Some industries in Canada invested much more than their counterparts in the United States, while other industries invested far less. Data are presented in terms of investment per worker by industry in Canada and the United States (Chart 21) and Canada as a percentage of investment per worker in the same industry in the United States (Charts 22, 23, 24, and 25).[12] In all cases, Canadian-dollar investment per worker data are adjusted to US-dollar figures using the average exchange rate for 2004. Charts 22, 23, 24, and 25 respectively show the gap in per-worker investment by industry for total ICT, computers, communication equipment, and software.

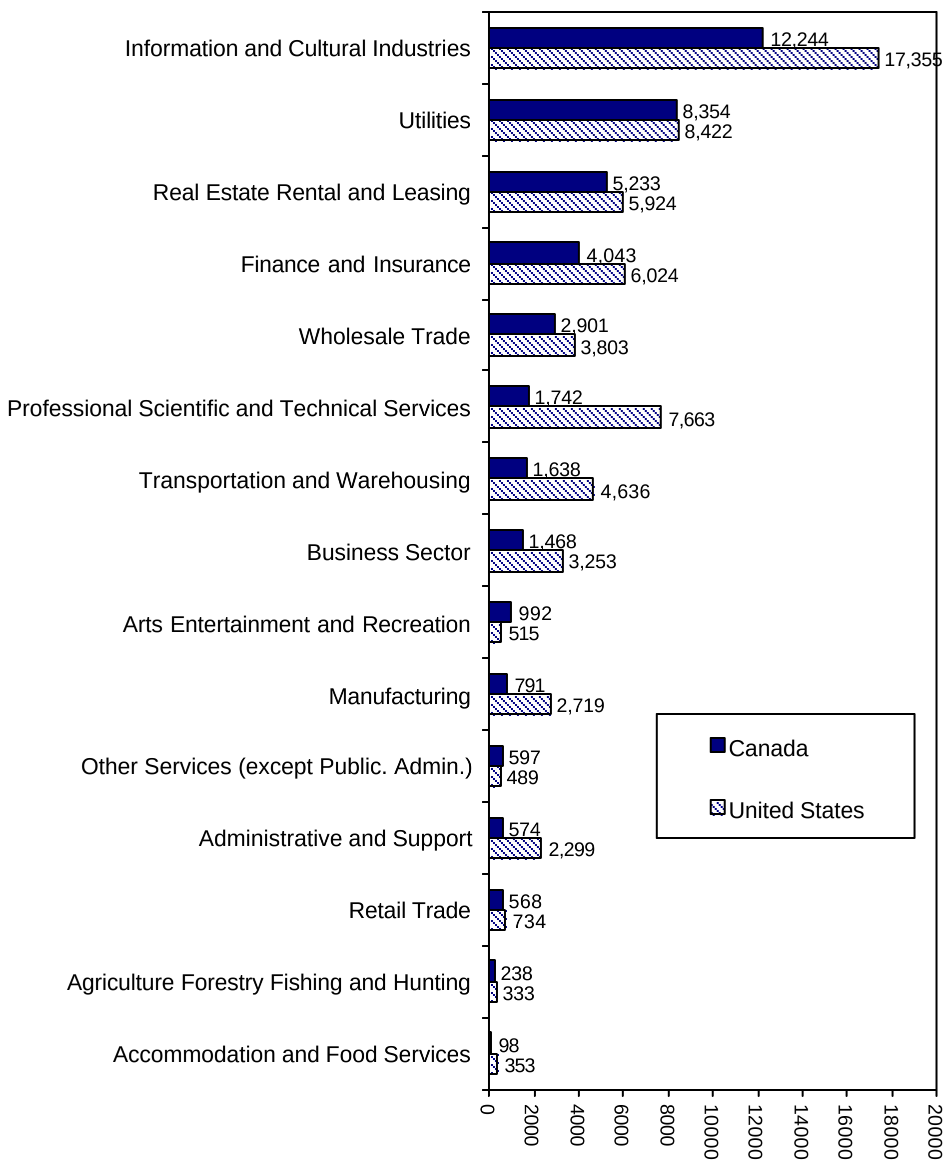
Absolute Levels of ICT Investment by Industry per Worker

ICT investment in both Canada and the United States varies greatly by industry (Chart 21). Before turning to a detailed comparison of the relative levels of ICT investment per worker in Canada and the United States, it is informative to briefly examine the absolute levels of ICT investment per worker by industry, expressed in US dollars. It should be noted that there are two industries excluded from this section, and therefore Chart 21, due to data problems. As will be discussed later in this report, Canadian estimates for the mining and oil and gas extraction industry and the construction industry are underestimates. The extent to which ICT investment per worker in other sectors is not accurately measured is not known at this time. Further research is necessary to determine the extent of these problems in both Canada and the United States.

The business sector average level of ICT investment in Canada was $1,468 per worker, compared to $3,253 per worker in the United States in 2004. Of the industries for which data are available, in both countries the information and cultural industries have the highest level of ICT investment per worker: $12,244 in Canada and $17,355 in the United States. Utilities also show very high levels of ICT investment per worker in Canada ($8,354) and the United States ($8,422). Other Canadian industries with above average levels of ICT investment per worker are real estate rental and leasing ($5,233), finance and insurance ($4,043), wholesale trade ($2,901), professional, scientific and technical services ($1,742), and transportation and warehousing ($1,638). As will be discussed in detail below, no industry that has an above average level of ICT investment per worker in Canada exceeds the level of ICT investment per worker of its US counterpart. The Canadian industries with the lowest levels of ICT investment per worker were accommodation and food services ($98), and agriculture, forestry, hunting and fishing ($238).

[12] Industries are comparable between Canada and the United States, because they are defined by the North American Industry Classification System (NAICS), which provides a uniform definition for each industry.

Chart 21: Total ICT Investment Per Worker by Industry in Canada and the United States, current US dollars, 2004

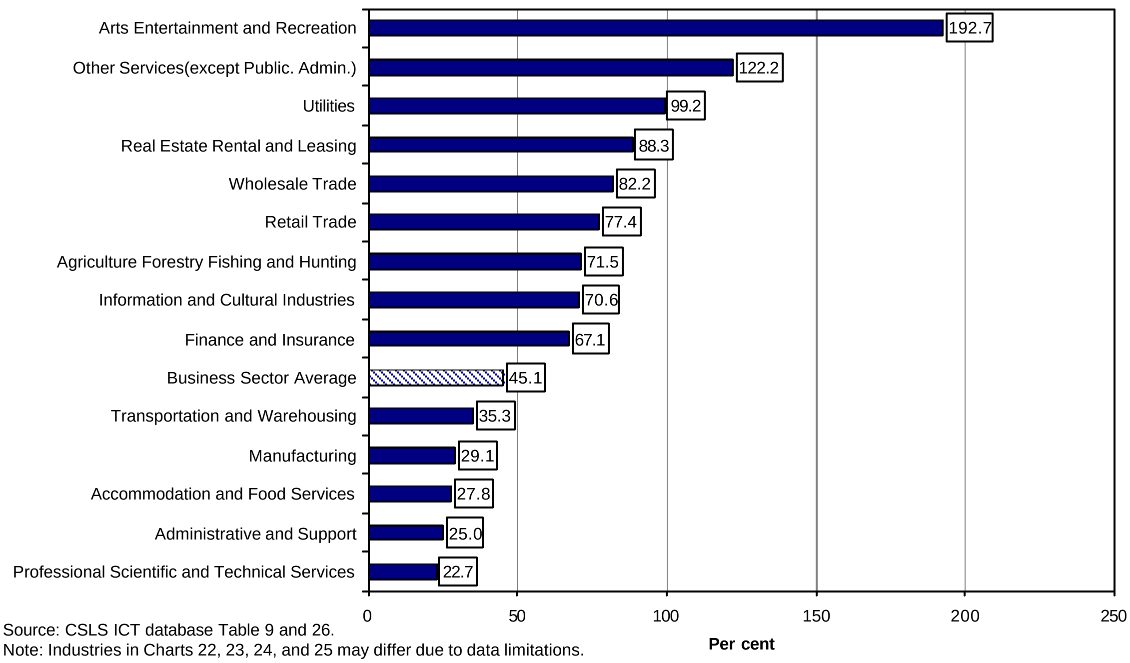


Source: Centre for the Study of Living Standards based on Statistics Canada, United States Bureau of Labour Statistics and Bureau of Economic Analysis

Relative Levels of ICT Investment by Industry per Worker

In terms of total ICT investment per worker, the Canadian business sector invested only 45.1 per cent of the US level (Chart 22). This average concealed significant variations across industries in relative levels of investment. Both arts, entertainment and recreation (192.7 per cent) and other services (122.2 per cent) invested more per worker in ICT than their US counterparts. The industries in Canada that invested the least in ICT relative to their US counterparts were: professional, scientific and technical services (22.7 per cent), administrative and support (25.0 per cent), accommodation and food services (27.8 per cent), manufacturing (29.1 per cent) and transportation and warehousing (35.3 per cent). Industries that were above average, but still invested less per worker than their US counterparts, were: finance and insurance (67.1 per cent), information and cultural industries (70.6 per cent), agriculture, forestry, fishing and hunting (71.5 per cent), retail trade (77.4 per cent), wholesale trade (82.2 per cent), real estate rental and leasing (88.3 per cent), and utilities (99.2 per cent).

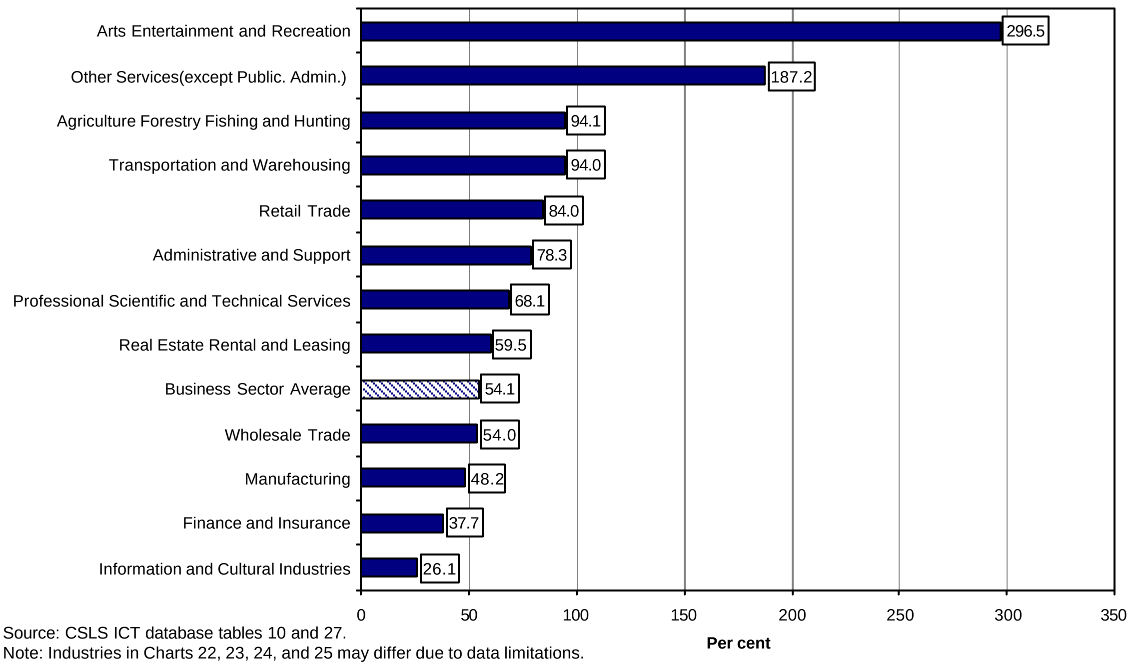
Chart 22: Total ICT Investment per Worker, by Industry, Canada as a Percentage of the United States Level (U.S. = 100), current dollars, 2004



Source: CSLS ICT database Table 9 and 26.
Note: Industries in Charts 22, 23, 24, and 25 may differ due to data limitations.

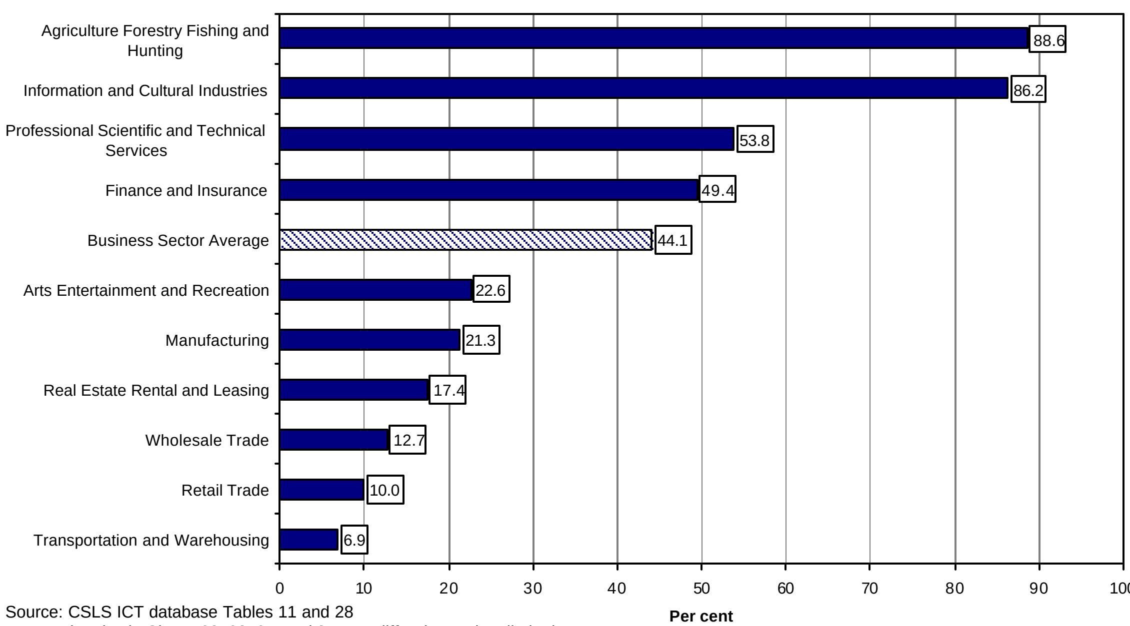
Canadian industries performed slightly better relative to their US counterparts in terms of computer investment per worker than total ICT investment (Chart 23). The business sector average was 54.1 per cent of the US level. The Canadian industries that invested the most in computers per worker, were: arts, entertainment and recreation (296.5 per cent) and other services (187.2 per cent). Industries that invested the least were the information and cultural industries (26.1 per cent), finance and insurance (37.7 per cent), manufacturing (48.2 per cent), and wholesale trade (54.0 per cent). Industries that invested more than the Canadian average, but still did not surpass the level of the investment of their US counterparts were: real estate rental and leasing (59.5 per cent), professional, scientific and technical services (68.1 per cent), administrative and support (78.3 per cent), retail trade (84.0 per cent), transportation and warehousing (94.0 per cent), agriculture, forestry, fishing and hunting (94.1 per cent).

Chart 23: Computer Investment per Worker, by Industry, Canada as a Percentage of the United States Level (U.S. = 100), current dollars, 2004



Source: CSLS ICT database tables 10 and 27.
Note: Industries in Charts 22, 23, 24, and 25 may differ due to data limitations.

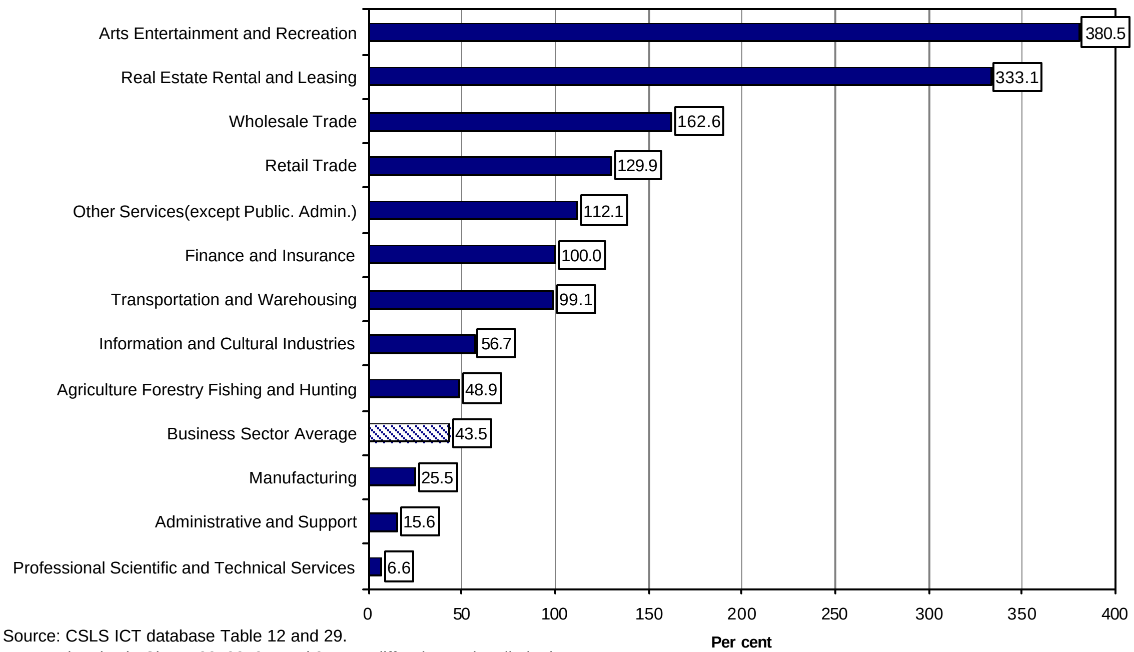
Chart 24: Communication Equipment Investment per Worker, by Industry, Canada as a Percentage of the United States level (U.S. = 100), current dollars, 2004



Source: CSLS ICT database Tables 11 and 28
Note: Industries in Charts 22, 23, 24, and 25 may differ due to data limitations.

Relative to US industries, Canadian industries invested the least on average on a per worker basis in communication equipment (Chart 24). The business sector average level of communication equipment investment per worker was 44.1 per cent of the level of the US business sector. No industry invested more in Canada than in the United States. The industries that invested the least per worker relative to their US counterparts were transportation and warehousing (6.9 per cent), retail trade (10.0 per cent), wholesale trade (12.7 per cent), real estate rental and leasing (17.4 per cent), manufacturing (21.3 per cent), and arts, entertainment and recreation (22.6 per cent). Industries that invested more than the Canadian average in communication equipment per worker were: finance and insurance (49.4 per cent), professional, scientific and technical services (53.8 per cent), information and cultural industries (86.2 per cent), and agriculture, forestry, fishing and hunting (88.6 per cent).

Chart 25: Software Investment per Worker, by Industry, Canada as a Percentage of the United States Level (U.S. = 100), current dollars, 2004



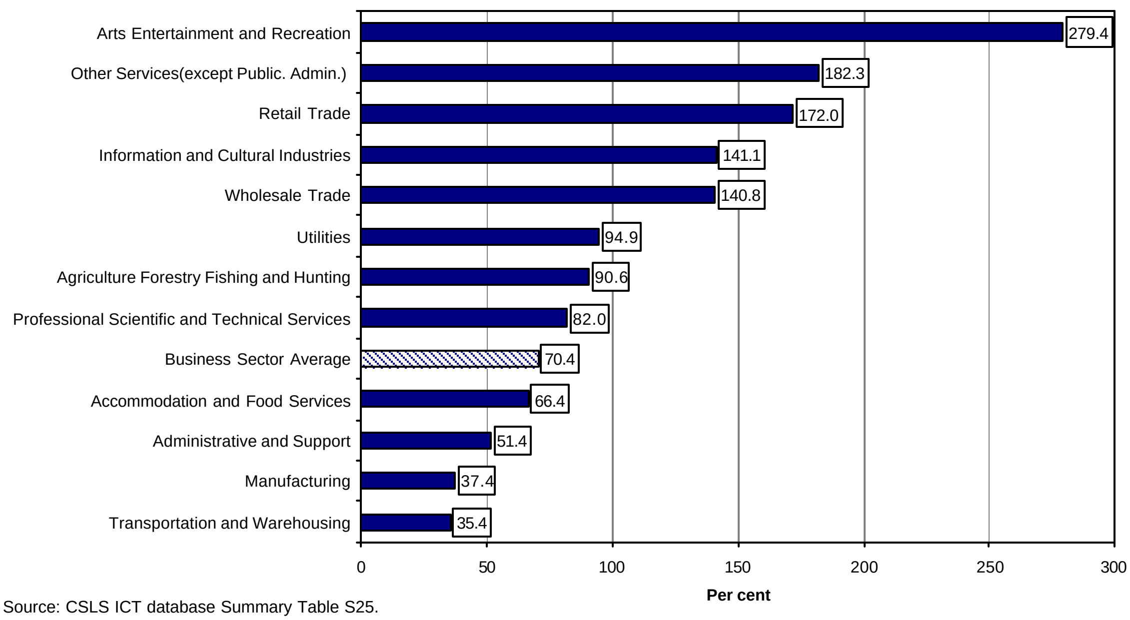
Source: CSLS ICT database Table 12 and 29.
Note: Industries in Charts 22, 23, 24, and 25 may differ due to data limitations.

Many Canadian industries invested more in software per worker than their US counterparts (Chart 25). Both arts, entertainment and recreation (380.5 per cent) and real estate rental and leasing (333.1 per cent) invested more than three times the level of their US equivalents. Other industries that invested more per worker in software in Canada than in the United States were: other services (112.1 per cent), retail trade (129.9 per cent), and wholesale trade (162.6 per cent). The industries that invested the least relative to the US level were: professional, scientific and technical services (6.6 per cent), administrative and support (15.6 per cent), and manufacturing (25.5 per cent). Canadian industries that invested an above average amount in software per worker, but did not exceed the US level, were: agriculture, forestry, fishing and hunting (48.9 per cent), information and cultural industries (56.7 per cent), transportation and warehousing (99.1 per cent), and finance and insurance (100.0 per cent).

Share-of-GDP Gap by Industry

Statistics Canada has not yet released estimates of GDP by industry in current dollars for years after 2002.[13] As a result, while ICT investment per-worker by industry estimates are available to 2004, the most recent estimates of ICT investment as a share of GDP by industry are for the year 2002. Charts 26, 27, 28, and 29 present Canadian ICT investment as a share of GDP, by industry, as a percentage of the US level, for total ICT, computers, communication equipment, and software respectively.

Chart 26: Total ICT Investment as a Share of GDP, by Industry, Canada as a Percentage of the United States level (U.S. = 100), current dollars, 2002



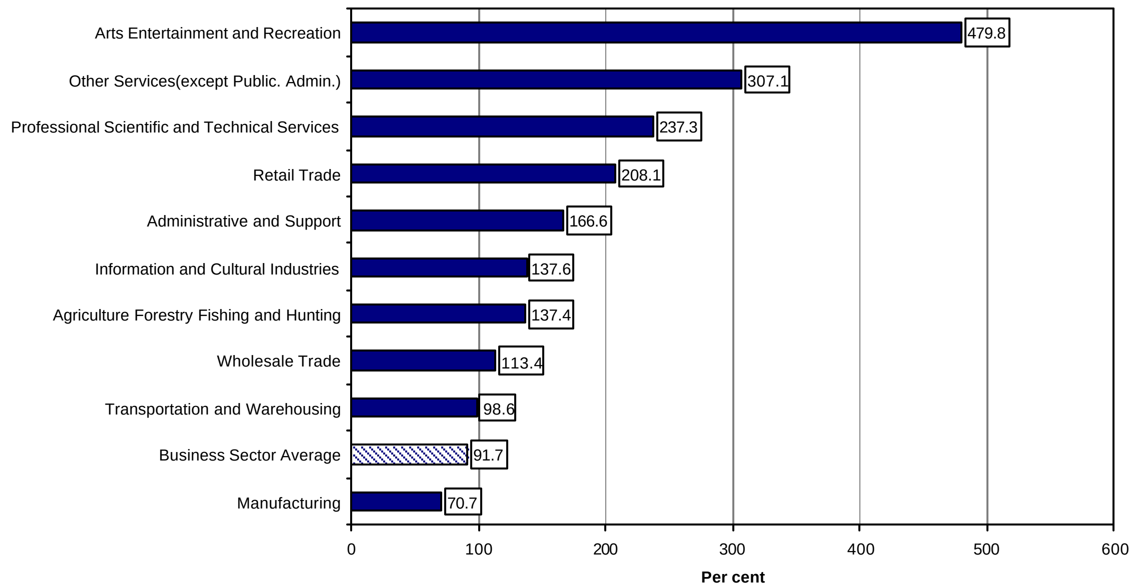
Source: CSLS ICT database Summary Table S25.
Note: Industries in Charts 26, 27, 28, and 29 may differ due to data limitations.

Chart 26 presents Canadian total ICT investment as a share of GDP as a percentage of the United States level by industry in current dollars for 2002. Overall, the Canadian business sector invested 70.4 per cent of the US level. This average obscures considerable variation among the industries. The Canadian arts, entertainment and recreation industry (279.4 per cent) invested almost three times more as a share of GDP than did its US counterpart. Other industries that invested more as a share of GDP in Canada than in the United States included other services (182.3 per cent), retail trade (172.0 per cent), information and cultural industries (141.1 per cent), and wholesale trade (140.8 per cent). On the other hand, some industries in Canada invested a far smaller amount in ICT relative to GDP than they did in the United States. Industries that invested less than the business sector average in total ICT as a share of GDP were: transportation and warehousing (35.4 per cent), manufacturing (37.4 per cent), administrative and

[13] Specifically, Table 379-0023 "Gross Domestic Product (GDP) at basic price in current dollars, system of national accounts benchmark values, by North American Industry Classification System (NAICS), annual, 1962-2002.

support (51.4 per cent), and accommodation and food services (66.4 per cent). Industries that invested more than the business sector average, but less than their US counterparts were: professional, scientific and technical services (82.0 per cent), agriculture, forestry, fishing and hunting (90.6 per cent), and utilities (94.9 per cent).

Chart 27: Computer Investment as a Share of GDP, by Industry, Canada as a Percentage of the United States level (U.S. = 100), current dollars, 2002



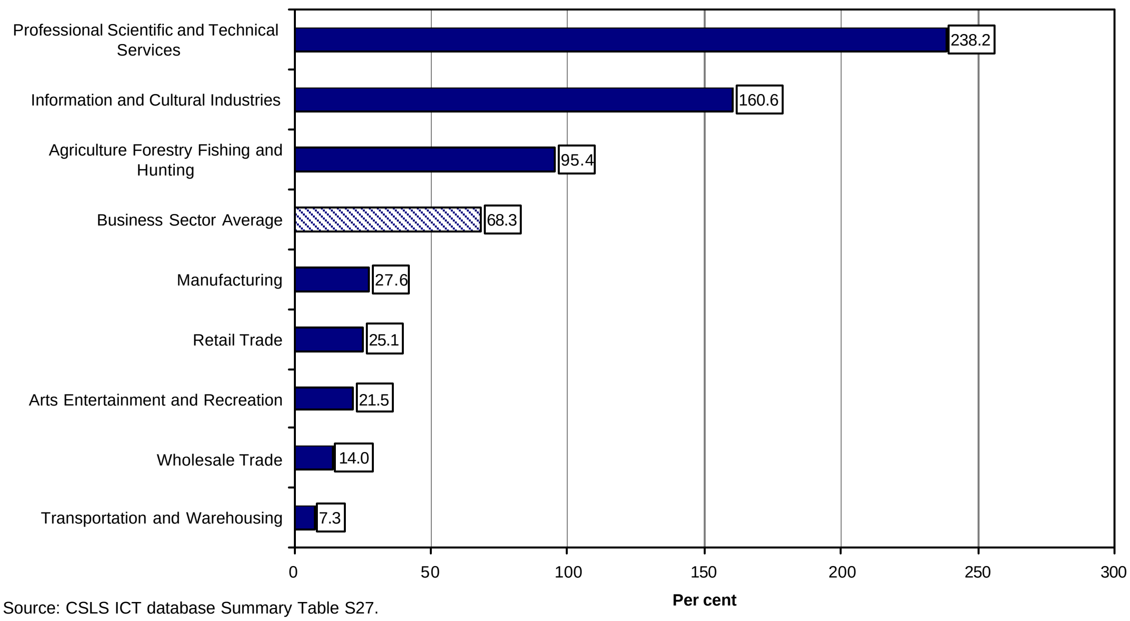
Source: CSLS ICT database Summary Table S26.
Note: Industries in Charts 26, 27, 28, and 29 may differ due to data limitations.

In terms of computer investment as a share of GDP, Canadian industries exhibited a high level of investment relative to other components of ICT: however, the business sector average computer investment as a share of GDP was still below the US level (91.7 per cent) (Chart 27).[14] Many Canadian industries invested more, as a share of GDP, in computers than their US counterparts: arts, entertainment and recreation (479.8 per cent), other services (307.1 per cent), professional, scientific and technical services (237.3 per cent), retail trade (208.1 per cent), administrative and support (166.6 per cent), information and cultural industries (137.6 per cent), agriculture, forestry, fishing and hunting (137.4 per cent), and wholesale trade (113.4 per cent). Transportation and warehousing (98.6 per cent) almost reached the level of investment of its US counterpart.

[14] Readers may note that the "Business Sector Average" appears to be quite low in comparison with the industries presented in Chart 18a. This paradoxical situation is correct for two related reasons. First, as noted above, unfortunately, data were not available for all industries in the Canadian economy. Nonetheless, the business sector total includes industries for which individual data were not available. Excluded industries in 2002 were utilities, finance and insurance, real estate rental and leasing, and accommodation and food services. As discussed above certain industries were excluded due to issues of comparability with US data: management of companies and enterprises, educational services, and health care and social assistance.

Manufacturing (70.7 per cent) exhibited the lowest level of computer investment as a share of GDP of industries for which data are available.

Chart 28: Communication Equipment Investment as a Share of GDP, by Industry, Canada as a Percentage of the United States level (U.S. = 100), current dollars, 2002

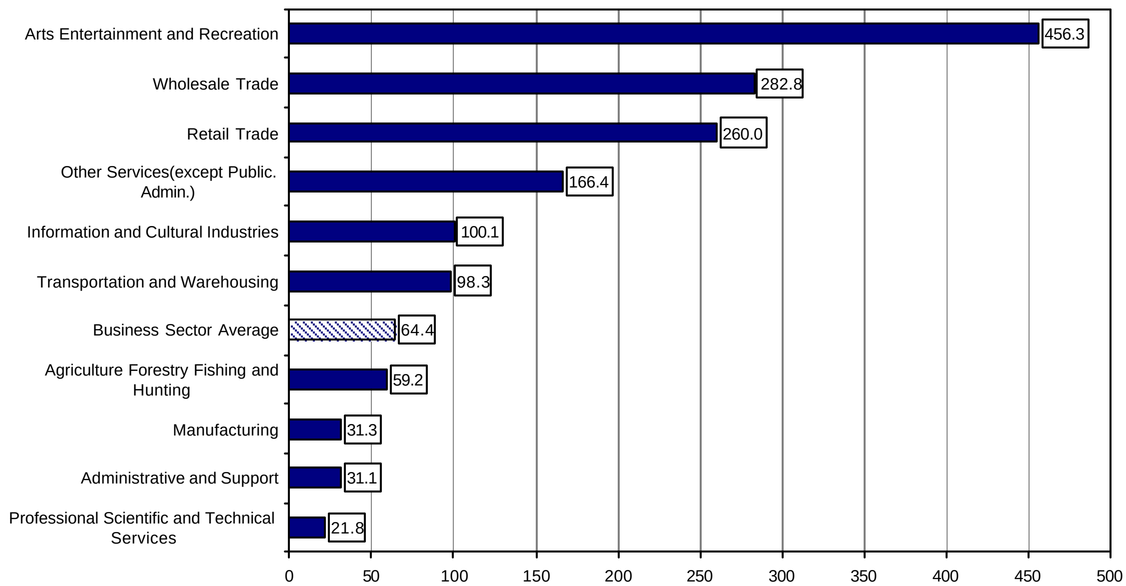


Source: CSLS ICT database Summary Table S27.
Note: Industries in Charts 26, 27, 28, and 29 may differ due to data limitations.

Canadian business sector communication equipment investment as a share of GDP was 68.3 per cent of the US level in 2002 (Chart 28). Canadian industries that had higher levels of investment in communication equipment as a share of GDP relative to their US counterparts were: professional, scientific and technical services (238.2 per cent) and information and cultural industries (160.6 per cent). Agriculture, forestry, fishing and hunting (95.4 per cent) almost reached the level of communication equipment investment of its US counterpart as a share of GDP. The industries that had the lowest levels of communication equipment investment as a share of GDP relative to their US counterparts were transportation and warehousing (7.3 per cent), wholesale trade (14.0 per cent), arts, entertainment and recreation (21.5 per cent), retail trade (25.1 per cent) and manufacturing (27.6 per cent).

In terms of software investment as a share of GDP in Canada relative to the United States, the business sector average was 64.4 per cent (Chart 29). Several industries in the Canadian economy outperformed their US equivalents: arts, entertainment and recreation (456.3 per cent), wholesale trade (282.8 per cent), retail trade (260.0 per cent), other services (166.4 per cent), and information and cultural industries (100.1 per cent). Transportation and warehousing (98.3 per cent) invested only slightly less than its US equivalent. Industries in Canada that invested less than the business sector average level as a share of GDP relative to the United States were: professional, scientific and technical services (21.8 per cent), administrative and support (31.1 per cent), manufacturing (31.3 per cent), and agriculture, forestry, fishing and hunting (59.2 per cent).

Chart 29: Software Investment as a Share of GDP, by Industry, Canada as a Percentage of the United States level (U.S. = 100), current dollars, 2002



Source: CSLS ICT database Summary Table S28.
Note: Industries in Charts 26, 27, 28, and 29 may differ due to data limitations.

ICT Investment per Worker Canada-US Gap Contributions by Industry

The Canada-US ICT investment per worker gap can be divided into industry contributions and industrial composition. The first measure can be thought of as the amount of ICT investment necessary in a specific industry for it to reach parity with its American counterpart. However, even if each industry in Canada had the same level of ICT investment per worker as its equivalent US industry, there could still be a gap if Canada had a larger proportion of its labour force in industries with relatively low ICT investment per worker levels.[15]

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[15] To estimate the amount of ICT investment necessary in each industry to bridge the gap with the corresponding American industry, the following formula was used :

$$I_g = (I_{u1} - I_{cl}) * L_{cl}$$

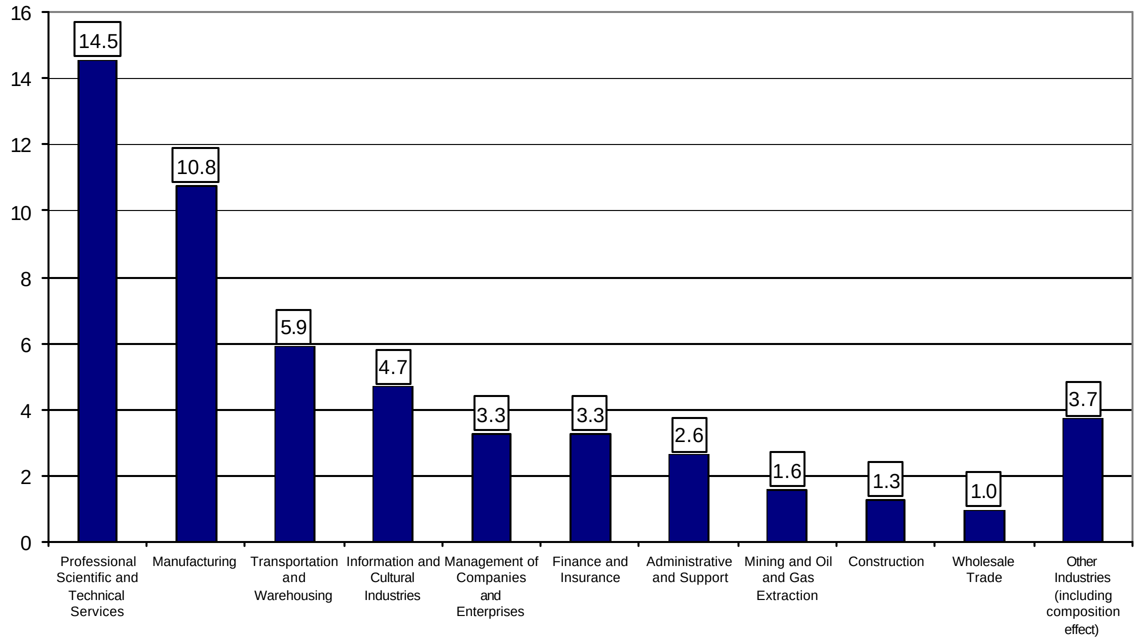
Where, I_g = Investment necessary to bridge the gap in Industry 1 (US$)
I_{c1} = Investment per Worker in Canada in Industry 1 ($US)
I_{u1} = Investment per Worker in the U.S. in Industry 1 ($US)
L_{cl} = Number of Workers in Canada in Industry 1

After, it is possible to estimate the proportion of the gap that can be accounted by that specific industry by dividing the amount of investment necessary to bridge the gap in that industry by the amount needed for the whole business sector :

$$\textit{Contribution of Industry 1 (in per cent)} = \frac{Ig_1}{Ig_b} * 100$$

If we add up all the industrial contributions, we can calculate the contribution of industrial composition to the gap as a residual :

Chart 30: Contributions by industry to Canada-US ICT Investment per Worker Gap, top ten industries, current dollars, 2004

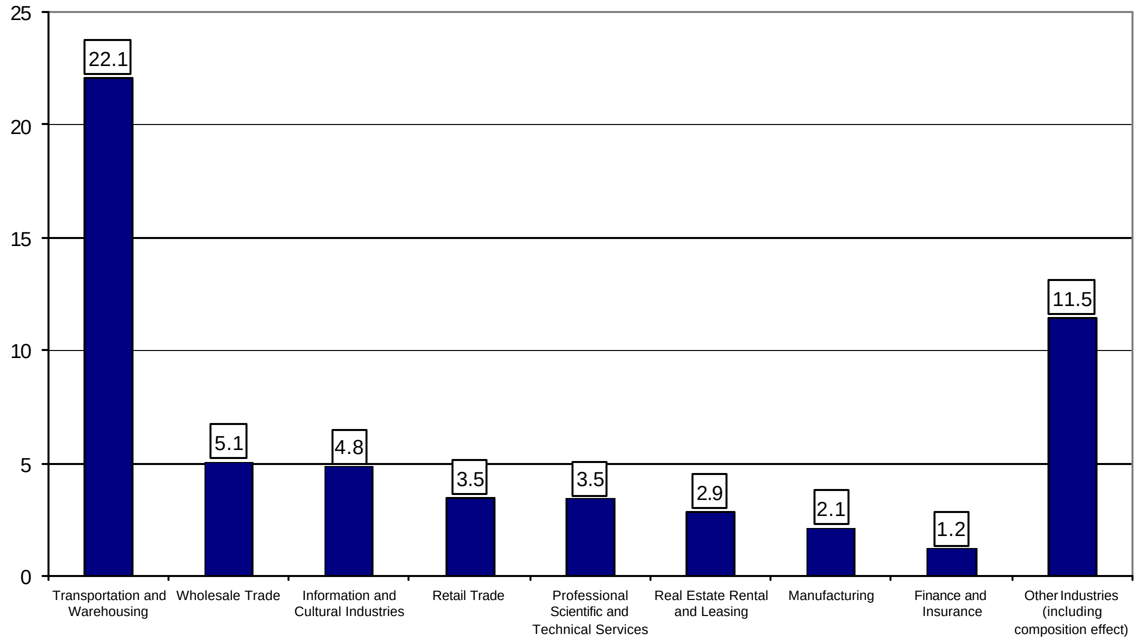


The results of this decomposition are shown in Appendix Table 6. In 2004, the industry contributing most to the gap was professional, scientific and technical services at 14.5 percentage points, accounting for more than a quarter of the gap. This large contribution was due both to the large ICT investment per worker gap in the industry (5,921 $US) and the fact it accounted for 8.2 per cent of the total labour force. The second biggest contributor was manufacturing, which accounted for 10.8 percentage points of the ICT investment per worker gap, or about 20.5 per cent.

Of the 52.6 percentage-point gap in 2004, almost three-quarters (39.2 percentage points) was accounted for by only five industries (Chart 30). Only two Canadian industries, arts, entertainment and recreation and other services, exceeded their American counterparts in ICT investment per worker and contributed to bridging the gap. However, their respective contributions of -0.4 percentage points and -0.2 percentage points were of little significance. Finally, if all Canadian industries contributed to closing the gap, there would still be a 2.3 percentage point gap in 2004 due to different industrial composition between Canada and the United States.

Contribution of Industrial Composition (in per cent) $= 100 - \sum_{1}^{i} \frac{Igi}{Igb}$

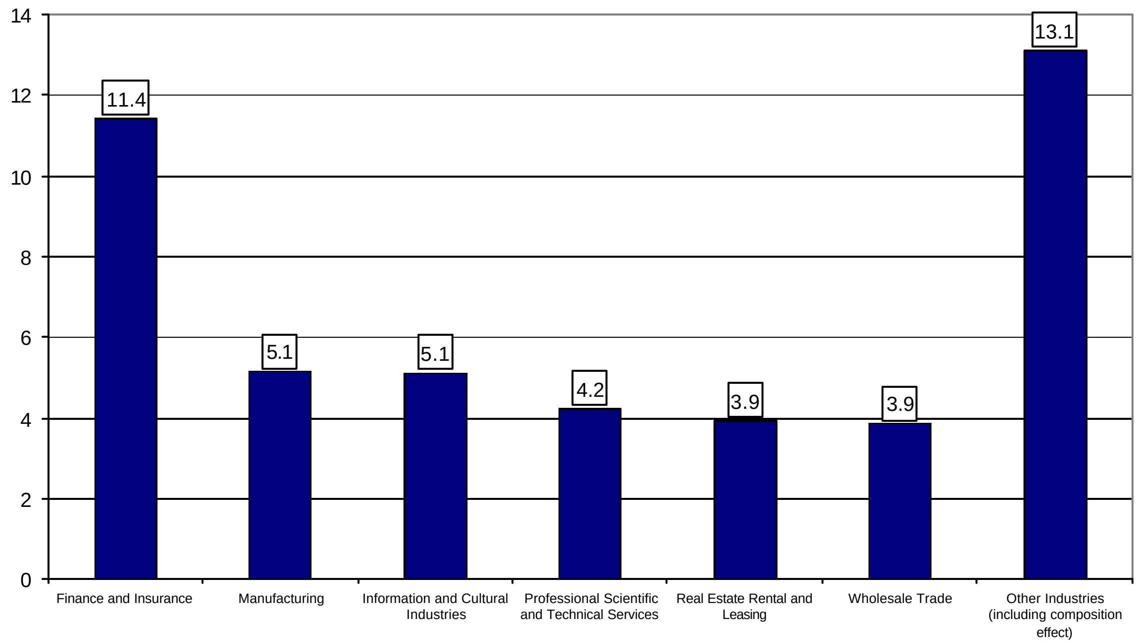
Chart 31: Contributions by industry to Canada-US ICT Communications Investment per Worker Gap, top eight industries, current dollars, 2004



It is worth noting that even though the mining and oil and gas extraction and the construction industries suffer from an under-estimation of their ICT investment levels (discussed in the section dealing with survey coverage issues), they together account for only 2.9 percentage points of the gap, or less than 6 per cent.

Repeating the decomposition for the three ICT components sheds light on the specific ICT investment weaknesses of certain industries. In 2004, the main contributor to the Canada-US ICT communications investment per worker gap was by far the transportation and warehousing industry with 22.1 percentage points, accounting for 39.0 per cent of the 56.7 percentage-point gap (Chart 31). Wholesale trade, with a 5.1 percentage-point contribution to the gap (8.9 per cent) was the only other industry that contributed more than five percentage points. All other industries contributed positively to the gap, although agriculture's contribution was almost less than 0.1 per cent. The industrial composition effect accounted for 2.2 percentage points, about 4.0 per cent of the gap.

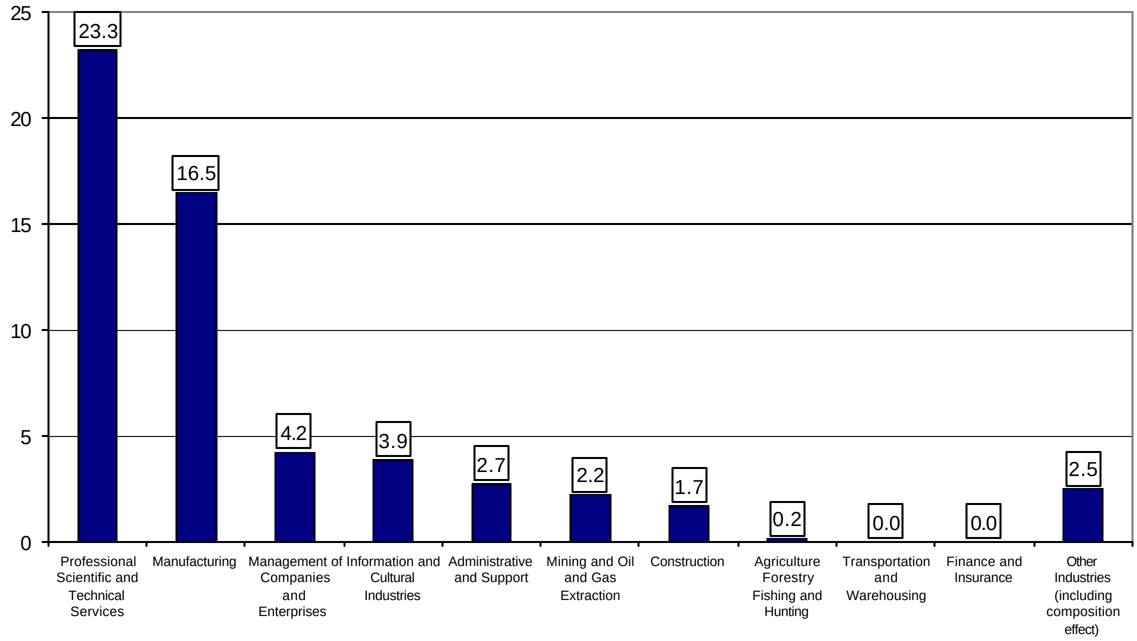
Chart 32: Contributions by industry to Canada-US ICT Computer Investment per Worker Gap, top ten industries, current dollars, 2004



The results are quite different for the Canada-U.S. ICT computer investment per worker gap. In 2004, the finance and insurance industry contributed 11.4 percentage points, which accounted for 24.4 per cent of the 46.8 percentage-point gap. The financial sector is already one of the most computer-intensive sectors in both the Canadian and US economies. However, it appears that the US industry is adopting new technologies at a much faster pace than Canadian industry. Manufacturing and information and cultural industries both contributed 5.1 percentage points to the gap (about 11 per cent), closely followed by professional, scientific and technical services with a 4.2 percentage-point contribution (9.0 per cent).

The Canada-US ICT software investment per worker gap is the most important of all three components, because software accounts for about half of all ICT investment. The results of the decomposition are broadly in line with those for total ICT investment. Professional, scientific and technical services and manufacturing were the two main contributors to the software investment per worker gap accounting for 23.3 and 16.5 percentage points respectively (40.6 and 28.8 per cent respectively). However, some industries, such as real estate and leasing (-2.4 percentage points) and wholesale trade (-2.0) did significantly better in Canada than in the United States.

Chart 33: Contributions by industry to Canada-US ICT Software Investment per Worker Gap, top ten industries, current dollars, 2004

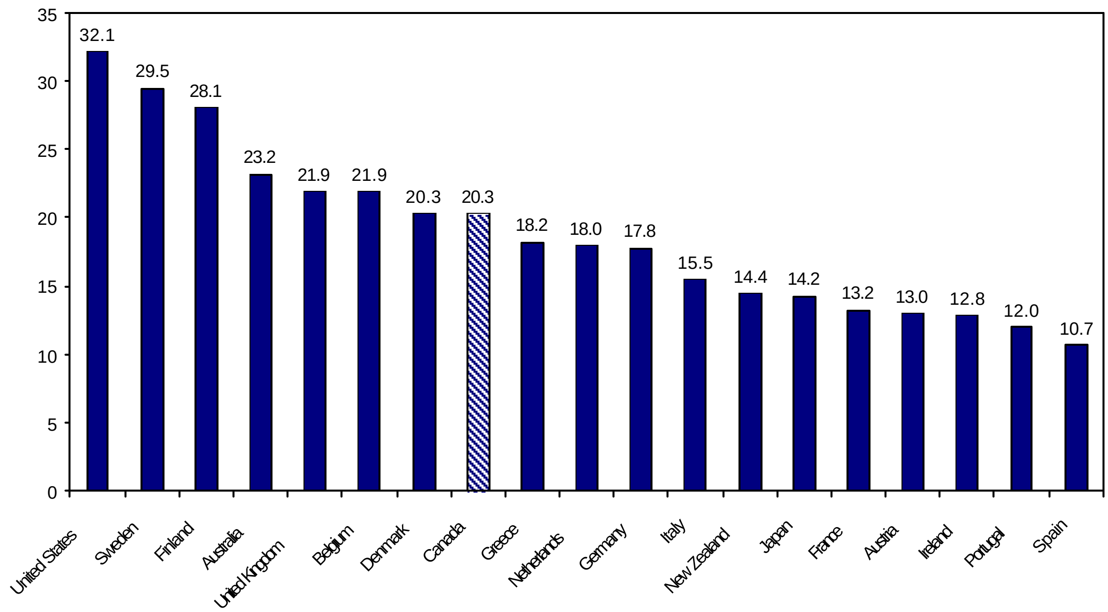


International Perspective on Canadian ICT Investment

Even though Canada's ICT investment performance is poor relative to the United States, its international position is much better. ICT investment data for 19 OECD countries in 2001 were used to assess Canada's performance from an international perspective. This short review focuses on three measures: the share of ICT investment in non-residential fixed investment, the share of ICT investment in GDP, and ICT investment per worker with market exchange rates used to adjust national currencies to US dollars.

Canada ranked eighth for its share of ICT investment in non-residential fixed investment with 20.3 per cent, compared to 32.1 per cent in the United States which ranked first (Chart 34). Sweden and Finland ranked second and third with 29.5 per cent and 28.1 per cent respectively. Many European countries, such as Spain (10.7 per cent), Portugal (12.0 per cent) and even Ireland (12.8 per cent) reported relatively low shares of ICT investment in non-residential fixed investment. Overall, Canada's performance was average, with seven of the selected countries in a plus or minus three percentage-point range. In fact, Canada's low ICT investment level relative to the United States is a result of an exceptionally strong performance by the US economy and not an exceptionally weak performance by the Canadian economy.

Chart 34: Share of ICT Investment in Non-Residential Fixed Investment in Selected OECD Countries at the Total Economy Level, 2001, per cent

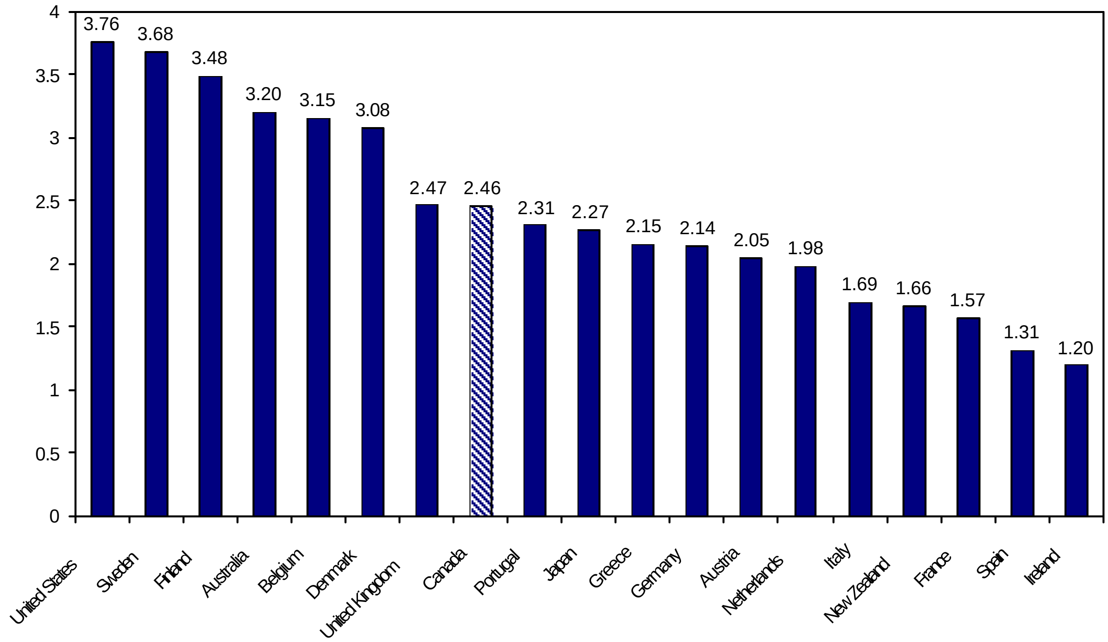


Source : CSLS ICT Database S30

Data on shares of ICT investment as a percentage of GDP in 2001 provides similar results (Chart 35). Canada ranked eighth again with 2.46 per cent and the United States was still leading with 3.76 per cent. Furthermore, the seven countries reporting a stronger performance than Canada are the same as those leading by the previous indicator, even though the order changed slightly with the United Kingdom falling from fifth to seventh place. Ireland (1.20 per cent), Spain (1.31 per cent) and France (1.57 per cent) reported lower percentages of ICT investment in GDP than Canada. The strikingly similar results between the two indicators suggest that the ratios of total non-residential investment to GDP among the selected countries are comparable. Again, Canada's performance is set in a much brighter light from an international perspective than when compared to the United States alone.

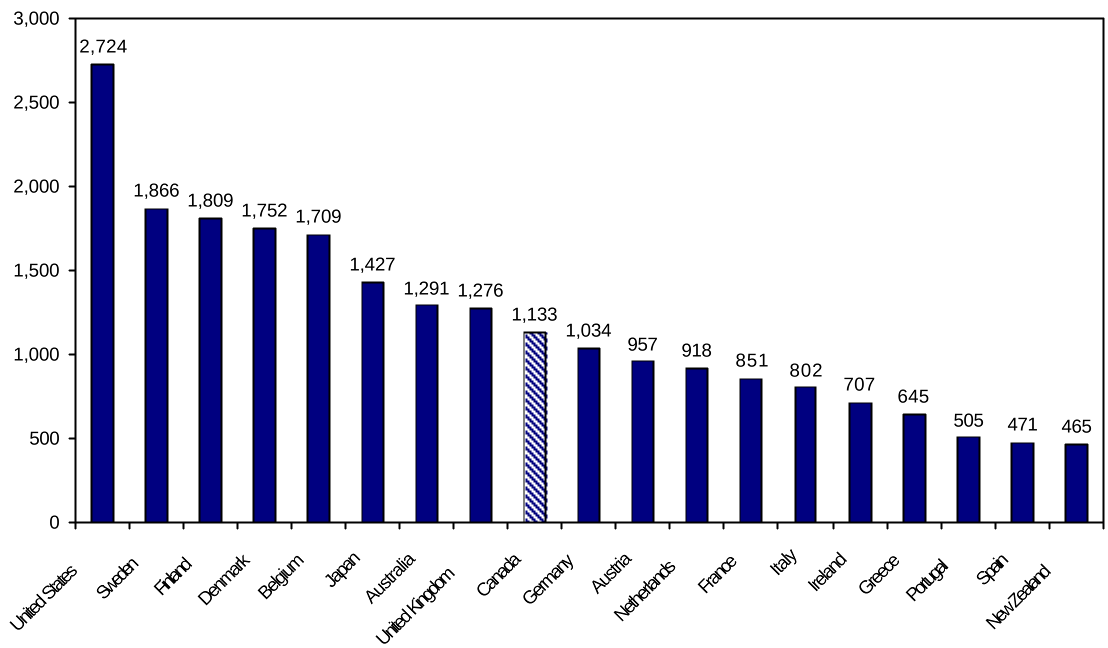
The third indicator, ICT investment per worker, was obtained by adjusting ICT investment reported in national currencies to US dollars using market exchange rates for 2001. Again, the results were relatively similar to those obtained with the other two indicators. Canada ranked ninth at $1,133 of ICT investment per worker, well behind the US level of $2,724 (Chart 36). Japan, with a high level of ICT investment per worker ($1,427), was among seven countries with which ranked higher than Canada by all three indicators. In terms of ICT investment per worker, the worst performer was New Zealand at $465 per worker. Canada's performance was average.

Chart 35: Shares of ICT Investment in GDP in Selected OECD Countries, 2001, per cent



Source : CSLS ICT Database Table S46

Chart 36: ICT Investment per Worker in Selected OECD Countries, 2001, US dollars, market exchange rate adjusted



Source : CSLS ICT Database Table S46

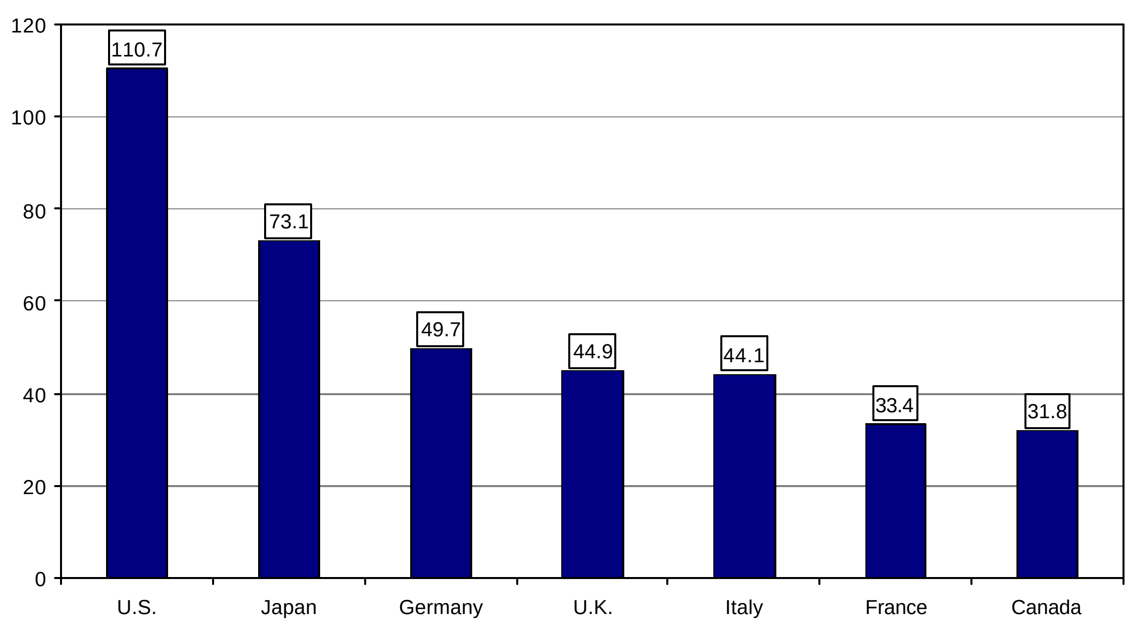
China and India

While the economies of China and India have grown rapidly in recent years, it will be many years before either country approaches the Canadian level of ICT investment per worker. Unfortunately, data is not available for a rigorous comparison of ICT investment intensity. Certain industries within China and India may have made significant investments in ICT, but aggregate ICT investment per worker remains well behind OECD countries. Many challenges and opportunities are created for the Canadian economy as a result of these emerging economic giants, however, Canada remains a significantly more ICT-intensive economy than either China or India.

International Perspective on Canadian ICT Capital Stock

While investment is a flow, capital stock is not. It is the measure of the value of the accumulated investment flows from previous years, less depreciation, which accounts for the obsolescence or wearing-out of capital. Chart 37 shows levels of ICT capital stock per capita in 2001 in the G7 countries relative to the United States in 2000. By this measure, Canada's stock of ICT capital per capita, at 31.8 per cent of the 2000 US level, is small relative to other G7 countries. The United States led the G7 with 110.7 per cent of its 2000 level. Japan's ICT capital stock was the second largest, at 73.1 per cent of the 2000 US level. Germany (49.7 per cent), the United Kingdom (44.9 per cent), and Italy (44.1 per cent) had levels of capital stock per capita slightly higher than France (33.4 per cent).

Chart 37: Levels of IT Capital Stock Per Capita (U.S. = 100.0 in 2000), 2001

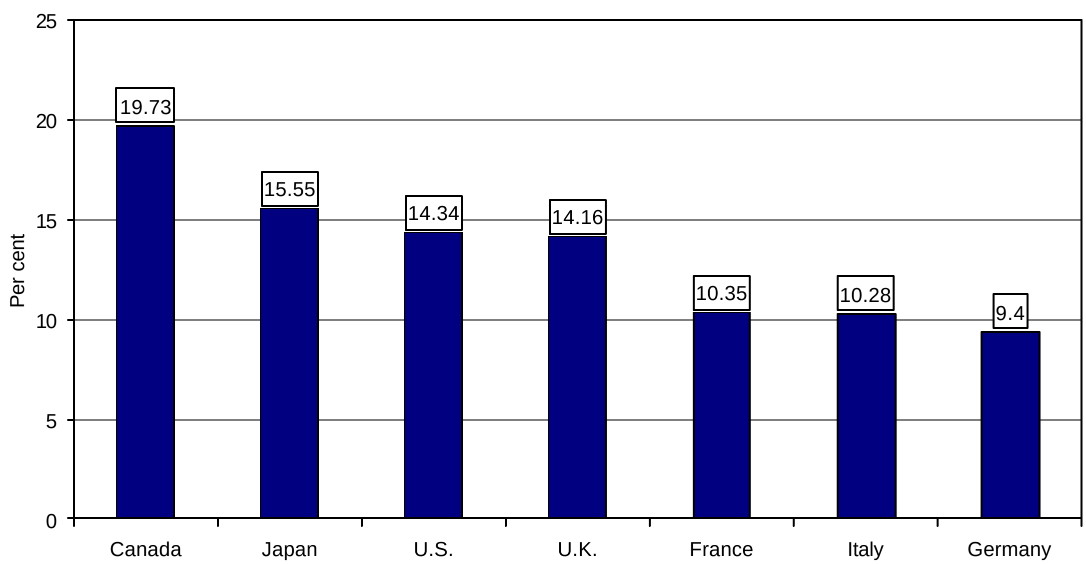


Source: Jorgenson *et al.* (2005), Table 3.6, p. 70.

The picture is slightly brighter for Canada in terms of the growth rate of ICT capital stock when compared to other G7 countries (Chart 38). Between 1995 and 2001, Canada's ICT capital stock grew at a rate of 19.73 per cent. Canada was followed by Japan (15.55 per cent), the United States (14.34 per cent), the United Kingdom (14.16 per cent), France (10.35 per cent), Italy (10.28 per cent), and Germany (9.40 per cent).

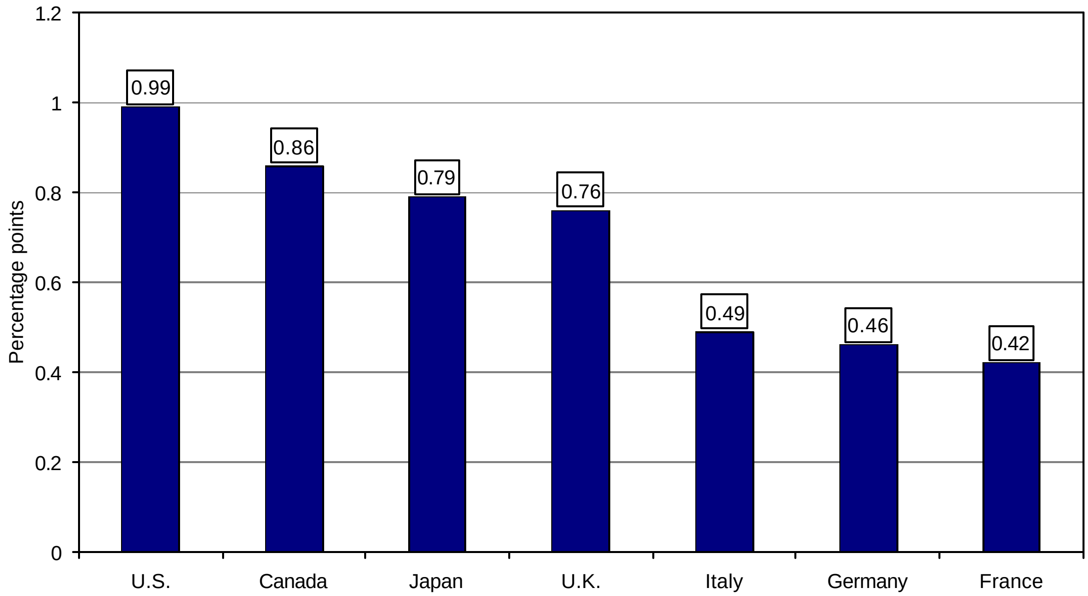
The United States led the G7 in the contribution of ICT capital to output growth (0.99 per cent) (Chart 39), but it was followed closely by Canada (0.86 per cent), Japan (0.79 per cent), and the United Kingdom (0.76 per cent). Italy (0.49 per cent), Germany (0.46 per cent) and France (0.42 per cent) saw a more modest contribution to output growth from ICT capital.

Chart 38: IT Capital Stock Per Capita Average Annual Growth Rate, per cent, 1995-2001



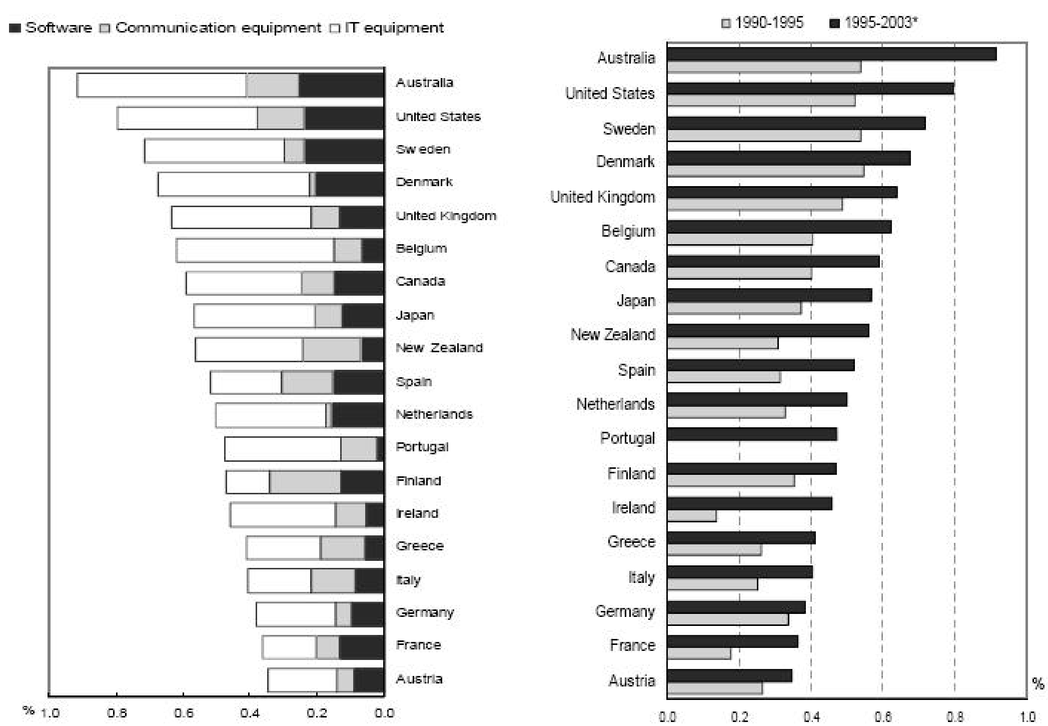
Source: Jorgenson *et al.* (2005), Table 3.9, p. 72

Chart 39: Contribution of IT Capital to Output Growth, percentage points, 1995-2001



Source: Jorgenson *et al.* (2005), Table 3.13, p. 74.
Note: Contribution is growth rate times value share.

Chart 40: Contributions of ICT Capital by Component, 1990-1995 and 1995-2003



1. 1991-1995 for Germany; 1995-2002 for Australia, France, Japan, New Zealand and Spain.
2. 1995-2002 for Australia, France, Japan, New Zealand and Spain.

Source: OECD Compendium of Productivity Indicators 2005, p. 21

The contribution of ICT capital to productivity growth in Canada in recent years has been fairly large from an international perspective. According to OECD estimates (Chart 40), during the 1995-2003 period, ICT capital contributed 0.6 percentage points to productivity growth per year, below the 0.9 points in Australia and 0.8 points in the United States, but still seventh out of 19 countries. Of this 0.6 points, IT equipment was responsible for approximately 0.4 points, software 0.2 points, and communication equipment 0.1 points.

Are ICT Investment Data Consistent with the Picture Emerging from Other ICT Indicators?

In addition to estimates of ICT investment, a country's ICT performance can be evaluated with other indicators. This part of the report will compare the findings presented above, *i.e.* the large ICT investment gap between Canada and the United States, with a number of common alternative ICT indicators. After a short review of Canada's ICT performance using alternative indicators, we will discuss the possible reasons that could explain the discrepancy between the other indicators and the large ICT investment gap observed between Canada and the United States.

Review of Alternative Indicators

Alternative indicators have been drawn from a broad scan of the ICT indicators literature. Exhibit 2 presents the twelve indictors selected.

Exhibit 2: ICT Indicators for Canada and the United States, 2004

	Canada	United States	Canada as a share of the U.S (per cent)
Telecommunications Indicators			
Broadband penetration per 100 inhabitants (ITU)	17.6	11.4	154.4
Cellular subscribers per 100 inhabitants (ITU)	47.2	61.0	77.4
Mainline subscribers per 100 inhabitants (ITU)	63.2	59.9	105.5
Internet subscribers to fixed networks per 100 inhabitants* (OECD)	22.3	33.0	67.6
Telecommunications Investment (CSLS, $US)			
Communications ICT Investment as a percentage of GDP	0.61	1.01	60.2
Communications ICT Investment per Worker	$357	$810	44.1
Communications ICT Capital Stock per Worker	$2,389	$4,348	54.9
Communications ICT Capital Stock per Capita	$1,675	$985	58.8
Computers Indicators			
Personal computers per 100 inhabitants (ITU)**	48.7	66.0	73.8
Personal computers per capita ratio, (IDC***)	-	-	86.2
Home	-	-	109.9
Small Businesses (1-99 employees)	-	-	81.3
Medium/Large Businesses (100+)	-	-	59.9
Government	-	-	58.5
Education	-	-	63.7
Computers' Investment ($US)			
Computer ICT Investment as a share of GDP	0.73	0.99	73.8
Computer ICT Investment per Worker	$427	$790	54.1
Computer ICT Capital Stock per Worker	$920	$1,487	61.8
Computer ICT Capital Stock per Capita	$573	$379	66.2

*2003 Data
** 2002 Data
*** Found in Fuss & Waverman (2005), originally from IDC

Broadband Penetration per 100 Inhabitants

The first indicator is the level of broadband penetration per 100 inhabitants.[16] This information is from the International Telecommunications Union (ITU), which maintains an extensive database of telecommunications-related indicators covering more than 100 countries (*World Telecommunications Indicators Database*).

In 2004, Canada led the G7 in broadband penetration, significantly outperforming the United States, which reported a broadband penetration level of only 11.4 subscribers per 100 inhabitants, less than two-thirds of Canada's level of 17.6 subscribers per 100 inhabitants. This high level of broadband penetration in Canada has been achieved in spite of a lower level of urbanization than the United States. It is also interesting to note that the OECD-produced indicator of broadband penetration for 2004 provides similar results with Canada reporting broadband penetration of 17.8 per cent compared to the United States 13.0 per cent[17].

Cellular Subscribers per 100 Inhabitants

The second indicator is the number of cellular subscribers per 100 inhabitants.[18] With 47.2 cellular subscribers per 100 inhabitants, Canada ranked 29th among the thirty OECD countries in 2004. Interestingly, the United States also did poorly by this measure, with only 61.0 subscribers per 100 inhabitants in 2004. Thus, the Canada-U.S. ratio in 2004 was 77.4 per cent.

There are several possible explanations for the relatively low number of cellular subscribers per 100 inhabitants in Canada. Contrary to most countries, Canada's fixed line telephone system provides free local calls, which is a major disincentive to the adoption of cellular phones compared to a fixed line system where pricing is partly based on usage. Moreover, Canada's cellular network does not allow for number portability, *i.e.* for subscribers to retain the same telephone number when changing cellular service providers. Finally, in Canada, adoption may be discouraged by higher prices for cellular service resulting from the small number of cellular service providers (three) relative to other countries. These reasons are often advanced to explain low cellular phone penetration in Canada (and to a lesser degree the United States) compared to other G7 countries.

Mainline Subscribers per 100 Inhabitants

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[16] Number of broadband subscribers divided by population and multiplied by one hundred.
[17] Online at: http://www.oecd.org/document/60/0,2340,en_2649_34225_2496764_1_1_1_1,00.html
[18] Refers to users of portable telephones subscribing to an automatic public mobile telephone service that provides access to the Public Switched Telephone Network (PSTN) using cellular technology. This can include analogue and digital cellular systems but should not include non-cellular systems. Subscribers to public mobile data services or radio paging services should not be included.

The third indicator is the proportion of mainline subscribers per 100 inhabitants.[19] In 2004, Canada had 63.2 mainline subscribers per 100 inhabitants, slightly more than the US level of 59.9. This translates to a Canada-U.S. ratio of 105.5 per cent. Interestingly, the proportion of mainline subscribers per 100 inhabitants in Canada has been falling since its 1999 peak (67.9). This fall is likely due to the increasing number of individuals relying only on cellular service and the increasing popularity of the voice over Internet protocol (VOIP) technology, which provides an alternative to traditional fixed line services. Another factor worth mentioning is the removal of second lines which were previously dedicated to dial-up Internet access and were eliminated as households moved to broadband Internet access.

Internet Subscribers to Fixed Networks per 100 Inhabitants

The fourth indicator, found in the *OECD Communications Outlook 2005*, tracks the number of Internet subscribers to fixed networks, which includes both dial-up and broadband subscribers, per 100 inhabitants. In 2003, Canada, with 22.3 subscribers per 100 inhabitants, was considerably lower than the United States (33.0 subscribers per 100 inhabitants), representing only 67.6 per cent of the U.S level.

Even though Canada is a leader in broadband penetration, indicators tracking wider Internet adoption seem to suggest that Canada is not keeping pace with the United States.

Personal Computers per 100 Inhabitants

According to data from the ITU, Canada had 48.7 personal computers per 100 inhabitants in 2002.[20] The United States had substantially more computers per 100 inhabitants, with 66. Canada, therefore, had only 73.8 per cent of the US level of computers per capita.

Data from IDC (found in Fuss and Waverman, 2005) suggest that Canada improved its relative position slightly with the level of computers per capita rising to 86.2 per cent of the US level.

[19] A mainline is a telephone line connecting the subscriber's terminal equipment to the public switched network and which has a dedicated port in the telephone exchange equipment. This term is synonymous with the term *main station* or *Direct Exchange Line (DEL)* that are commonly used in telecommunication documents. It may not be the same as an access line or a subscriber. Some countries include the number of ISDN channels; if so, this should be specified in a note. Fixed wireless subscribers should also be included.

[20] The number of Personal Computers (PC) measures the number of computers installed in a country. The statistic includes PCs, laptops, notebooks etc, but excludes terminals connected to mainframe and mini-computers that are primarily intended for shared use, and devices such as smart-phones that have only some, but not all, of the functions of a PC (e.g., they may lack a full-sized keyboard, a large screen, an Internet connection, drives etc).

Reconciling Alternative Indicators and Investment Data

Telecommunications Indicators Are Inconsistent With Investment Data

It is hard to identify major deficiencies in the supply of telecommunication services available to Canadians. Relative to other OECD countries Canada has high levels of access to mainline telephone, cable television and broadband services, and Canadian telephony prices are among the lowest in the OECD. How does this fact relate to the relatively low level of ICT investment? In fact, most of the telecommunications indicators are related to the number of subscribers, capturing primarily consumers' adoption of telecommunications. They do not necessarily tell the story from the firms' perspective. It is possible that even though consumers widely adopt ICT, firms do not. Therefore, while economy-wide indicators of adoption report good results, business' ICT investment might still be low. However, this cannot explain the significant discrepancy between the measures because providing good quality ICT services to consumers requires substantial amounts of ICT-related investment. The relation between encouraging alternative indicators, and Canada's dismal ICT investment performance remains a mystery.

Computers Indicators Are Consistent With Investment Data

Data suggests that Canadian households use around 10 per cent more computers per capita than US households. However, Canadian businesses tend to use far fewer computers than their US counterparts. Data on the use of personal computers by Canadian businesses show small businesses using 20 per cent fewer computers and medium to large businesses using 40 per cent fewer computers. Since the labour share of small businesses is about 50 per cent in Canada, one can estimate that Canadian businesses use approximately 30 per cent fewer computers than do American businesses.

These data seem to be consistent with the low level of computer investment as a share of GDP (73.8 per cent of the United States), computer investment per worker (54.1 per cent of the United States), and computer capital stock per worker (61.8 per cent of the United States) observed in 2004 in Canada (Exhibit 2). In other words, Canada's lower business investment in computers compared to the United States is definitely reflected in the alternative indicators, but not so for communications ICT.

Part Two: Explanations for the Canada-US ICT Investment Gap

This part of the report provides a detailed discussion of possible causes of the Canada-US ICT investment gap. The explanations are divided into five main areas: Statistical and methodological differences, differences in economic structure, differences in relative costs and prices, differences in managerial attitudes and culture, and differences in framework variables. Before beginning the assessment of hypotheses to explain the gap, a survey of the factors influencing ICT adoption is provided.

An Overview of the ICT Adoption Issue

Why do Canadian firms appear to adopt and use less ICT than their US counterparts? A brief overview of the different conceptual frameworks that have been used to study the adoption process as well as the modelling of technological diffusion is useful to understand potential Canada-US differences in ICT adoption. This section, which draws on Centre for the Study of Living Standards (2005a), provides a brief overview of these issues.

The diffusion of innovations has been explored from a number of different perspectives: historical, sociological, economic (including business strategy and marketing) and network- and systems-theoretical. Since the innovation and diffusion process is extremely complex and differs widely by firm size, industry, and other specific firm-related characteristics, much insight can be gained from interdisciplinary investigation.

The sociological and organizational literature focuses on systems of interactions, the role of economic factors, the strategies of firms and development agencies, and the important role of organizations and institutions. This work is exemplified by Rogers (1995), who provides a useful set of five analytic categories that classify the attributes that influence the potential adopters of an innovation:

(1) the relative advantage of the innovation;
(2) its compatibility, with the potential adopter's current way of doing things and with social norms;
(3) the complexity of the innovation;
(4) trialability, that is the ease with which the innovation can be tested by a potential adopter; and
(5) observability, that is the ease with which the innovation can be evaluated after trial.

In addition to these attributes, Rogers also points to a variety of external or social conditions that may accelerate or slow the diffusion process:

(1) whether the decision is made collectively, by individuals, or by a central authority;
(2) the communication channels used to acquire information about an innovation, whether mass media or interpersonal;
(3) the nature of the social system in which the potential adopters are embedded, its norms, and the degree of interconnectedness; and
(4) the extent of change agents' (advertisers, development agencies, etc.) promotion efforts.

In contrast to the focus on the external environment touted by sociologists, economists have grounded their approach in the decision-making of the micro-economic unit. They have tended to view the process as the cumulative result of a series of rational individual calculations that weigh the marginal benefits of adopting a new technology or business practice against the costs of change. In general, analyses suggest that factors that affect the diffusion path are:

(1) firm characteristics widely defined to include size, location, history, among others;
(2) discount rates and attitudes to risk;
(3) price, technology and market expectations; and
(4) the number of product variants on the market.

The marketing literature on diffusion is primarily focused on two questions: how to encourage consumers and customers to purchase new products or technologies; and how to detect or forecast the adoption of new products in the marketplace. The Bass (1969) model has found perennial acceptance, and argues that mass media are important early on in the diffusion process but that as time passes, interpersonal communication becomes far more important. The Bass model is a specific example of a larger set of models, known as "epidemic models", in which technology may be considered to spread, as might an infection in a population.

The decision to adopt a new innovation is unlike most economic decisions in that at any point in time the choice being made is not between adopting or not adopting a new innovation, but a choice between adopting now or deferring the decision until later. The distinction is important not merely stylistically, but because of the nature in which it affects the perceptions of the benefits and costs. By and large, the benefits from adopting a new technology are flow benefits that are received throughout the life of the acquired innovation. The costs, however, are typically borne at the time of adoption and cannot be recovered. This is especially true of non-pecuniary real costs associated with learning.

Adoption is characterized by sunk costs, which implies that adoption is an absorbing state, in the sense that we rarely observe a new technology being abandoned in favour of an old one. This is because once the new technology is adopted, the costs are sunk and the decision to abandon requires giving up the benefits without regaining the costs. In addition, under uncertainty about the benefits of the new technology, there is an option value to waiting before sinking the costs of adoption. This value arises from the fact that waiting may reduce the chance that the wrong decision is made. Thus, while diffusion may be delayed, it is not necessarily inefficient per se, because it reduces the likelihood of less productive technology adoption.

No matter the source or nature of a technology, the adoption of technology takes time. The classic observation regarding diffusion is that when the number of users of a new product (market penetration) is plotted versus time, the resulting curve is S-shaped. This suggests that the rate at which the new innovations are adopted starts at a low level and increases slowly. The rate of adoption then becomes larger until a point of inflection is reached, after which the penetration rate continues to increase, but at a decreasing rate.

When the diffusion of past innovations of widely different characteristics is plotted as a function of time, the classic S-shaped pattern emerges. However, what is typically striking is the wide variation in the elapsed time for diffusion. This has inspired researchers to derive a list of factors that might be expected to influence the diffusion of innovations. Hall (2004) classifies these determinants into four main groups:

(1) those that affect benefits received;
(2) those that affect the costs of adoption;
(3) those related to the industry or social environment; and
(4) those related to uncertainty and information problems.

The extent to which the older technology approximates as a substitute for the new innovation is an extremely influential determinant in the diffusion rate of the product or practice. When researchers compared, for example, the historical diffusion pattern for the automatic clothes washer to that of the radio in the United States, they found that the adoption of the latter was approximately 10 times more rapid than the former. The rationale offered is that manual clothes washing machines provided acceptable substitutes to the automatic version, whereas there was no good substitute for the radio.

The cost of technology includes not only the price of acquisition, but more importantly the cost of the complementary investment and the real costs of learning (time and effort) required to make use of the technology. The significance of complementary investment, such as the training of workers, is increasing as modern technologies become more complex. In addition, the adoption of a new innovation may require the re-organization of the workplace that will use it. Brynjolfsson (2000) finds that the full cost of adopting new computer information systems based on networked personal computers is about ten times the cost of the hardware.

In general, larger firms adopt new innovations first. However, while large dominant firms can spread the costs of adoption over more units, they may also not feel the pressure to reduce costs that leads to investment in new technologies.

Research by Statistics Canada on technology use in Canada found that the benefits arising from technology adoption cited by manufacturing establishments were (in order of importance):

(1) Improvements in product quality;
(2) Productivity gains due to labour reductions;
(3) Increased skill requirements;
(4) Increased capital requirements;
(5) Greater product flexibility (relatively more important in Canada than the United States due to short production runs in the Canadian economy);
(6) Reduced setup time;
(7) Increased equipment utilization rate; and
(8) Lower inventory.

Barriers to technology adoption cited by manufacturing establishments were (in order of importance):

(1) Overall cost;
(2) Lack of financial justification;
(3) Cost of technology acquisition;
(4) Need for market expansion;
(5) Cost of education and training;
(6) Time to develop software;
(7) Cost to develop software;
(8) Lack of technical support; and
(9) Worker resistance.

Another general barrier to technology adoption not captured by the Statistics Canada surveys may be a lack of leadership across firms on average. Worker resistance is generally at the bottom of the list of problems in Canada as well as in the United States. The most significant difference in the two countries is the greater emphasis that is placed by Canadian plant managers on the need for market expansion.

A recent study conducted by the U.K. Department of Trade and Industry titled *Business in the Information Age: The International Benchmarking Study 2004* provides insight into the reasons for the adoption of advanced technologies and the barriers to this adoption for 11 countries (United Kingdom, Canada, France, Germany, Italy, Sweden, Ireland, United States, Australia, Japan, and South Korea). A total of 2,716 businesses in the United Kingdom and 500 in each of the 10 other countries were surveyed on ICT usage, plans, and sentiment within their businesses.[21] The survey offers a unique

[21] The survey included micro businesses (0-9 employees), small businesses (10-49 employees), medium businesses (50-249 employees), and large businesses (250+ employees). The survey results were weighted to reflect employee distribution; therefore, data referencing, for example, "30 per cent of businesses" should be understood to mean "businesses accounting for 30 per cent of all employment in that country". Weighting by employment takes into account the economic importance of the businesses involved and

opportunity to benchmark Canadian experience in the area of technology adoption against that of other countries.

The study investigated the main drivers of ICT adoption among businesses, and identified to what extent these drivers were realized in incidences where technology was implemented. Canadian enterprises identified increased efficiency and reduced cost as the two most important drivers behind the adoption of ICT, with 22 per cent and 15 per cent of all businesses pointing to these two factors respectively (Exhibit 3). These perceptions are consistent with the international average of 21 per cent for increased efficiency and 16 per cent for reduced cost. Indeed, improving efficiency was the most commonly cited driver of adoption for all but two of the 11 countries surveyed.

The next three most important reasons for businesses in Canada to adopt ICT technology were: Customer communication (13 per cent), speed of access to information (13 per cent), and keeping up with progress (12 per cent). These reasons appear to be somewhat less of a concern for Canadian businesses than for businesses in other countries. For example, all other countries gave greater weight to keeping up with progress as a reason to adopt ICT, while the international average double that of Canada. The final three reasons identified by Canadian businesses for adopting ICT—improving quality of service (8 per cent), staff communication (8 per cent), and enabling more information to be shared (6 per cent)—appear to be equally important for Canadian businesses as they are for their international counterparts.

According to the study, costs remain the single most significant barrier to the adoption of ICT technologies for Canadian businesses. Furthermore, by breaking down costs into set-up costs and running costs, the study finds that set-up costs are perceived as a far greater impediment to technological adoption than are running costs. Relative to the other 10 countries analyzed in this study, Canada ranks very high in terms of business perceptions of cost as a barrier. In fact, Canada had the highest percentage of businesses that perceived running costs as a barrier, at 32 per cent in 2004, and ranked second highest in terms of business perceptions toward set-up costs, with 46 per cent of Canadian businesses identifying them as a barrier to ICT implementation (Chart 41).

English-speaking countries were most likely to cite costs, both fixed and variable, as a barrier to ICT implementation. France, Germany and Italy were found to be the least concerned with costs as a barrier to adoption among the countries studied.

"Functional aspects" (lack of time and resources and difficulty integrating IT systems) and "people factors" (lack of skills, reluctance of staff, and lack of knowledge) were also analyzed across countries as potential barriers to ICT implementation. In terms of "functional aspects", Canada was found to be in the middle of the pack in terms of business perceptions toward both barriers, with 15 per cent of Canadian businesses citing lack of time and resources and only 5 per cent of Canadian businesses mentioning difficulties integrating IT systems as serious impediments (Chart 42).

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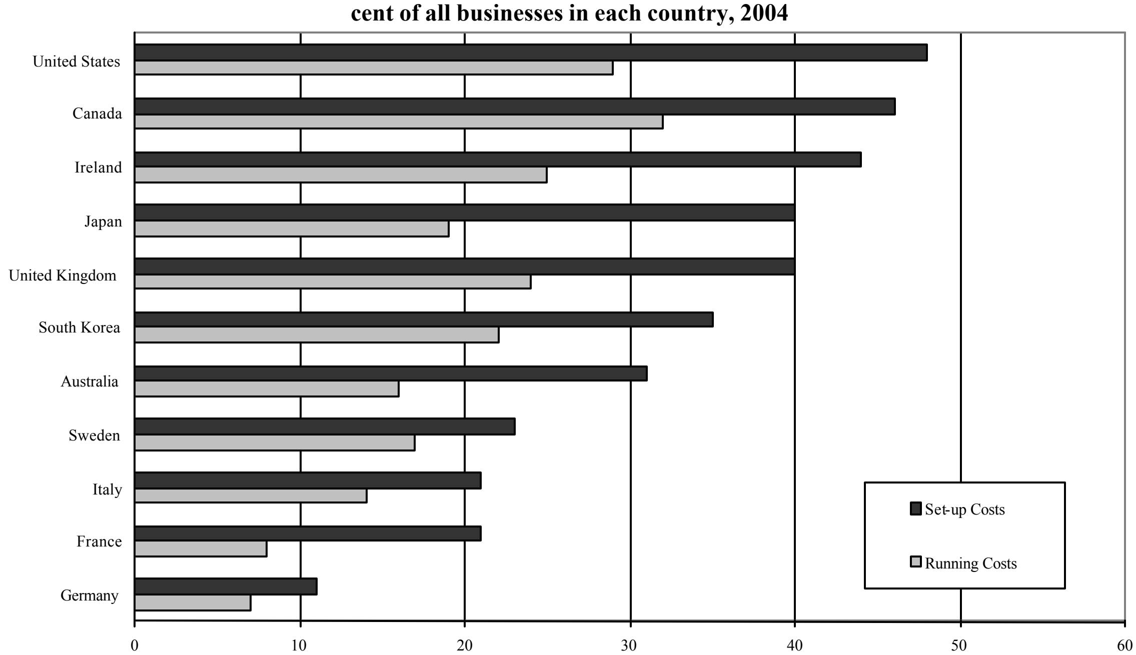
allows for more meaningful comparisons to be made between countries, avoiding distortions due to differing industrial structures in each country.

Exhibit 3: Reasons for Adopting ICT as Identified by Businesses, per cent of all businesses in Canada and the United States, 2004

	Canada	United States	International Average (excluding Canada)
Increased efficiency	22	14	21
Reduced cost	15	13	16
Customer communication	13	13	17
Speed of access to information	13	17	16
Keep up with progress	12	20	24
Improve quality of service	8	6	6
Staff communication	8	7	9
Enable more information to be shared	6	..	7
Customer demands	..	..	8
Integral to my type of business	..	..	8
Simplify process	..	..	14
Supplier communication	..	..	11
Keep up with competitiors	..	7	9

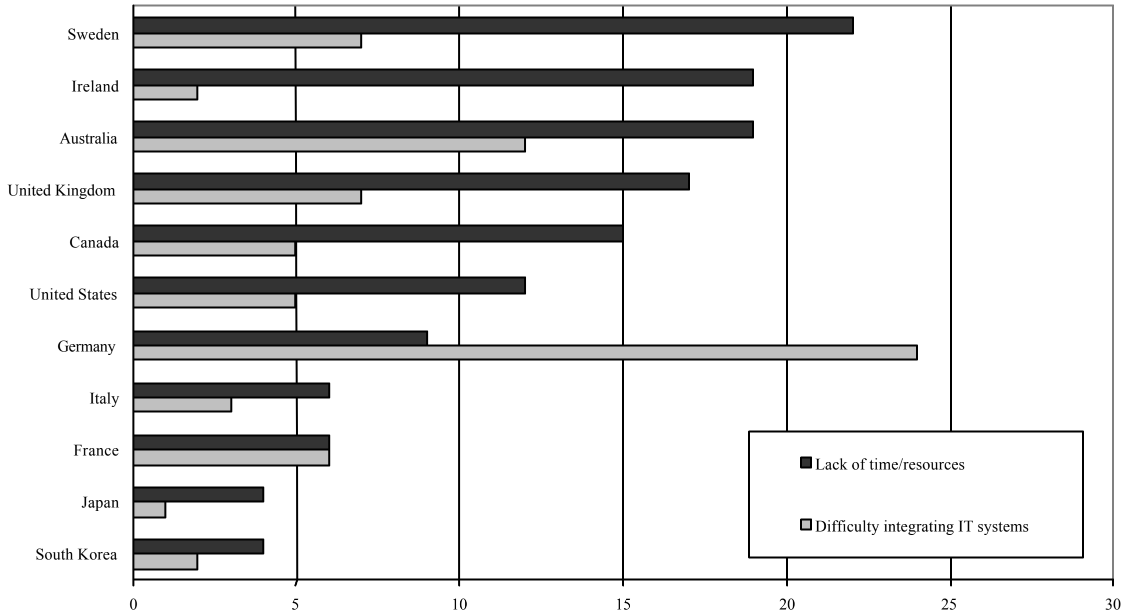
Source: "Business in the Information Age: The International Benchmarking Study 2004", Department of Trade and Industry, United Kingdom, Figure 8.3e.

Chart 41: Business Perceptions of Cost as a Barrier to Technology Implementation, per cent of all businesses in each country, 2004



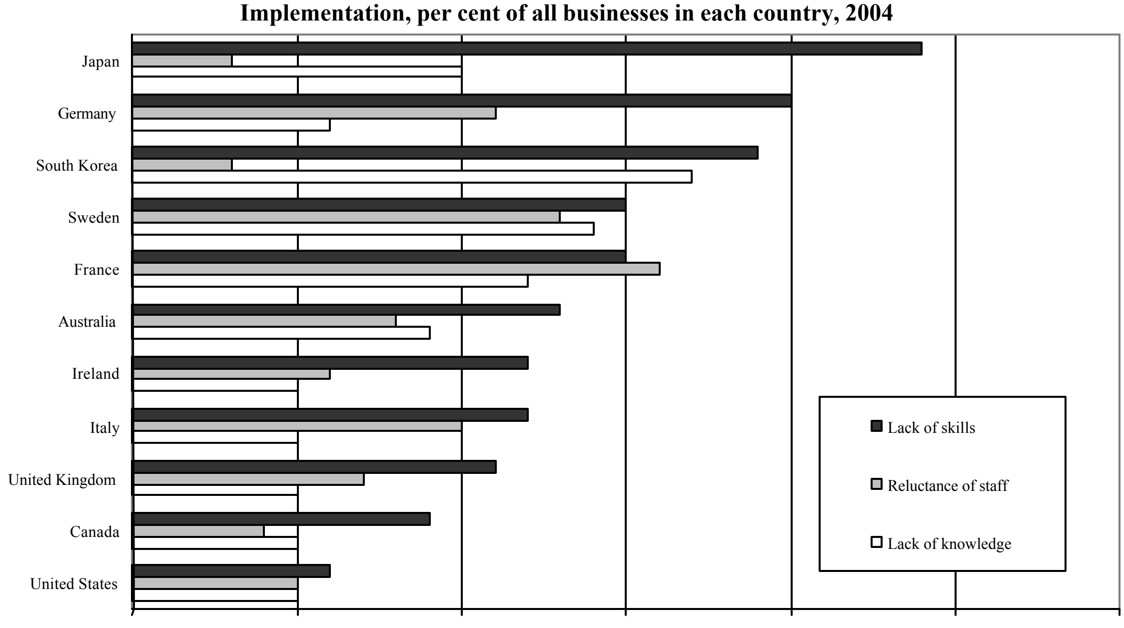
Source: "Business in the Information Age: The International Benchmarking Study 2004", Department of Trade and Industry, United Kingdom, Figure 5.2g. Question posed to 2,716 businesses in the United Kingdom and 500 businesses in each other country: "Can you tell me what has made it difficult for you to implement technology?"

Chart 42: Business Perceptions of "Functional Aspects" as a Barrier to Technology Implementation, per cent of all businesses in each country, 2004



Source: "Business in the Information Age: The International Benchmarking Study 2004", Department of Trade and Industry, United Kingdom, Figure 5.2i. Question posed to 2,716 businesses in the United Kingdom and 500 businesses in each other country: "Can you tell me what has made it difficult for you to implement technology?"

Chart 43: Business Perceptions of "People Factors" as a Barrier to Technology Implementation, per cent of all businesses in each country, 2004



Source: "Business in the Information Age: The International Benchmarking Study 2004", Department of Trade and Industry, United Kingdom, Figure 5.2j. Question posed to 2,716 businesses in the United Kingdom and 500 businesses in each other country: "Can you tell me what has made it difficult for you to implement technology?"

"People factors" were discovered to be relatively insignificant obstacles to Canadian businesses in terms of ICT adoption. Of the 11 countries studied, Canada ranked second last, with only 9 per cent of businesses citing lack of skills as troublesome, 4 per cent identifying reluctance of staff, and 5 per cent attributing lack of knowledge as a serious barrier (Chart 43). According to this evidence, it is clear that costs, both set-up and running costs, pose far greater challenges to Canadian businesses in implementing ICT than do "functional aspects" or "people factors".

Exhibit 4: Impediments to Advanced Technology Use by Canadian Manufacturing Establishments (percentage citing impediment by category)

	All Firms	Technology Users	Non-Users
Cost-related	**68.5**	**76.9**	**63.1**
Capital	47.0	48.9	45.7
Equipment	53.0	58.8	49.3
Software development	17.5	22.9	14.1
Maintenance	12.4	12.8	12.1
Technology acquisition	27.9	28.1	27.8
Institution-related	**16.4**	**16.6**	**16.4**
R&D investment tax credit	7.7	9.8	6.4
Capital cost allowance	8.4	9.5	7.6
Regulations and standards	9.9	8.1	11.1
Labour-related	**28.8**	**34.5**	**25.2**
Skill shortage	20.2	22.7	18.6
Training difficulty	16.8	20.5	14.4
Labour contract	5.8	7.2	4.9
Organization-related	**20.9**	**26.1**	**17.7**
Difficulty in introducing change	13.0	15.9	11.1
Management attitude	7.9	9.4	7.0
Worker resistance	9.0	10.7	7.9
Information-related	**16.0**	**19.6**	**13.7**
Lack of information	10.4	10.5	10.4
Lack of service	7.7	8.2	7.4
Lack of support from vendors	8.6	11.0	7.1

Source: Baldwin and Lin, 2001

Note: Although the Baldwin and Lin analysis is based on Statistics Canada's 1993 Survey of Innovation and Advanced Technology, the general picture they draw, and the findings reported in here, are largely consistent with many other recent international business surveys and studies.

A study by Baldwin and Lin (2001) is particularly relevant to suggesting explanations for why Canadian firms may use less ICT than firms in other countries. Based on data from Statistics Canada's 1993 *Survey of Innovation and Advanced Technology*, their study revealed impediments to advanced technology adoption perceived by Canadian manufacturing firms. Two caveats are worth noting in regard to this material. First, the study explored only manufacturing establishments, and second, 'advanced technology' is only an imperfect proxy for ICT. Nonetheless, the results presented in Exhibit 4 are largely consistent with many other recent international business surveys and studies.

Impediments to advanced technology use were decomposed into five categories: cost-, institution-, labour-, organization-, and information-related. The most important impediments were cost-related. The costs of equipment and capital were cited by 53 and 47 per cent of firms respectively as impediments. Also important was the cost of technology acquisition, cited by 27.9 per cent of firms. The second most important category of impediments was labour-related (28.8 per cent of firms), especially in the area of skills shortages (20.2 per cent of firms). The least important impediments were institution and information related. This finding suggests, at least in the early 1990s, that neither the tax and regulatory environment nor a lack of information among Canadian firms was the primary impediment to advanced technology adoption.

Statistical and Methodological Differences

Definitional Differences in Information and Communications Technology Investment in Canada and the United States

One possible explanation for the ICT investment gap between Canada and the United States may be that a difference in the definition of information and communication technology investment exists between statistical agencies in the two countries.

At the aggregate level there is a degree of consensus about the definition of ICT investment. According to the OECD,

> ICT investment is defined in accordance with the 1993 System of National Accounts. It covers the acquisition of equipment and computer software that is used in production for more than one year. ICT has three components: information technology equipment (computers and related hardware), communications equipment and software. Software includes acquisition of pre-packaged software, customised software and software developed in house. (OECD 2005)

As the list of items included in the definition of ICT investment in Canada and the United States contained in Appendix 1 demonstrates, there does not appear to be any material difference in the way ICT investment expenditure is defined by Statistics Canada and by the Bureau of Economic Analysis in the United States. All asset categories found in the US definition of ICT have their counterpart in the Canadian list of assets. Discussion with officials at Statistics Canada and the Bureau of Economic Analysis failed to reveal any apparent differences in the definition of ICT investment used by the statistical agencies.

Since there is no material difference in the items that constitute ICT, it cannot be concluded that there is a difference in the definition of ICT between Canada and the United States. As a result, there is no support for the hypothesis that such a difference in definition could help to explain the gap in ICT investment intensity between the two countries.

Comparison of Canada and US ICT Investment Estimation Methods

One hypothesis put forward to explain the Canada-US ICT investment gap is that differences in the methodologies and survey procedures used to generate ICT investment estimates between the Canadian and US statistical agencies are in whole or in part responsible for the ICT investment intensity gap.

Computers and Communication Equipment

In Canada investment expenditure on computers and communication equipment is determined in the same way as investment expenditure for most other assets—by the Survey of Capital and Repair Expenditures (CAPEX) of Statistics Canada. On a CAPEX questionnaire, businesses are required to enter the amount of capital expenditure on "computers and related equipment" and on "telecommunications, cable and broadcasting" equipment. Theses numbers are then adjusted for consistency with the National Accounts based on production, import and export data. As noted briefly above, there are two industries in Canada that have underestimated ICT investment because of survey methodology. The oil and gas extraction sub-industry of the mining and oil and gas extraction industry is not surveyed for ICT investment expenditure. This situation results in underestimates of ICT investment in the mining and oil and gas extraction industry. The other industry subject to underestimation is construction. ICT investment expenditure estimates for the construction industry are based on 20-year-old benchmarks, which are unlikely to reflect the current reality of ICT investment in the industry. The extent of the underestimation of total ICT investment resulting from these issues is unclear.

In the United States, the method for estimating investment expenditure on computers and communications equipment is somewhat different. The United States Bureau of Economic Analysis (BEA) produces the National Income and Product Accounts (NIPA) from which the data used for estimating investment is drawn. The BEA classifies investment in ICT under the investment category "information processing (IP) equipment and software."

The following discussion draws heavily on BEA working paper WP2002-02 "Information Processing Equipment and Software in the National Accounts" by Bruce T. Grimm, Brent R. Moulton, and David B. Wasshausen.[22] Although the paper was

[22] Available on the BEA website at http://www.bea.doc.gov/bea/papers/IP-NIPA.pdf

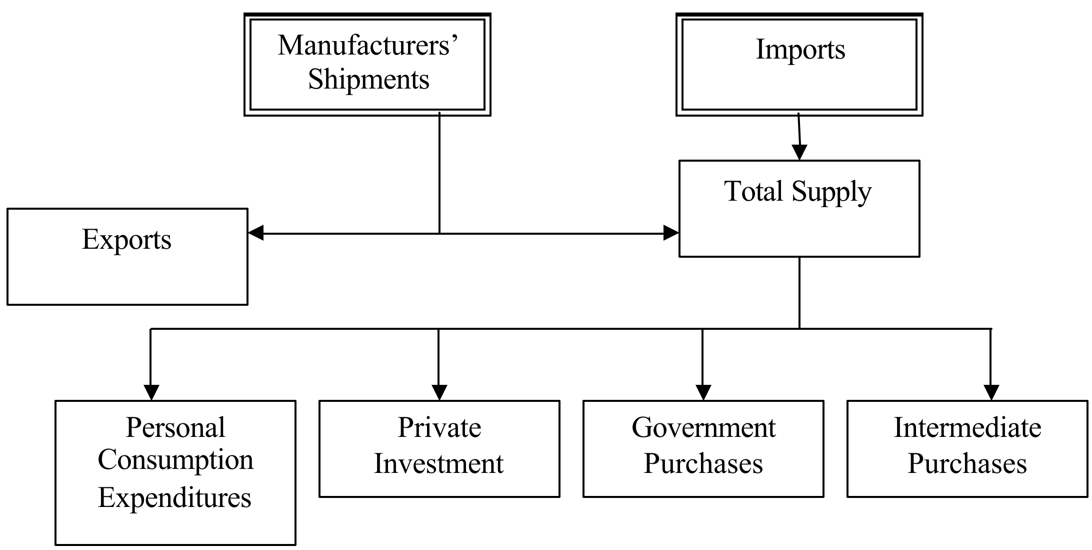
presented in 2002, according to BEA officials, it remains essentially up to date with respect to estimation methodology.

> IP equipment and software investment, excluding own-account software, is determined in current prices primarily by the 'commodity-flow' methodology, with periodic benchmarking to the quinquennial I-O (input-output) tables. The commodity flow method is a 'supply-side' approach, which traces commodities from their domestic production or importation to their final purchase. (Grimm et al., 2002: 5)

Exhibit 5 illustrates the commodity-flow method.

> The strength of the commodity-flow method is that it draws on the very detailed commodity classification and comprehensive coverage of the economic censuses, as well as the conceptual rigor of an I-O table in which production and uses of commodities are reconciled for benchmark years. It provides detailed information on investment by industry or by class of purchaser. (Grimm et al., 2002: 5)

Exhibit 5: Commodity Flow



Source: Grimm, et al, 2002: Chart 3

The critical question is whether US indirect supply-side commodity-flow methodology produces different ICT investment estimates compared to those from the Canadian direct demand-side survey methodology. Discussions with officials in both statistical agencies indicated differences in methodologies used to estimate ICT investment appear not to be a source of incomparability between the estimates. But no detailed studies have been done on the issue and further research is required for a definitive answer to the question.

Software

Some work has been done in Canada on comparing the estimation methodology for software investment employed by Statistics Canada with that employed by the BEA. The principle paper on the topic is "Capitalization of Software in the National Accounts" by Chris Jackson of the Income and Expenditure Accounts Division at Statistics Canada.[23] The Canadian National Accounts only began to treat software as investment, as opposed to current expenditure, during 2001. This change brought Canada in line with other G7 countries, including the United States, and with the recommendations of the 1993 System of National Accounts.

Software investment is in some ways more complicated to estimate than either computer investment or communications equipment investment. Software is subdivided into three categories: pre-packaged, custom-design, and own-account software. The estimation methodology for each type will be discussed in detail below. Pre-packaged software is the type of software that consumers are most familiar with; it is off-the-shelf software such as standard operating systems and office suites. Custom-design software is software that is created for a specific purpose, and would usually have limited utility outside of that function. Own-account software is simply custom-design software created in-house, that is, by the company that will use the software.

The methodology for the estimation of investment expenditure on all three types of software appears to be essentially the same in Canada and the United States. In both countries, a commodity-flow methodology is applied similar to that described above.

Pre-Packaged and Custom-Design Software

In Canada both pre-packaged and custom-design software are estimated using the commodity-flow methodology (Jackson, 2003: 16).[24] Table 3 provides an example.

Table 3: Software Commodity-Flows, Canada, 1998 (millions of dollars)	
Domestic Production	6,389
+ Margins on domestic sales	1,728
+ Imports	2,002
= Total supply of software	10,117
- Exports	2,151
- Personal Expenditure	410
= Intermediate use of software	7,557
- Software embedded in hardware	373
= Investment in software	7,185
Source: reproduced from Jackson, 2003: 16	

[23] Available on the Statistics Canada website at http://www.statcan.ca/cgi-bin/downpub/listpub.cgi?catno=13-604-MIE2002037

[24] It should be noted that government investment in pre-packaged and custom-design software is estimated "from administrative data on software purchases, survey data on sales to government (Survey of Computer Services), and capital spending on software (CAPEX)." Business investment, however, with which this report is concerned, is estimated using the commodity flow methodology. (Jackson, 2003: 18)

Own-Account Software

In neither Canada nor in the United States is there a source of direct information on own-account software expenditures. As a result, in both countries these expenditures are constructed from labour costs, specifically, the compensation of computer programmers and computer systems analysts. Benchmark estimates are necessary since the detailed earnings data by industry are only available in the censuses, which are conducted every five years. Table 4 shows the calculations made by Statistics Canada to adjust the labour cost figures in order to generate the own-account software investment figures for benchmark year 1995.

Table 4: Own-account software benchmark, Canada, 1995 (millions of dollars)	
Labour cost for computer programmers and systems analysts	7,117
- Deduction for work on software to be embedded or sold	3,032
- Deduction for time spent on non-investment related work	2,042
= Labour cost of own-account software development	2,043
+ Cost of other inputs	939
= Investment in own-account software	2,982
Note: Figures may not add due to rounding *Source: reproduced from Jackson, 2003: 19*	

One divergence between the Statistics Canada and BEA methodologies concerns the deduction from labour costs of own-account software that is embedded in hardware or sold. Some software developed on own-account is embedded in hardware and then captured as investment in computer hardware, while other own-account software may be sold by the firm which developed it on own-account. In order to avoid double counting Statistics Canada has determined that the labour cost for programmers and systems analysts in all industries not engaged in producing software or embedding it in hardware is about one percent of all wages, salaries and supplementary labour income.

> This percentage is used to cap the labour cost of programmers and systems analysts in software producing and embedding industries, on the assumption that costs over and above this threshold are related to software production and/or embedding, not the everyday running, maintenance and development of software systems that is nowadays integral to operations in most industries. (Jackson, 2003: 19)

In Canada, this cap results in a deduction of 43 percent of total labour costs attributable to programmers and systems analysts. (Jackson, 2003: 19) In the United States, this deduction was eliminated as of December 2003 except in the case of own-account software produced by custom-design software firms.[25] The magnitude of the remaining deduction is not available at this time.

[25] In 2003 these reductions were approximately USD 23 billion.

The second deduction in Table 4, "deduction for time spent on non-investment related work," refers to time spent by programmers and systems analysts on work that should not be classified as investment. The methodology in this regard is an identical 50 percent reduction in Canada and the United States.

Overall, both deductions together result in a 71.3 per cent reduction in Canada (calculated from Table 4) and a reduction of approximately 75 per cent in the United States (Grimm, et al., 2002: 7) of the initial labour cost of computer programmers and systems analysts. The change in the US methodology in December 2003 has altered these figures, but the magnitude of the change is not available at this time.

The final adjustment made in Table 4 is to increase "Labour cost of own-account software development" by 50 per cent to account for non-labour inputs to own-account software production. The BEA makes a similar addition for intermediate inputs based on "the relationship between intermediate inputs and compensation derived primarily from the Census Bureau's census of service industries." (Parker and Grimm, 2000: 14) This addition results in an increase of 100 percent.

Overall, it is difficult to determine whether Statistics Canada and the BEA are producing comparable figures for ICT investment. In the case of the addition of intermediate non-labour inputs to own-account software estimates, the BEA figures appear to have an upward bias relative to Statistics Canada figures. However, when looking at the deduction made for double counting of software developed by custom-design firms, but then embedded in hardware and sold, the direction of the relative bias is unclear. If there is a statistical methodology discrepancy between Statistics Canada and BEA ICT investment data, then it seems likely such a discrepancy lies in the estimation of own-account software. More research is required by statistical agencies to determine the overall comparability of ICT investment data, with special attention to own-account software.

While there are some differences between how the Canadian and US ICT investment estimates are derived, it also seems that adjustments made to the data are similar. However, as noted above, there are methodological discrepancies, which call into question the comparability of some ICT investment estimates, especially for own-account software. Further research is required to determine the importance of these differences.

Differences in Survey Coverage of Industries

Underestimation of Construction and Mining and Oil and Gas Extraction ICT Investment in Canada

Statistics Canada data underestimate investment in ICT in two industries: mining and oil and gas extraction and construction. In mining and oil and gas extraction, the oil and gas extraction sub-industry is not surveyed; consequently, no ICT investment estimates are available, and total ICT investment for the industry is underestimated. Similarly, ICT investment is not surveyed in the construction industry; however, ICT investment estimates are available but are based on 20-year-old benchmarks that do not reflect the current state of ICT investment in the industry. Table 5 provides some information on the impact that this underestimation of ICT investment might have on total ICT investment per worker in Canada, both on absolute levels and relative to the United States.

The methodology used to construct Table 5 is to change the level of investment per worker in the mining and oil and gas extraction industry, then the construction industry, then both of these industries together, to ascertain the impact of the underestimation of ICT investment on total business sector ICT investment per worker. In the top panel of Table 5, the industries are eliminated from both the Canadian and US economies. The elimination of mining and oil and gas extraction results in an increase of business sector total ICT investment per worker in Canada (from $US 1,567 to $US 1,582), while in the United States the elimination results in a decrease ($US 3,331 to $US 3,327 per worker). The elimination of construction makes a much larger impact on total ICT investment per worker in Canada ($US 1,567 to $US1,680) and in the United States ($US 3,331 to $US 3,627). Finally, when both mining and oil and gas extraction and construction are eliminated, ICT investment per worker increases in Canada ($US 1,567 to $US 1,698) and in the United States ($US 3,331 to $US 3,624). When both industries are eliminated, the ratio of ICT investment per worker in Canada to ICT investment per worker in the United States decreases from 47.0 per cent to 46.8 per cent, a decrease of 0.2 percentage points.

In the second panel of Table 5, ICT investment per worker in mining and oil and gas extraction and in construction is assumed to be 50 per cent of the US level of ICT investment per worker in those industries. This assumption seems reasonable given that the overall level of ICT investment per worker in the Canadian business sector seems to be roughly half the level of the United States (45.1 per cent or 47.0 per cent, see notes (1) and (2) in Table 5). Under this assumption, increasing ICT investment per worker in the mining and oil and gas extraction and construction industries to 50 per cent of the US level increases total ICT investment per worker in Canada to $US 1,602, compared with $US 1,567 before. This change increases the ratio of Canadian to US per worker investment to 48.1 per cent from 47.0 per cent.

Table 5: Simulation, Total ICT Investment per worker, current US Dollars, 2004

	Canada	United States	Canada as a proportion of the United States, per cent
Business Sector (1)	1,468	3,253	45.1
Business Sector (2)	1,567	3,331	47.0
Mining and Oil and Gas Extraction (3)	627	4,111	15.2
Construction (3)	214	764	28.1
Business Sector (2) less			
Mining and Oil and Gas Extraction	1,582	3,327	47.5
Construction	1,680	3,627	46.3
Both	1,698	3,624	46.8
Business Sector (2) with following Canadian sectors at 50 per cent of US business sector level of ICT investment per worker			
Mining and Oil and Gas Extraction	1,589	3,331	47.7
Construction	1,580	3,331	47.4
Both	1,602	3,331	48.1
Business Sector (2) with following Canadian sectors at 100 per cent of US business sector level of ICT investment per worker			
Mining and Oil and Gas Extraction	1,620	3,331	48.6
Construction	1,609	3,331	48.3
Both	1,662	3,331	49.9

Notes:

(1) Total provided by Canadian and US statistical agencies.
(2) Total consistent with industry-level estimates (sum of industries).
(3) Canadian data underestimated because industries are not survey for ICT capital expenditures.
Canada-US exchange rate used to convert Canadian dollars to US dollars is the 2004 average: 0.768467228074669 = CAD/USD

As an upper bound on the effect of underestimation in the mining and oil and gas extraction and construction industries, the ICT investment per worker in each industry was increased to 100 per cent of the US level. This adjustment increased total business sector ICT investment per worker to $US 1,662 from $US 1,567. The Canada-US ICT investment per worker ratio increased from 47.0 to 49.9 per cent. It is reasonable then to assume that at most, underestimation of ICT investment per worker in mining and oil and gas extraction and in construction would increase the ratio of Canada to US ICT investment per worker by 2.9 percentage points (from 47.0 to 49.9 per cent).

Differences in Economic Structure

Industrial Structure

Differences in industrial structures between Canada and the United States could in principle account for part of Canada's lower ICT investment per worker relative to the United States. ICT investment per worker in the business sector is a weighted average of the level of ICT investment per worker in every industry comprising the business sector, with the number of workers in each industry divided by the total number of workers in the business sector serving as the "weight" for each respective industry. If industries that traditionally utilize above-average levels of ICT per worker represent a smaller proportion of business sector employment in Canada than in the United States, then all else being equal, total ICT intensity would be lower in Canada relative to the United States.

Table 6: Summary of Results for Simulation Scenario of Total ICT Investment in Canada Weighted by U.S. Industry Employment Shares, current U.S. dollars, 2004

		Canada		United States	Proportion of Actual Canadian Values to U.S. Values	Proportion of Simulated Canadian Values to U.S. Values
		Actual	Simulated			
		A	B	C	(A ÷ C) x 100	(B ÷ C) x 100
D	Total ICT Investment (thousands)	19,346,428	20,294,167	346,986,000	5.58	5.85
E	Employment (thousands)	12,345	12,345	104,168	11.85	11.85
F	GDP (millions)	771,440	771,440	8,137,300	9.48	9.48
		D ÷ E				
	Total ICT Investment per Worker	1,567	1,644	3,331	**47.0**	**49.4**
		(D ÷ (F x 1,000)) x 100				
	Proportion of Total ICT Investment to GDP	2.51	2.63	4.26	**58.8**	**61.7**

Source: CSLS database of ICT investment and capital stock trends.

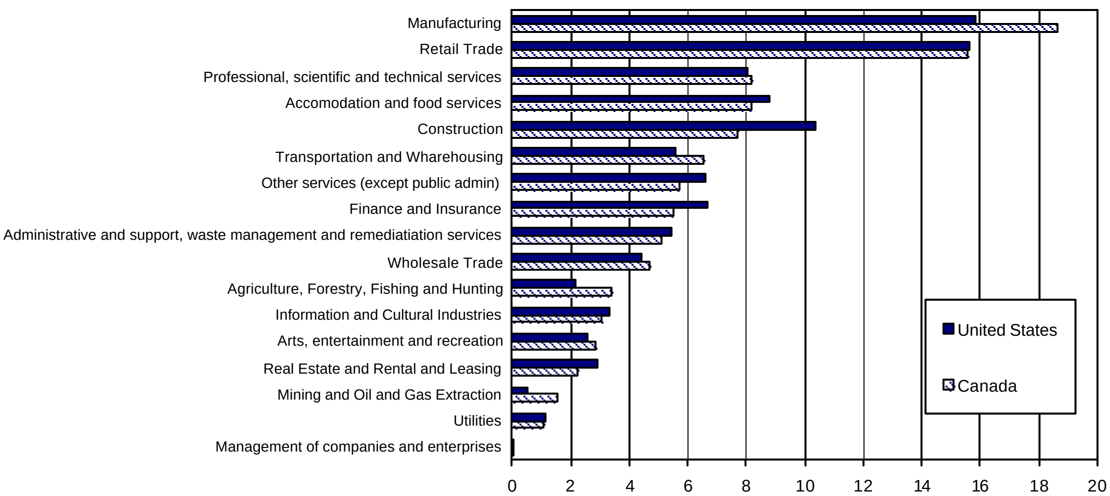
Note: The business sector GDP value utilized for Canada is that reported by Statistics Canada, which naturally excludes most of the GDP of the educational services and healthcare and social assistance industries as these industries are largely comprised of public and not private sector. Additionally, current dollar values for Canada for 2004 only exists for the business sector as a whole and not for individual industries. The business sector GDP value utilized for the United States is that reported by the Bureau of Economic Activity minus the GDP values for the educational services and healthcare and social assitance industries, for consistency.

In fact, when ICT investment by industry in Canada is weighted by US employment shares in order to simulate total ICT investment in Canada, and if our industrial structure mirrored that of the United States, as is done in Table 6, total business sector ICT investment for 2004 would have increased from $19.3 billion[26] to $20.3 billion. This represents an increase of $1.0 billion or 4.9 per cent. As the number of workers in the Canadian business sector is assumed to remain the same, the level of ICT investment per worker would rise accordingly. The simulated level of ICT investment

[26] All dollar figures are in US current dollars.

per worker for the Canadian business sector would be $1,644, an increase of $77 from the actual 2004 value of $1,567.[27]

Chart 44: Employment Shares by Industry in the Business Sector, Canada and the United States, 2004



Source: Data for Canada is collected from unpublished sources of the Labour Force Survey. Data for the United States is collected from the Current Population Survey available through the Bureau of Labour Statistics.
Note: The business sector is defined as the summation of all of the above industries, so that industry employment weights relative to the business sector are calculated by dividing the employment level for each respective industry by the summation of the employment values for all the industries listed. Employment values include both business and public sector components for each industry. In all of the industries listed above, the porportion of public sector employees in total employment is marginal. Public administration, educational services and healthcare and social assistance industries have been excluded from the above analysis since a significant proportion of the total employment values for these industries are public sector employees.

[27] Table 9v of the Centre for the Study of Living Standards' database of ICT investment and capital stock trends shows the level of ICT investment per worker in the business sector in Canada for 2004 to be $1,468. Similarly, Table 26v from the same database shows the level of ICT investment per worker in the business sector in the United States for 2004 to be $3,253. The discrepancy between these numbers and those utilized above is partly due to differences and limitations in data sources. For both Canada and the United States, the reported value for employment in the business sector is the summation of business sector employees from each industry. However, employment values by industry are only available for each industry as a whole (both business and public components combined). Therefore, in order to calculate employment weights for each industry relative to the business sector in each country, and have these weights add to 100, it was necessary to compute simulated values for each respective business sector based on the summation of individual industry values. Public administration industries are omitted in the calculation of the simulated business sector (for both countries) since investment data is not available for the United States. Educational services and healthcare and social assistance industries are also omitted in this calculation since a significant proportion of the total employment values for both industries are public sector employees (this would be true for public administration as well). For the rest of the industries, public sector employees only account for a small proportion of the industry total employment values. The same industries are omitted in the calculation of (simulated) business sector ICT investment for consistency. The business sector GDP value utilized for Canada is that reported by Statistics Canada, which naturally excludes most of the GDP of the educational services and healthcare and social assistance industries as these industries are largely comprised of public and not private sector. Additionally, current dollar values for Canada for 2004 only exists for the business sector as a whole and not for individual industries. The business sector GDP value utilized for the United States is that reported by the Bureau of Economic Activity minus the GDP values for the educational services and healthcare and social assistance industries, for consistency.

Compared to the United States level of ICT investment per worker in the business sector, $3,331, differences in industrial structures between the two countries can be inferred to account for 4.4 per cent of the overall absolute ICT investment per worker gap between Canada and the United States. Alternately, we can examine the proportion of ICT investment per worker in the Canadian business sector to that in the United States. The proportion of the actual 2004 values places Canada at 47.0 per cent[28] of the US level. When the simulated level of ICT investment per worker in Canada is compared to the actual US value, the proportion increases to 49.4 per cent or by 2.4 percentage points. Therefore, differences in industrial structures between Canada and the United States can be said to account for 2.4 percentage points of the total 53.0 percentage point gap (4.4 per cent).

When ICT investment by industry in Canada is weighted by U.S. employment shares, industries that account for a larger share of total business sector employment in the United States than in Canada will become relatively more important under the simulation than in actuality in determining the overall level of ICT investment in the Canadian business sector. However, it is important to note that the magnitude of impact that any industry that becomes relatively more important in employment shares will have on business sector ICT investment is directly related to the level of ICT investment per worker in that industry. In other words, a relative increase in the importance of an industry that has a high level of ICT investment per worker will increase aggregate business sector ICT investment more so than an industry with the same relative increase in employment share importance under the simulation but that has a low level of ICT investment per worker. Thus, both the change in industry employment weights and the level of ICT investment per worker in each industry combine to determine the final contribution of each industry under the simulated experiment.

Information and cultural industries, finance and insurance industries, and real estate and rental and leasing industries have a relatively high level of ICT investment per worker in Canada. In 2004, their figures were $12,244, $4,043 and $5,233 respectively, all well above the Canadian business sector ICT investment per worker average (see Appendix Table 7). Furthermore, these industries account for a greater share of total business sector employment in the United States than in Canada. In the United States, information and cultural industries account for 3.3 per cent of business sector employment, compared to 3.1 per cent in Canada. Finance and insurance industries account for 6.7 per cent of business sector employment in the United States, compared to 5.5 per cent in Canada. Finally, real estate and rental and leasing industries in the United States account for 2.9 per cent of business sector employment while accounting for only 2.2 per cent in Canada. As a result, when simulating aggregate business sector ICT investment per worker in Canada using US industry employment weights, all three industries contribute substantially, and more so than any of the other industries, to a higher level of ICT investment per worker in Canada. The finance and insurance industry

[28] The benchmark value for the proportion of ICT investment per worker in the Canadian business sector to that in the United States the above value due to the need to calculate simulated values for the business sector as described previously in footnote 26.

contributes 61.6 per cent of the simulated change in business sector ICT investment per worker, real estate and rental and leasing industries 45.4 per cent, and information and cultural industries 43.0 per cent.[29]

Finally, utilities, construction, retail trade, management industries, administrative and support industries, accommodation and food services, and other service industries (except public administration) all positively contribute to an increase in aggregate ICT investment per worker in the Canadian business sector under the simulation, since all of these industries account for a greater share of employment in the business sector in the United States than in Canada (Chart 44).

Industries that have a smaller employment share of total business sector employment in the United States than in Canada would negatively impact growth in aggregate business sector ICT investment per worker if Canada's industry employment shares mirrored those in the United States in 2004. Of these industries, manufacturing, transportation and warehousing, and wholesale trade would produce the greatest negative effect under the simulation. Manufacturing accounts for 15.8 per cent of business sector employment in the United States, compared to 18.6 per cent in Canada. While manufacturing in Canada has a low (below average) level of ICT investment per worker ($791), the large gap in employment shares between the two countries ensures a significant negative contribution to the simulation (-28.7 per cent). Wholesale trade and transportation and warehousing each have high (above average) levels of ICT investment per worker in Canada -- $2,628 and $1,638 respectively – but a relatively small gap in employment shares between Canada and the United States. Employment shares in 2004 for wholesale trade and transportation and warehousing were 4.4 per cent and 5.6 per cent in the United States versus 4.7 per cent and 6.6 per cent in Canada, respectively. Consequently, wholesale trade and transportation and warehousing contribute -11.1 and -20.2 per cent respectively of the change in ICT investment per worker. The rest of the industries that had a smaller employment share of total business sector employment in the United States than in Canada include: agriculture, forestry, fishing and hunting; mining and oil and gas extraction; professional, scientific, and technical services; and arts, entertainment and recreation industries.

The 2004 level of GDP in the Canadian business sector is assumed to remain the same under the simulation as it was in actuality (as was the number of workers). Consequently, the proportion of ICT investment to GDP will rise accordingly. The simulated proportion of ICT investment to GDP for the Canadian business sector would be 2.63 per cent, an increase of 0.12 percentage points (or 6.6 per cent) from the actual 2004 value of 2.51 per cent (see Table 6). This increases the proportion of ICT investment to GDP between Canada and the United States to 61.7 per cent from 58.8 per cent.[30]

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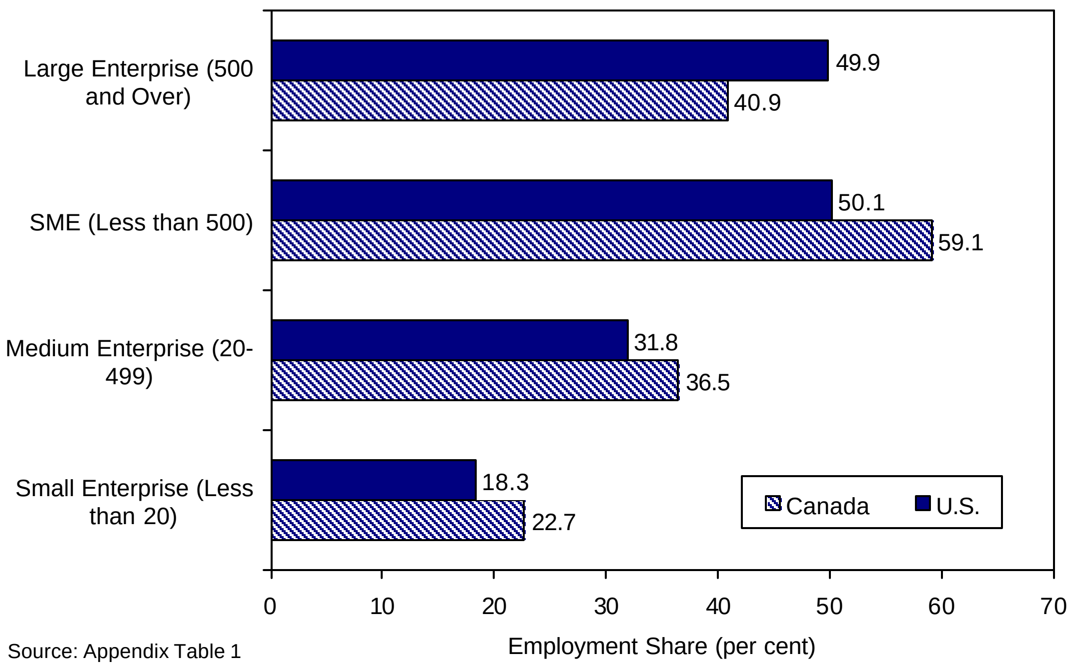
[29] Detailed data and calculations are available from the authors.

[30] The benchmark value for the proportion of ICT investment to GDP between Canada and the United States differs from the above value due to the need to calculate simulated values for the business sector as described previously in footnote 26. Since proportions of shares do not need to be calculated in common currency terms, as is done in Appendix Table 7 where all dollar figures are in U.S. current dollars, we test

Differences in Firm Size

Canada has a relatively larger proportion of small firms than the United States. In 2002, 22.7 per cent of Canadian employees were working in firms with fewer than 20 employees (defined as small enterprises[31]), compared to 18.3 per cent in the United States (See Chart 45). [32] Similarly, 36.5 per cent of Canadian employees were employed by firms with 20-499 employees (defined as medium enterprises), compared to 31.8 per cent in the United States. In contrast, the employment share of workers in firms having 500 and more employees (defined as large enterprises) in Canada (40.9 per cent) was significantly lower than that in the United States (49.9 per cent).[33]

Chart 45: Employment Share by Employment Size of Enterprise, Business Sector, Canada and the United States, 2002



Source: Appendix Table 1

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the sensitivity of this proportion in Appendix Table 8 where the Canadian dollar values are in current Canadian dollars. The actual proportion of ICT investment to GDP between Canada and the United States is 58.8 per cent, and the simulated value is 61.7 per cent. These figures are exactly the same as the proportions calculated under common currency.

[31] The size of an enterprise can be defined in many ways, such as by the value of its annual sales or shipments, by its annual gross or net revenue, or by the size of its assets or the number of its employees. Different countries, even different institutions within a country, define enterprise size standards differently according to their own needs. Here we use the definition based on the number of employees. Although there might be some differences in defining small or medium enterprises, the term "SME" is commonly used to refer to all enterprises with fewer than 500 employees; while firms with 500 or more employees are classified as "large" enterprises.

[32] Unless addressed explicitly, all data for employment share are for business sector in both countries.

[33] Examining US longitudinal data reveals another trend in employment growth by enterprise size: the percentage increase in workers employed in larger firms is greater than in SMEs. During the period 1988-2002, the total number of employees in the United States had increased 28 per cent from 87,844,303 to 112,400,654 (See Appendix Table 2). Large firms had a 40.3 per cent increase in employment; while SMEs

The employment share by employment size of enterprise by industry also shows that most industries in Canada had higher share of employees working in SMEs than in the United States in 2002. In fact, 14 of 17 sectors (data not available for two sectors) had greater proportion of SME employees in Canada than in the United States. The exceptions were mining, utilities, and education services. (Appendix Table 5)

Empirical Evidence on ICT Use by Firm Size

There is a large amount of empirical research that indicates that firm size has an influence on ICT adoption. Data on e-business from Statistics Canada's *Survey of Electronic Commerce and Technology* (SECT) may provide information about the relationship between firm size and ICT use. Table 7 shows the use of basic technologies such as PCs, E-mail and the Internet by firm size for 2000-2002. Large firms have universally embraced these technologies, while a significant proportion of small firms have not. Medium-sized firms are not surprising in between small and large firms in ICT use. Small firms did somewhat close the ICT gap with large firms between 2000 and 2002. In percentage points the gap narrowed between small and large firms in the use of PCs (from 21 to 16 points), E-mail (from 42 to 31 points) and the Internet (from 38 to 26 points).

Table 7: Basic ICT Use by Firm Size in Canada, per cent, 2000-2002

	Use of PCs			Use of E-mail			Use of the Internet		
	2000	2001	2002	2000	2001	2002	2000	2001	2002
Small Firms[1]	79	82	84	56	62	68	59	68	73
Medium Firms[2]	98	96	97	85	89	90	87	91	92
Large Firms[3]	100	98	100	98	96	99	97	94	99
Gap[4]	21	16	16	42	34	31	38	27	26

Source: Uhrbach, Mark and Bryan van Tol (2004) P.7, in which data were from Statistics Canada, Survey of Electronic Commerce and Technology (SECT), 2004.

Notes:
1. Fewer than 20 employees.
2. Firms with 20-499 employees for manufacturing sector and 20-99 for other sectors.
3. Firms with 500 or more employees for manufacturing sector and 100 and more employees for other sectors.
4. Refers to gaps between large and small firms.

The SECT also revealed that the adoption of more advanced ICT such as websites and e-commerce was dominated by large firms. Table 8 is based on the survey data for the period 2001-2003. It indicates that although firms of all sizes were slower to implement these more advanced ICTs, small firms consistently lagged behind medium-

only had a 17.6 per cent increase. Similarly, employment in Canada increased more for large firms than for SMEs over the 2000-2004 period. Large firms had an 8.2 per cent increase in employment; while SMEs had a 6.8 per cent increase in employment (See Appendix Table 3).

and large-size firms. The proportion of firms having a website, selling online and purchasing online increases as firm size increases. For instance, only 29 per cent of small firms had their own website in 2003, lagging well behind the 66 per cent and 77 per cent of medium- and large-size firms respectively. More than twice as many large firms were selling online (16 per cent) as small firms (6 per cent) in 2003, and the rate of large firms purchasing online (61 per cent) was also far higher than that of small and medium firms (SMEs) (35 per cent and 50 per cent respectively). These data suggests that these new technologies were first adopted by large firms. Uhrbach and van Tol (2004) observed that this situation opened up an ICT adoption gap between small and large firms.

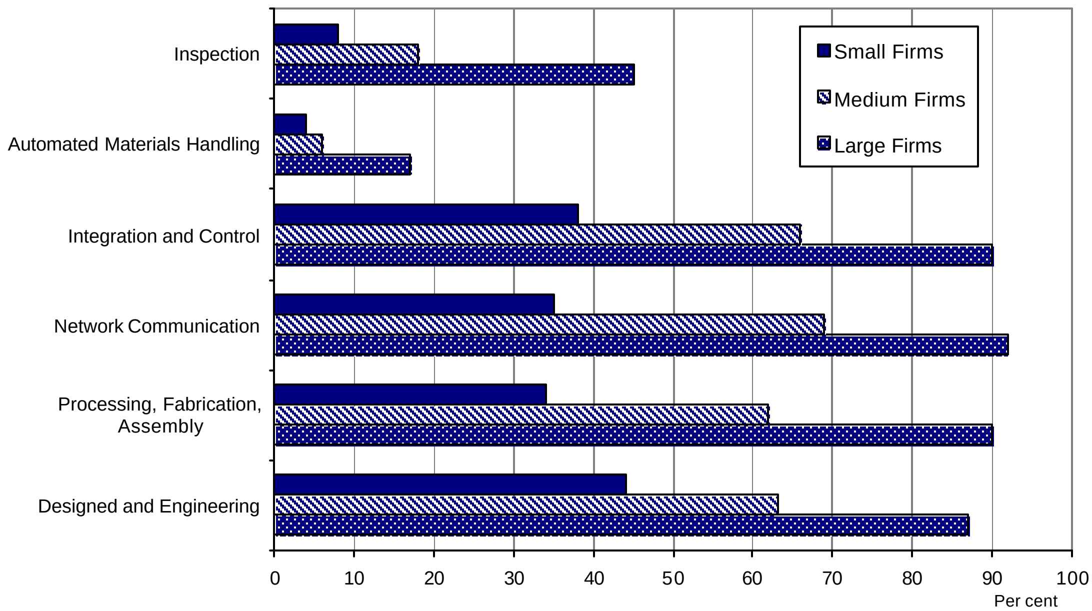
Table 8: Advanced ICT Use by Firm Size in Canada, per cent, 2001-2003

	Own Website			Sell online			Purchase online		
	2001	2002	2003	2001	2002	2003	2001	2002	2003
Small Firms[1]	24	27	29	6	7	6	20	29	35
Medium Firms[2]	57	62	66	12	13	14	30	47	50
Large Firms[3]	74	77	77	15	16	16	52	57	61
All Firms[4]	29	32	34	7	8	7	22	32	37

Source: Industry Canada (2005) Key Small Business Statistics, Table 14, in which data were from Statistics Canada, Survey of Electronic Commerce and Technology (SECT), 2004.

Notes:
1. Fewer than 20 employees.
2. Firms with 20-499 employees for manufacturing sector and 20-99 for other sectors.
3. Firms with 500 or more employees for manufacturing sector and 100 and more employees for other sectors.
4. Data are weighted by the number of all firms, not weighted by firm size.

Chart 46: Technology Adoption Rate by Size of Enterprise, per cent of plants using advanced technologies, 1998



Source: Baldwin, Rama, and Sabourin (1999) Table 5.1.
Note: Small, medium and large plants are defined as having 0 to 99, 50 to 249, and 250+ employees respectively.

Data from the Australia Bureau of Statistics (ABS) Longitudinal Survey also revealed that "large firms were earlier and stronger in the uptake of ICT" (Australia Productivity Research Commission, 2004: 39). The data shows that nearly all medium and large firms (*i.e.* firms employing 50 persons or more by ABS's definition) used computers by 1996-97. However, the use of computers by smaller firms (*i.e.* firms with employment of fewer than 50 persons) varied significantly across sectors. The rate of small firms using computers ranged from 40 to 80 per cent, far behind medium and large firms. Another Australian study (Rawnsley et al., 2003) also found that there is a positive relationship between firm size and information technology and Internet use.

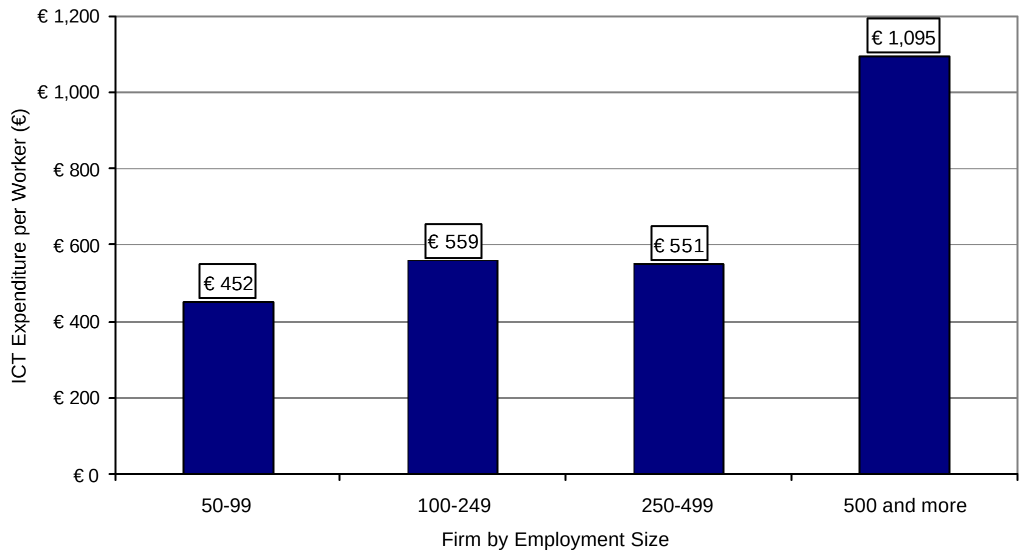
Finally, research by Statistics Canada on technology adoption by firm size shows that certain types of advanced technology are more likely than others to be used by firms depending on size.

Empirical Evidence on ICT Investment by Firm Size

Many economists have shown that the level of ICT investment has strong links to firm size. For instance, in 2000 Fabiani *et al.* (2005) used a survey based on a representative sample of 1,475 manufacturing firms with more than 50 employees to monitor ICT investments in Italy. Their findings suggest that firm size, in terms of employment, was a key determinant of the level of investment in ICT. The ICT expenditure per worker in firms with 500 or more employees, which was €1,095, was nearly twice as much as that of firms with less than 500 employees (€452 for firms with 50-99 employees, €559 for firms with 100-249 employees, and €551 for firms with 250-

499 employees) (Chart 47). The situation clearly shows that larger firms invested relatively more in ICT than small- and medium-size firms.

Chart 47: ICT Expenditure per Worker by Firm Size in Italian Manufacturing, 2000

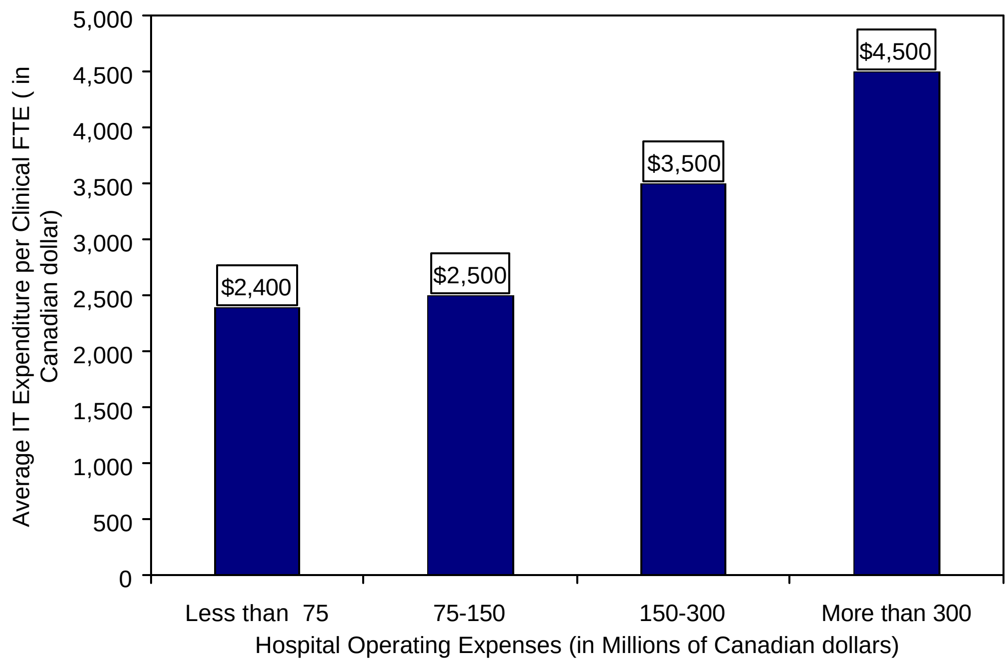


Source: Fabiani, Silvia, Fabiano Schivardi and Sandro Trento (2005), P.231.
Note: ICT expenditure per worker refers to firms' expenditures for purchasing and maintenance of ICT, and for training and consulting concerning ICT.

Another survey from Canada Health Infoway reveals the same investment pattern for 244 Canadian health organizations (Industry Canada, 2003). The survey divided the organizations into four categories by annual operating budget and found that the hospitals' average IT expenditure per clinical FTE [34] rose with the budget (Chart 48). While small health care organizations (i.e. those with budget less than $75 million) only spent $2,400 on IT per clinical FTE; large health care organizations (i.e. those with budget more than $300 million) spent $4,500 per clinical FTE on IT in 2002. The survey also found that the level of IT spending in the Canadian health care organizations is relatively low: mean spending for organizations surveyed is about 2.5 per cent of operating budget, compared to 5 per cent in the United States.

[34] A clinical FTE includes allied health and nursing professionals and excludes physicians.

Chart 48: IT Spending by Canadian Hospitals, 2002



Source: Industry Canada (2003) *Key Indicators on ICT Infrastructure, Use and Content*, p. 36.

A study by UK National Statistics (Clayton, 2005) also indicates that hardware investment is positively correlated with firm size (measured by employment) in manufacturing and services. These results are consistent with the positive relationship between the firm size and ICT use, which indicate that the larger the firm, the more likely it is to invest in ICT equipment and software, and thus the more likely to use ICT.

Analysis on the Firm Size Differences in ICT Investment and Use

Why do large firms invest and adopt ICT capital more than small firms? Following are three explanations of the role of the differences by firm size found in the literature.

First, small firms may remain unaware of the value of ICT investment and adoption. Compared to large firms, small firms are less informed by the latest technological progress, lacking knowledge about using ICT to optimize business. For example, the 2005 UK annual Small Business e-Adoption Survey reveals that over half (51 per cent) of small businesses did not consider ICT equipment important to their current needs (Bytestart, 2005). That is, smaller firms are less aware that adoption of ICT can increase profitability, thus spend less on ICT than larger firms.

Second, the different ICT investment intensity could be due to the difference in cost of capital. Generally the cost of ICT equipment and software is relatively higher for small firms. In particular, the level of investment risk that might be acceptable to a larger firm because it has substantial resource reserves might not be acceptable to a smaller one. For example, the OECD conducted a survey in 2001 to investigate how firms feel about the cost of internet use. It found that the proportion of smaller businesses (defined as 10-49 employees in this survey) that perceived internet access charges as too high was greater than that of larger businesses (defined as 250 and more employees) in most countries. Moreover, small firms tend to be disadvantaged relative to their larger counterparts in terms of access to finance. An analysis on German firms over the time period 1968-85 (Audretsch and Elston, 1994) indicates that smaller firms have investment functions which are more sensitive to liquidity constraints than do the larger enterprises.

The third factor that causes the differences in ICT investment and use might be the differences in the benefits by firm size. Usually, larger firms have greater expected benefits of using ICT than smaller firms do. Research by the Australia Productivity Research Commission (2004) reveals that the number of business locations, which is a proxy for size and complexity of operation of a firm, was positively related to computer use in a number of Australia sectors. An empirical study on US firms (Bresnahan et al., 2002) also shows that productivity gains are much stronger for those firms that use ICT to reduce the number of hierarchical levels. This would suggest that the benefit in the organizational improvements of ICT adoption is greater for larger firms.

Canada's ICT Investment Gap and the Firm Size Pattern---- a Simulation

What would the ICT investment gap be if Canada had the same proportion of large firms as the United States? A simulation would be helpful to explain how the different firm size patterns account for the difference in ICT investment in Canada and US.

In 2002, the average ICT investment per worker in Canadian business sector was $1,294, compared to $ 2,963 in United States. [35] Thus ICT investment per worker in Canada as a share of ICT investment per worker in the United States was 43.7 per cent. We first assume that large firms spend twice as much as SMEs on ICT investment per worker. [36] With a 40.9 per cent employment share, the average ICT investment per worker in larger Canadian firms would be $1,837; while it would be $919 in SMEs. By using U.S. employment shares to weight Canadian ICT investment per worker, the average ICT investment per worker in Canada would rise to $ 1,376. Therefore, under the simulation, ICT investment per worker in Canada as a share of ICT investment per worker in the United States increases to 46.4 per cent, reducing the actual gap (56.3 percentage point difference) by 2.8 percentage points. We then assume that large firms

[35] Figures in this paragraph are in U.S. dollars. All Canadian figures have been adjusted by the exchange rate.

[36] We assume this ratio based on the results from Fabiani et al. (2005), which shows that the ICT expenditures per worker in larger Italian manufacturing firms with 500 and more employees was around twice as much as in small and medium sized firms (also see Chart 47).

spend only 50 per cent more than SMEs on ICT investment per worker in 2002. Using U.S. employment shares by firm size to weight Canadian ICT investment per worker also slightly increases the proportion of ICT investment per worker in Canada as a share of ICT investment per worker in the United States. The average ICT investment per worker in Canada would be $1,342, and the proportion would rise to 45.3, reducing the investment gap by 1.6 percentage points.

We obtained the similar results by using US employment share to weight the proportion of ICT investment as a share of GDP in Canada. In 2002, ICT investment as a share of GDP in Canadian business sector was 2.88 per cent; while the proportion in US business sector was 4.11 per cent. Thus the proportion of ICT investment as a share of GDP in Canada over that in the United States was 70 per cent. Again, we first assume that large firms spend twice as much as SMEs on ICT. By using US employment distribution by firm size, we can obtain a much greater amount of ICT investment in Canada, thus obtain a bigger proportion of ICT investment as a share of GDP, which would be 3.07 per cent. Therefore, the proportion of ICT investment as a share of GDP in Canada over that in the United States would become 74.5 per cent under simulation, reducing the investment gap by 4.5 percentage points. When we assume that large firms spend 50 per cent more on ICT than SMEs do, and use US employment share to weight Canada ICT investment, we find that the proportion of ICT investment as a share of GDP in Canada over that in the United States rises to 72.7 per cent, reducing the gap by 2.6 percentage points.

In summary, there is a significant effect of firm size on ICT use and investment. Large firms generally adopt ICT earlier and spend more on ICT expenditures than SMEs. Thereby the fact that Canada has a relatively greater proportion of SMEs can account for part of the Canada-US ICT investment gap.

Direct Foreign Investment

One quarter of the assets of non-financial corporations in Canada were under foreign control in 2000 (Baldwin and Gellatly, 2005). This is a much higher proportion than in the United States. Multinationals often purchase ICT assets such as computers, servers and software in the home country for use in the host countries, with the result that these investments are sometimes not recorded as investments in the host country. This could mean that ICT investment is overestimated in the United States and underestimated in Canada, explaining part of the gap.

Physical ICT assets such as computers purchased in the United States and shipped to Canada for use by the foreign subsidiary should be captured as imports at the border and recorded as ICT investments in Canada.

The situation is less clear for software purchased in the United States and then shipped electronically to Canada. In principle, such transactions should be recorded by the Canadian subsidiary as an import of software. But the Survey of Electronic

Commerce and Technology (SECT) conducted by Statistics Canada does not identify whether or not software used by firms is purchased in Canada. Therefore, it is difficult to distinguish those firms that use software paid for by their US headquarters (thus the value of software might not be accounted for the firm's software investment data) from those that both use and purchase software in Canada. Statistics Canada is aware of this situation and plans to address the issue in future surveys. Therefore, there may be underestimation of software investment in Canada because of the large presence of multinationals. The fact that of the three ICT asset types, software intensity in Canada, relative to the United States, is lower than computer or communication intensity may represent support for this explanation.

Physical ICT assets such as servers purchased in the United States by multinationals, but which electronically support the Canadian operations from the United States definitely result in less ICT investment in Canada compared to a situation of no multinational operating in Canada. However, the importance of this phenomenon is likely small. More research on this issue is needed.

Differences in Relative Costs and Prices

Differences in the relative prices of new technologies across countries can explain differences in the rate of adoption of ICT investment goods. If ICT prices are higher in Canada than the United States, either in absolute terms (exchange rate adjusted), or relative to other factors of production, then adoption and hence ICT investment may be slower in this country. The low value of the Canadian dollar in recent years may have made ICT much more expensive relative to labour in Canada than in the United States. The data provide support for this hypothesis.

ICT Investment Goods Price Differences

If input costs, other than the cost of capital, are lower in Canada than in the United States, then we would expect that firms in Canada would choose a greater ratio of non-capital inputs to capital in their input mix. This decision would result in a lower level of capital per worker and probably a lower level of ICT capital per worker in Canada relative to the United States. Unfortunately, no specific data on ICT capital costs is available at this time. This section is based on the study entitled *The CEO's Guide to International Business Costs* produced by KPMG and Competitive Alternatives in 2004.[37] This report was based on data collected primarily between April and November 2003.

Cost Components

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[37] Available online at http://www.competitivealternatives.com/

The non-machinery and equipment input costs faced by businesses can be grouped into five categories: labour costs, facility costs, transportation costs, utility costs, and taxes. The share of each input cost in total input costs varies by country and sector. Table 9 provides some data on the relative importance of these costs in the manufacturing and non-manufacturing sectors in the eleven countries studied in the report.[38] These figures are 10-year averages. Unfortunately, no information is available at this time on the relative importance of location-sensitive costs in Canada and the United States separately.

Table 9: Relative Importance of Key Location-Sensitive Cost Factors; percentage range, 2003

	Manufacturing operations[1]	Non-manufacturing operations[2]
Labour costs		
Salaries and wages	40-51	54-61
Statutory benefits	6-8	7-9
Other benefits	10-13	14-17
Total labour	56-72	75-85
Lease costs (non-manufacturing)	n/a	4-14
(subset of facility cost)		
Transportation costs (road, air, sea)	1-17	n/a
Utility costs		
Electricity/natural gas	2-9	1-2
Telecommunications	0-1	1-5
Total utilities	2-10	2-7
Non-operating (depreciation, financing)	12-24	1-5
Taxes		
Property	1-3	n/a
Other	0-1	n/a
Income taxes[3]	3-8	3-8
Total taxes	5-11	3-8

1. Range for seven manufacturing operations included in overall results: food processing, specialty chemicals, electronics assembly, metal machining, pharmaceutical products, plastic products, precision components
2. Range for five non-manufacturing operations included in overall results: biomedical R&D, electronic systems development and testing, advanced software, content development, shared service center
3. Varies with revenue. Modeled operations are assigned revenues in line with typical industry targets.
Source: Exhibits 1.3 and 5.1 in KPMG Competitive Alternatives 2004

Labour Costs

Table 10 summarizes the difference in labour costs between Canada and the United States. Total labour costs are the sum of salaries and wages, employer-paid statutory benefit plans (e.g. employment insurance or the Canada/Québec Pension Plan contributions) and other employer-sponsored benefits (e.g. group supplemental health

[38] Australia, Canada, France, Germany, Iceland, Italy, Japan, Luxembourg, the Netherlands, the United Kingdom, and the United States

insurance or pension plans). Overall, Canadian labour costs are approximately 80 percent of the US level.

Table 10: Labour Cost Comparison, 2003

	Average salaries and wages per employee		Benefits				Average total labour costs per employee	
			Statutory		Non-statutory			
	Current USD	Canada/ U.S. (percent)	Percent of payroll	Canada/ U.S. (percent)	Percent of payroll	Canada/ U.S. (percent)	Current USD	Canada/ U.S. (percent)
Canada	39,539	82.3	8	80.0	21	95.5	50,919	80.3
United States	48,019		10		22		63,379	

Source: KPMG Competitive Alternatives 2004

Another aspect of labour costs which is important to take into account is difference in salaries and wage structures that exist between Canada and the United States. The fact that average Canadian labour costs are about 80 percent of US labour costs conceals the fact that Canada-US relative labour costs differ by salary level. Table 11 presents data on this distributional aspect of labour costs.

Table 11: Labour Cost Comparison, 2003, by salary size

	USD salary range				
	Unskilled	**Skilled**	**Technical/Professional**	**Senior tech/professional & line management**	**Senior management**
	Less than 32,000	**32,000 – 47,999**	**48,000 – 74,999**	**75,000 – 95,999**	**Greater than 96,000**
# positions in study	9	10	14	6	3
Labour costs Canada/U.S. percent	93.4	85.3	80.4	76.0	77.3

Source: KPMG Competitive Alternatives 2004

Table 11 shows that Canada has lower labour costs than the United States at all salary levels and that labour costs are relatively lower in Canada at higher salary levels. The implication of this finding is that Canada has a greater advantage in labour costs over the United States in higher-skilled and higher-paid labour.

Other Costs

Information is also available about relative facility costs, transportation costs, and utilities (energy and telecommunication) costs in Canada and the United States in 2003. As a general rule, the costs are higher in the United States, again giving a greater incentive to US firms to adopt ICT where there is a possibility of substituting ICT for any of these inputs.

ICT Capital Costs

If we assume that ICT capital goods are freely traded between Canada and the United States then we would expect margins in the two countries to be the same in the wholesale and retail sectors. Unfortunately, it appears that there has been no research to date on the relative prices of these goods between the two countries.

Canada has lower labour costs than the United States. These lower labour costs are observed at all salary levels, although they are lower at higher salary levels. Facility costs are variable. The start-up costs of a new industrial facility in Canada are slightly higher than in the United States, while leasing costs are substantially lower. Transportation costs appear to be approximately 28 percent lower than in the United States. Finally utility costs are generally lower than in the United States, with telecommunications costs as the only exception. If ICT capital good costs are roughly equal in Canada and the United States when expressed in a common currency, then other lower Canadian costs would probably lead to lower ICT investment in Canada relative to the United States, since Canadian businesses will choose higher proportions of cheaper inputs in place of the relatively more costly ICT inputs.

Differences in Managerial Attitudes and Culture

In the preparation of this report the authors have had discussions with a large number of businesspersons regarding possible reasons for lower ICT spending by Canadian firms than their US counterparts. Many put forward the view that Canadian firms behave differently than US firms in many ways, and that these differences may account for lower ICT spending in this country. Unfortunately, these explanations must remain speculative in nature as there is to our knowledge no hard data for their assessment. This section reviews a number of these putative differences in managerial attitudes and culture.

It is often asserted that Canadian businesses are more conservative and risk averse that their US counterparts. If this were true, this could account for a greater reluctance to be on the cutting edge of perhaps unproven technology and hence lower ICT spending.

It is also asserted that Canadian businesses tend to be less aware of the latest developments in ICT because of their distance from the major ICT development centres in the United States such as Silicon Valley. This lack of awareness may reflect a basic lack of interest in ICTs, less aggressive marketing and sales promotion by ICT equipment vendors in Canada, or a lower level of technical understanding of ICTs and their benefits. Such a situation would again explain lower ICT spending.

Finally, it is sometimes said that Canadian managers are more reluctant to undertake the organizational changes and the training investments needed for the effective implementation of ICT and hence invest less in ICT. The lower level of employee training in Canada compared to the United States may support this view.

Different managerial attitudes toward ICT on the part of Canadian managers compared to their US counterparts may arise from differences in education. The Ontario Task Force on Competitiveness, Productivity and Economic Progress found that Ontario managers and CEOs have lower educational attainment overall, and in particular in business, than those in the United States. Only 31 per cent of Ontario managers possess a university degree of any sort versus 46 per cent of US managers (Task Force on Competitiveness, Productivity and Economic Progress; November, 2004). As well, CEOs of Ontario's largest corporations tend to have less formal business education at the graduate level than their US counterparts. This trend is unlikely to change anytime soon according to attitudinal surveys.

In a survey conducted by the Task Force on Competitiveness, Productivity and Economic Progress, the public and business community were asked what advice they would give to young people on the level of education they should attain. Relative to their US counterparts, the Ontario public and business community were more likely to recommend a college diploma as the highest level of education to receive, whereas in the United States students were encouraged to attain a bachelor's or graduate degree.

Differences in Framework Variables[39]

In addition to the factors that directly affect ICT investments, such as relative costs, managerial attitudes, and the economic structure of the economy, there are a number of other factors that more indirectly influence ICT investment. These factors include the ICT skills that the workforce possesses, the corporate tax system that affects the incentive to invest, and the level of the competitive intensity of the economy.

ICT Training and Education

The effective use of ICT requires workers with the skills needed to use the new technologies. This may require complementary investments in worker training.[40]

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[39] The adoption of open source software by firms in not recorded in ICT investment flows since there is no financial transaction. If Canadian firms make greater use of open source software than their American counterparts, recorded software investment would be less in this country. Equally, the use of pirated software is not recorded in ICT investment flows. If Canadian firms have a tendency to copy software without paying for it more than American firms, software investment would be lower in Canada. Industry experts indicate that they are not aware of significant differences between Canada and the United States in either the use of open source and pirated software.

[40] ICT skills can be acquired through workplace training rather than formal education. A 2005 study by James Chowhan of Statistics Canada investigates factors related to the incidence and intensity of ICT training. The study focuses on whether training incidence and training intensity are more closely associated with the technological competencies of specific workplaces than with membership in ICT and science-based industry environments. For this report, a firm-based index that measures the technological competency of workplaces directly was constructed. It was found that workplaces which score highly on this index are over three times more likely to train than those that rank zero. Firm size is also a factor. Large and medium-sized enterprises are 3 and 2.3 times more likely to train their employees than small

Canadian firms tend to invest less than their US counterparts in employee training, so this situation may put them at a disadvantage in the use of ICT. Canada also trails the United States in several key areas of education, which is likely a contributor to our relative ICT investment gap.

On a per capita and per student basis, the United States out invests Ontario by significant margins, particularly at the university level. Ontario's yearly education expenditure as a proportion of US spending averaged from 1995 to 1999 was at 86 per cent, 87 per cent, and 49 per cent for K-12, college, and university respectively on a per capita basis. On a yearly per student basis, Canadian expenditure as a proportion of US spending averaged over the same years was at 85 per cent, 68 per cent, and 57 per cent for K-12, college, and university respectively. Lower levels of spending on a per capita and per student basis on education at all levels is likely to contribute to Canada's ICT investment gap relative to the United States by reducing the relative quality of education Canadian students receive and their relative interaction with ICT during their schooling years.

Ontario's lower rate of investment in university education can also be seen in the difference in graduation rates between Ontario and the United States. Ontario trails the United States in degrees conferred per thousand population by 8.7 per cent (5.69 per thousand versus 6.23 per thousand). Although at the bachelor's level we actually out perform the United States, at the Master's and PhD levels we produce graduates at half the rate they do. Institutes of higher education are the primary source of new knowledge and the application of knowledge to business and social challenges. As a result, lower levels of post-graduate degrees can contribute to Canada's ICT investment gap relative to the United States.

ICT training and education is not only important in improving the productivity of Canadian businesses, but also in the actual adoption of ICT. A 2004 study by the Canadian e-Business Initiative focusing on the e-business capabilities of small and medium-sized enterprises (SME) found that 50 per cent of Canadian SMEs had not adopted even a single Internet Business Solution[41] (IBS). Small SMEs adopt less IBS than larger SMEs. The poorest performing industries were found to be the retail, wholesale, and manufacturing sectors. As a result of a series of Canadian and international studies on the IBS adoption behaviour of SMEs, the Canadian e-Business Initiative was able to conclude that "Canadian SMEs lag behind their US and EU counterparts in the adoption of operationally-focused IBS" (2004, p2).

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workplaces, respectively. Lastly, workplaces with high-skilled workforces are more likely to train than workplaces with lower-skilled workforces. Technological competency is found to be the main determinant of training intensity. The size of the workplace, the average cost of training, and the skill level of the workplace are also influential factors, but to a lesser extent. Other factors such as sector, outside sources of funding, and unionization status, are not influential factors in determining the intensity of training.

[41] Internet Business Solutions are defined initiatives that combine the Internet with networking, software and computing hardware technologies, to enhance or improve existing business processes or to create new business opportunities.

The lack of internal capability for IBS implementation was found to be one of the main reasons for the lack of IBS adoption. When examining the justifications of SMEs for IBS adoption, SMEs cited increased competitiveness, increased revenues, and cost reduction as the most important considerations, in order of importance. However, the report notes that it is surprising that commonly cited justifications for IBS adoption such as pressure from competitors or suppliers were not deemed to be important. A lack of understanding as to the benefits of IBS may be responsible for the poor adoption performance of SMEs. In another survey conducted by the Canadian e-Business Initiative and cited in the same report, businesses were directly asked about the reasons for their non-adoption of IBS. Of the reasons cited, one dominated: the business case for an IBS was uncertain. However, while some SMEs may never need to use IBS, data collected by the Canadian e-Business Initiative clearly show that for the majority of SMEs, IBS adoption results in substantial financial and operational benefits. Additionally, SMEs tend to be inherently cautious about new initiatives, particularly in areas that may be unfamiliar to them. Once again, small SMEs are disadvantaged relative to larger SMEs as they are less confident that they have the skills to implement IBS.

Differences in Taxes

ICT investment, like all types of investment, is determined by the ex ante expected return on the investment, which is in part determined by the marginal effective tax rate on ICT business investment. It is also determined by the size of after-tax profits from the previous period, which also is influenced by corporate tax rates.

The fact that non-residential business investment as a share of GDP in Canada is currently comparable to that in the United States suggests that the corporate tax system in this country has not had a negative effect on overall business investment relative to the United States. The marginal effective tax rate (METR) on business investment in 2005 was 35.2 per cent in Canada, compared to 34.5 per cent in the United States, a very small difference (Finance Canada, 2005).[42] This situation reflects significant decreases in taxes in Canada since 2000, including the reduction in the federal general corporate income tax rate, which reduced the METR by 3.6 percentage points, the elimination of the federal capital tax (2.3 points), and CCA changes (1.4 points). In 2000 there was a larger gap between the Canadian and US METRs.

To assess the link between ICT investment and taxes, one must focus on the tax rate for ICT assets, not the overall tax rate. According to the CD Howe Institute, the METR for ICT investment in Canada was 53.2 per cent in 2005. This rate is higher than the rate for overall business investment because of the short life on ICT assets compared to non-ICT assets. The Department of Finance (2005:53) has recently released a study on the marginal effective tax rates on business investment on machinery and equipment, which includes ICT assets. It estimates that in 2005 the METR for machinery and equipment in Canada will be 32.1 per cent, compared to 35.1 per cent in the United States

[42] Similar estimates are reported by Mintz et al.(2005).

(Department of Finance, 2005: 53). Unfortunately, estimates are not publicly available for ICT investment. But based on the M&E estimate, it appears that the METR for ICT investment in Canada is comparable if not below that of the United States at this time, and hence cannot explain the current ICT investment shortfall. However, just as the overall METR was higher in 2000 in Canada than in the United States, the METR for ICT was also higher at this time. Thus in the past the higher taxes on ICT assets may have contributed somewhat to lower ICT investment in this country.

Differences in Competitive Intensity

It is now well recognized that competition is a key driver of productivity growth (Lewis, 2004). When firms are under competitive pressures they are more likely to innovate and introduce new productivity-enhancing technologies such as ICT. Consequently, a possible reason for the lower ICT investment in Canada relative to the United States may be less competitive pressure in this country.

It is difficult to capture the intensity of competitive pressures in one country, let alone across countries. Nevertheless many believe that Canadian product markets are in general less competitive than US markets, due to the smaller size of the Canadian market and to a lesser degree, restrictions imposed on foreign investment in Canada. If true, this situation may account for some of the Canada-US ICT investment intensity gap.

Conclusion

This report has been unable to identify one factor that can account for the Canada-US ICT investment gap. Rather it has identified a number of factors which, when taken together, can account for much, but certainly not all, of the current gap, as measured by ICT share of GDP, of around 38 percentage points. These factors were Canada's industrial structure, the firm size distribution of employment, underestimation of ICT investment by Statistics Canada, lower labour costs, and to a lesser extent, the high degree of foreign ownership and smaller proportion of Canadian managers with university education.

A key question is the relevance of these findings for the task of identifying ways to reduce the Canada-US ICT investment gap, a crucial step towards reducing the Canada-US labour productivity gap. Certain of these factors cannot be influenced by policy while others can. The industrial structure reflects Canada's comparative advantage and is not easily amenable to policy initiatives. Equally, the firm size distribution of businesses also reflects structural influences, but can be influenced by tax policy. Indeed, some argue the greater importance of small and medium sized enterprises (SMEs) in Canada relative to the United States reflects the more favourable tax treatment of SMEs in this country. It is unclear that one would want to reverse this situation just to promote ICT investment. Equally, foreign investment makes an important contribution to both employment and productivity growth in this country and it is in our interest to encourage it even though it may lead to a downward bias in our official ICT investment estimates. Higher labour costs would give firms an incentive to adopt labour-saving ICT, but it is certainly not appropriate for government to raise labour costs for business. Rather a higher level of real wages must be earned through productivity advance, which in turn requires more ICT investment.

The one factor that can be influenced by public policy is the proportion of managers with university education. The federal government and provincial governments currently devote significant resources to university education, but additional resources may still be needed to encourage a greater proportion of young Canadians to pursue university education.

Even though the report finds that certain factors such as the level of taxes on ICT investment do not currently explain the Canada-US ICT investment gap, it does not follow that changes to these factors could not affect the gap. For example, the marginal effective tax rate on ICT assets is currently slightly smaller in Canada than in the United States so does not account for the gap. But lower taxes on ICT investment relative to those in the United States could potentially incite additional ICT investment and contribute to a closing of the gap.

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Appendices

Appendix 1: List of ICT Assets in Canada and the United States

Qualitative comparison of the composition of ICT investment asset types in Canada and the United States	
United States	**Canada**
United States (NIPA Categories and I-O Commodity and Item Descriptions)	**Asset Type**
Computers and peripheral equipment	**Computers Statistics Canada internal code: 8001**
Electronic computers	Central processing units
workstations, microprocessor-based, single-user systems	Computers and accessories
other computers (array, analog, hybrid, or special-use computers)	Disk drives
personal computers	EDF equipment
PC servers (excluding UNIX servers)	Hardware
other portables (i.e. palmtops)	Main frames
large and medium scale host computers (mainframes, super computers, and Unix servers)	Micro computers
Other single user computers	Mini computers
PDAs (personal digital assistants)	Tape drives
Notebooks, subnotebooks	Terminal and other work stations
Laptops	Printers and plotters
Computer storage devices	Word processors
optical disk drives including CD-ROM, WORM, and rewritable	
serial access storage equipment (e.g. tape drives)	
magnetic disk drives (rigid and flexible) and other direct access storage equipment	
multiuser system storage devices (disk and optical subsystems, disk arrays)	
Computer terminal	
display terminals	
teleprinters	
Other computer peripheral equipment	
computer monitors	
impact computer printers, including line and serial type	
accessories for computer peripherals (e.g. device supports, ergonomic aids, etc.)	
printers, non-impact (including laser, inkjet, thermal, and ion deposition)	
optical scanning devices, (bar code, flat bed, etc.), plotters	

keying equipment, mice, digitizers, light pen tablets, manual input devices, ao I/O dev	
other peripheral equipment	
Computer systems design services	
computer systems integrators	
Used and secondhand goods	
Used computing equipment	
Communications equipment	**Telecommunications equipment – Statistics Canada Internal code: 7003**
Computer terminals	Network switching equipment hardware including IP switches (routers) and PBXs used as public switches
teleprinters	Terminal equipment
Telephone apparatus	PBXs
telephone switching and switchboard equipment	Telephone
facsimile communication equipment	Handsets
voice messaging and call processing equipment	cellular phones
carrier line equipment	key systems
telephone sets	Modems
other telephone and telegraph (wire apparatus)	palm pilots
Broadcast and wireless communications equipment	fax machines
all other communication systems and equipment	Pagers
amateur radio station communication systems and equipment	satellite terminals / dishes
broadcast, studio, and related electronic equipment	satellite decoders
fiber optics equipment	satellite set-top boxes
aeronautical radio station communication systems and equipment	Transmission equipment
radio navigation and locating radio station communications systems and equipment	Transponders
broadcast (sound and TV) radio station equipment	Receivers
mobile communications systems and equipment, including cellular phones	cross connects
fixed radio station communication equipment	Multiplexes
Other communications equipment	optical electronics
vehicular and pedestrian traffic control equipment	satellite earth stations
electric railway signals and safety control equipment	cell site equipment

intercom systems	Antennas
Audio and video equipment	cable head end equipment and components
television receivers, including combination models	cable distribution systems
loudspeakers and microphones	plant equipment
	Broadcasting and radio communication equipment
Search, detection, and navigation instruments	
search, detection, navigation, and guidance systems	Radar and navigational instruments
Other communication and energy wire	radar and sonar equipment
telephone and telegraph wire and cable	radio navigational aid apparatus
Guided missile and space vehicles	GPS receivers
miscellaneous equipment	Other communication equipment
Telecommunications	Conventional communication equipment
force account, telephone equipment installation force account telegraph equipment installation	
Architectural and engineering services	
engineering services	
Used and secondhand goods (negative)	
Used TVs	
Used communication equipment	
Software	**Software - Statistics Canada internal code: 7005**
Software publishers	Computer software
packaged computer software for mainframe computers	off the shelf pre-packaged (excluding telecommunication network applications)
computer-assisted design (CAD) and other engineering and design software	custom designed / contracted out (excluding telecommunication network applications)
cross-industry and operating systems applications for personal computers	developed-in-house / own account (excluding telecommunication network applications)
	(developed-in-house) - for telecommunication network switching equipment
health care software	
banking and finance software	
insurance software	
other vertical industry applications consumer applications for personal computers	
Custom computer programming services	
own-account software	
custom computer programming and support services	
Noncomparable imports	
other private services	
fees and royalties paid to affiliated foreigners	
fees and royalties paid to unaffiliated foreigners	

Source: Statistics Canada and United States Department of Commerce, Bureau of Economic Analysis: http://www.bea.doc.gov/bea/faq/national/IOcompPESv1.xls

Appendix 2: Decomposition of the Canada-US ICT Investment Gap

At one level the gap between Canadian and US ICT investment is a mathematical equation composed of several terms. As a result, this expression can be decomposed into its constituent factors and the contribution to the gap of each factor can be calculated. This appendix derives these contributions for the Canada-US ICT investment intensity gap on a per-worker and on proportion-of-GDP basis. As is standard practice in this note, all variables only relate to the business sector and to non-residential investment (e.g. GDP, investment, and employment).

Definition of Variables

ICT investment:	***X***
Total non-residential investment:	***I***
Employment:	***E***
GDP:	***Y***
Canada/US Purchasing Power Parity (PPP) for GDP:	$\boldsymbol{P_Y}$
Canada/US Purchasing Power Parity (PPP) for ICT investment:	$\boldsymbol{P_I}$

Definitions of Relationships

1. Variables in Canadian dollars are subscripted with a 'C' and variables in US dollars are subscripted with a 'US'. Ratios without subscripts are Canada/US ratios.
2. I/Y is the ratio of Canadian to US total non-residential business sector investment a as share of total business sector GDP.

$$\frac{I}{Y} = \frac{\left(\frac{I_C}{Y_C}\right)}{\left(\frac{I_{US}}{Y_{US}}\right)}$$

3. X/I is the ratio of Canadian to US ICT investment share of total investment

$$\frac{X}{I} = \frac{\left(\frac{X_C}{I_C}\right)}{\left(\frac{X_{US}}{I_{US}}\right)}$$

4. X/Y = (I/Y)*(X/I) is the ratio of Canadian to US ICT investment share of GDP. It is a positive function of the overall share of non-residential investment in GDP and the share of ICT investment in non-residential investment.

$$\frac{X}{Y}=\left(\frac{\frac{X_C}{Y_C}}{\frac{X_{US}}{Y_{US}}}\right)=\left(\frac{\frac{I_C}{Y_C}}{\frac{I_{US}}{Y_{US}}}\right)\times\left(\frac{\frac{X_C}{I_C}}{\frac{X_{US}}{I_{US}}}\right)$$

5. Y/E is the ratio of Canadian to US GDP per worker in US dollars (labour productivity). Note that the Canadian output in Canadian dollars (Y_C) is converted to US dollars with the PPP for GDP (P_Y).

$$\frac{Y}{E}=\frac{\left(\frac{Y_C\times P_Y}{E_C}\right)}{\left(\frac{Y_{US}}{E_{US}}\right)}$$

6. P_I/P_Y is the ratio of PPP for ICT investment to PPP for GDP

7. X/E = (Y/E)*(P_I/P_Y)*(X/Y) is the ratio of Canadian to US ICT investment per worker in US dollars. Note that the Canadian output in Canadian dollars (Y_C) is converted to US dollars with the PPP for GDP (P_Y). This ratio is a positive function of the ratio of GDP to employment (labour productivity), the ratio of the purchasing power parity for ICT investment to the purchasing power parity value of GDP (P_I/P_Y), and ICT investment as a share of GDP.

$$\frac{X}{E}=\left(\frac{\frac{Y_C\times P_Y}{E_C}}{\frac{Y_{US}}{E_{US}}}\right)\times\left(\frac{P_I}{P_Y}\right)\times\left(\frac{\frac{X_C}{Y_C}}{\frac{X_{US}}{Y_{US}}}\right)$$

Appendix Table 1: Estimates of ratios for business sector in Canada and the United States, current dollars, 2004			
Variable	**Canada**	**United States**	**Can/U.S. ratio†**
Total investment/GDP (I/Y)	0.136	0.134	1.015
ICT investment/total investment (X/I)	0.185	0.305	0.607
ICT investment/GDP (X/Y)	0.025	0.041	0.616
GDP per worker (Y/E)	$63,594	$79,909	0.796
Canada-US PPP for ICT (P_I)			0.768‡
Canada-US PPP for GDP (P_Y)			0.835
ICT investment per worker (X/E)	$1,468**	$3,253	0.451

Source: CSLS ICT database
†Ratios may not exactly equal the quotient of the figures in the table due to rounding
‡Given that ICT goods are internationally traded, their PPP is close to the market exchange rate, which in 2003 averaged approximately 0.768 USD per CAD (Canadian dollar).
*PPP adjusted figure; GDP PPP exchange rate CAD/USD = 0.835
**PPP adjusted figure; ICT investment PPP CAD/USD = 0.768

Calculation of contributions for Canada-U.S. ratios to the ICT intensity gap

Proportion-of-GDP Ratio

Equation 1

$$\frac{X}{Y} = \frac{\left(\frac{I_C}{Y_C}\right)}{\left(\frac{I_{US}}{Y_{US}}\right)} \times \frac{\left(\frac{X_C}{I_C}\right)}{\left(\frac{X_{US}}{I_{US}}\right)} = \frac{(0.136)}{(0.134)} \times \frac{(0.185)}{(0.305)} = (1.015)\times(0.607) = 0.616$$

The ICT investment gap between Canada and the United States in terms of ICT investment as a proportion of business sector GDP is 38.4 percentage points (100 points – 61.6 points). To determine the individual contribution of each factor in equation (1) the following formula is used:

$$(2)\quad f(h) = [(1-a)\times(\log_a(h))]\times 100$$

In this formula a is the Canada-US ICT investment ratio, in this case 0.616. The equation is then applied in turn to each ratio (h) in equation (1) (I/Y and X/I) to generate $f(h)$, the contribution of each factor to the Canada-US gap $(1 - a)$ in percentage points.

Equation (2) is applied as follows. In the case of total investment as a share of GDP h = (I/Y) = 1.015:

$$f\left(\frac{I}{Y}\right)$$
$$= \left[(1-a)\times\left(\log_a\left(\frac{I}{Y}\right)\right)\right]\times 100$$
$$= [(1-0.616)\times(\log_{0.616}(1.015))]\times 100$$
$$= [(0.384)\times(-0.0307)]\times 100$$
$$= [-0.0117]\times 100$$
$$= -1.2$$

In the case of ICT investment as a share of total investment h = (X/I) = 0.607:

$$f\left(\frac{X}{I}\right)$$
$$= \left[(1-a)\times\left(\log_a\left(\frac{X}{I}\right)\right)\right]\times 100$$
$$= [(1-0.616)\times(\log_{0.616}(0.607))]\times 100$$
$$= [(0.384)\times(1.030)]\times 100$$
$$= [0.396]\times 100$$
$$= 39.6$$

In order to calculate the 'percent of gap' that is explained by total investment as a share of GDP (I/Y) and ICT investment as a share of total investment (X/I), the percentage point numbers resulting from the above calculations are divided by the total 38.4 and multiplied by 100.

Appendix Table 2: Contributions to the Canada-US ICT investment gap, proportion-of-GDP basis

Canada-US ratio	**Percentage points**	**Percent of gap**
Total investment as a proportion of GDP (I/Y)	-1.2	-3.1
ICT investment as a proportion total investment (X/I)	39.6	103.1
Sum total	**38.4**	**100.0**

As a result of these manipulations we can see that the ICT investment gap on a proportion-of-GDP basis is entirely explained by the fact that ICT investment as a proportion of total investment is lower than in the United States. The fact the total investment as a proportion of GDP is larger in Canada than in the United States actually counteracts the effect of lower ICT investment relative to total investment.

Per-worker Ratio

Equation 3

$$\frac{X}{E}$$
$$= \left(\frac{Y}{E}\right) \times \left(\frac{P_I}{P_Y}\right) \times \left(\frac{I}{Y}\right) \times \left(\frac{X}{I}\right)$$
$$= \frac{\left(\frac{Y_C \times P_Y}{E_C}\right)}{\left(\frac{Y_{US}}{E_{US}}\right)} \times \left(\frac{P_I}{P_Y}\right) \times \left(\frac{I}{Y}\right) \times \left(\frac{X}{I}\right)$$
$$= \frac{(65{,}594)}{(79{,}909)} \times \left(\frac{P_I}{P_Y}\right) \times \left(\frac{I}{Y}\right) \times \left(\frac{X}{I}\right)$$
$$= (0.796) \times \left(\frac{0.768}{0.835}\right) \times (1.015) \times (0.607)$$
$$= 0.451$$

(rounding results in imprecise products)

The ICT investment intensity gap between Canada and the United States in terms of ICT investment per worker is 54.9 percentage points (100 points – 45.1 points).

Based on formula (2), and applying the same methodology that was used to derive Appendix Table 2 we obtain:

Appendix Table 3: Contributions to the Canada-US ICT investment gap, per-worker basis

Canada-US ratio	**Percentage points**	**Percent of gap**
Total investment as a proportion of GDP (I/Y)	-1.0	-1.9
ICT investment as a proportion total investment (X/I)	34.4	62.7
GDP per worker (Y/E)	15.7	28.6
Canada-U.S. PPP for ICT divided by Canada-U.S. PPP for GDP (P_I/P_Y)	5.8	10.5
Sum total	**54.9**	**100.0**

Appendix Table 3 demonstrates that 62.7 per cent of the Canada-US ICT investment intensity gap in terms of ICT investment per worker is explained by Canada's lower share of ICT investment in total investment relative to the United States. Canada's higher share of investment in GDP only slightly compensates for this large gap, by -1.9 per cent. Other factors contributing to the Canada-US ICT investment gap per worker are Canada's lower GDP per worker (labour productivity), contributing 28.6 percent, and the fact that the Canada-US PPP for ICT is lower than the Canada-US PPP for GDP, contributing 10.5 per cent.

Appendix 3: Effects of Industrial Structure on M&E Investment

Differences in industrial structures between Canada and the United States could in principle account for part of the disparity in machinery and equipment investment, ICT investment, and non-ICT machinery and equipment investment on a per worker basis between the two countries. Investment per worker in the business sector is a weighted average of the level of investment per worker in every industry comprising the business sector, with the number of workers in each industry divided by the total number of workers in the business sector serving as the "weight" for each respective industry. If industries that traditionally utilize above-average levels of investment per worker represent a smaller proportion of business sector employment in Canada than in the United States, then this would impose a downward bias on overall investment intensity in Canada relative to the United States. The opposite is true for industries that utilize below-average levels of investment per worker in Canada than in the United States.

The effect of differences in industrial structures between Canada and the United States on the level of business sector ICT investment per worker has already been investigated in Part Two of this document. It was found that if Canada's business sector mirrored that of the United States in industrial structure in 2004, then Canada's relative ICT investment per worker gap to the United States would have decreased by 4.4 per cent. Similarly, Canada's ICT investment as a share of GDP gap relative to the United States would have decreased by 4.9 per cent. This section shall examine the influence of industrial structures between the two countries on machinery and equipment investment and non-ICT machinery and equipment investment on a per worker basis and as a share of GDP.

When total machinery and equipment investment by industry in Canada is weighted by U.S. employment shares in order to simulate total machinery and equipment investment in Canada if our industrial structures mirrored those in the United States, as is done in Appendix Table 9, total business sector machinery and equipment investment for 2004 decreases from $65.44 billion[43] to $64.60 billion. This represents a decrease of $0.84 billion or 1.3 per cent. As the number of workers and the level of GDP in the Canadian business sector is assumed to remain the same, the level of machinery and equipment investment per worker and as a share of GDP will fall accordingly. The simulated level of machinery and equipment investment per worker for the Canadian business sector would be $5,233, a decrease of $68 from the actual 2004 value of $5,301 (see Appendix Table 10).[44] The simulated level of machinery and equipment investment

[43] All dollar figures are in U.S. current dollars.

[44] Summary Table S38 of the Centre for the Study of Living Standards' database of ICT investment and capital stock trends shows the level of machinery and equipment investment per worker in the business sector in Canada for 2004 to be $4,851. Similarly, Summary Table S38 shows the level of machinery and equipment investment per worker in the business sector in the United States for 2004 to be $8,066. The discrepancy between these numbers and those utilized above is partly due to differences and limitations in data sources. For both Canada and the United States, the reported value for employment in the business sector is the summation of business sector employees from each industry. However, employment values by industry are only available for each industry as a whole (both business and public components combined). Therefore, in order to calculate employment weights for each industry relative to the business sector in each

as a share of business sector GDP would be 8.37 per cent, a decrease of 0.11 percentage points from the actual 2004 share of 8.48 per cent.[45]

The United States level of machinery and equipment investment per worker in the business sector in 2004 was $7,998. If Canada's business sector industrial structures mirrored those of the United States, then the gap in machinery and equipment investment per worker between the two countries would have increased from $2,697 to $2,765, an increase of 2.5 per cent. Alternately, we can examine the proportion of machinery and equipment investment per worker in the Canadian business sector to that in the United States. The proportion of the actual 2004 values places Canada at 66.3 per cent of the U.S. level (Appendix Table 10). When the simulated level of machinery and equipment per worker in Canada is compared to the actual U.S. value, the proportion decreases to 65.4 per cent, a decrease of 0.9 percentage points.

The United States value of total machinery and equipment investment as a share of business sector GDP in 2004 was 10.24 per cent. If Canada's business sector industrial structures mirrored those of the United States, then the gap in machinery and equipment investment as a share of GDP between the two countries would have increased from 1.76 percentage points to 1.87 percentage points, an increase of 6.3 per cent. Alternately, we can examine the proportion of machinery and equipment as a share of GDP in the Canadian business sector to that in the United States. The proportion of the actual 2004 values places Canada at 82.9 per cent[46] of the U.S. level (Appendix Table 10). When the simulated level of machinery and equipment as a share of GDP in Canada is compared to the actual U.S. value, the proportion decreases to 81.8 per cent.

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country, and have these weights add to 100, it was necessary to compute simulated values for each respective business sector based on the summation of individual industry values. Public administration industries are omitted in the calculation of the simulated business sector (for both countries) since investment data is not available for the United States. Educational services and healthcare and social assistance industries are also omitted in this calculation since a significant proportion of the total employment values for both industries are public sector employees (this would be true for public administration as well). For the rest of the industries, public sector employees only account for a small proportion of the industry total employment values. The same industries are omitted in the calculation of (simulated) business sector ICT investment for consistency. The business sector GDP value utilized for Canada is that reported by Statistics Canada, which naturally excludes most of the GDP of the educational services and healthcare and social assistance industries as these industries are largely comprised of public and not private sector. Additionally, current dollar values for Canada for 2004 only exists for the business sector as a whole and not for individual industries. The business sector GDP value utilized for the United States is that reported by the Bureau of Economic Activity minus the GDP values for the educational services and healthcare and social assistance industries, for consistency.

[45] Summary Table S40 of the Centre for the Study of Living Standards' database of ICT investment and capital stock trends shows the proportion of machinery and equipment investment as a share of business sector GDP in Canada for 2004 to be 8.29 per cent. The above value differs from that in Summary Table S40 due to the need to calculate simulated values for the business sector as described previously in footnote 43.

[46] The benchmark value for the proportion of machinery and equipment investment as a share of GDP in the Canadian business sector to that in the United States differs from the value above due to the need to calculate simulated values for the business sector as described previously in footnote 43.

When non-ICT machinery and equipment investment by industry in Canada is weighted by U.S. employment shares in order to simulate non-ICT machinery and equipment investment in Canada if our industrial structures mirrored those in the United States, as is done in Appendix Table 11, total business sector non-ICT machinery and equipment investment for 2004 decreases from $46.10 billion to $44.30 billion. This represents a decrease of $1.80 billion or 3.9 per cent. As the number of workers and the level of GDP in the Canadian business sector is assumed to remain the same, the level of non-ICT machinery and equipment investment per worker and as a share of GDP will fall accordingly. The simulated level of non-ICT machinery and equipment investment per worker for the Canadian business sector would be $3,589, a decrease of $145 from the actual 2004 value of $3,734.[47] The simulated level of non-ICT machinery and equipment investment as a share of business sector GDP would be 5.74 per cent, a decrease of 0.24 percentage points from the actual 2004 share of 5.98 per cent.[48]

The United States level of non-ICT machinery and equipment investment per worker in the business sector in 2004 was $4,667. If Canada's business sector industrial structures mirrored those of the United States, then the gap in machinery and equipment investment per worker between the two countries would have increased from $933 to $1,078, an increase of 15.5 per cent. Alternately, we can examine the proportion of non-ICT machinery and equipment investment per worker in the Canadian business sector to that in the United States. The proportion of the actual 2004 values places Canada at 80.0 per cent of the U.S. level (Appendix Table 10). When the simulated level of machinery and equipment per worker in Canada is compared to the actual U.S. value, the proportion decreases to76.9 per cent.

The United States value of non-ICT machinery and equipment investment as a share of business sector GDP in 2004 was 5.97 per cent, and therefore essentially identical to Canada's proportion of non-ICT machinery and equipment investment as a share of business sector GDP (a difference of 0.01 percentage points). If Canada's business sector industrial structures mirrored those of the United States, then Canada would develop a gap in non-ICT machinery and equipment investment as a share of GDP relative to the United States of 0.23 percentage points. Alternately, we can examine the proportion of non-ICT machinery and equipment as a share of GDP in the Canadian business sector to that in the United States. The proportion of the actual 2004 values

[47] Summary Table S42 of the Centre for the Study of Living Standards' database of ICT investment and capital stock trends shows the level of non-ICT machinery and equipment investment per worker in the business sector in Canada for 2004 to be $3,383. Similarly, Summary Table S42 shows the level of non-ICT machinery and equipment investment per worker in the business sector in the United States for 2004 to be $4,812. The above values differ from those in Summary Table S42 due to the need to calculate simulated values for the business sector as described previously in footnote 43.

[48] Summary Table S44 of the Centre for the Study of Living Standards' database of ICT investment and capital stock trends shows the proportion of non-ICT machinery and equipment investment as a share of business sector GDP in Canada for 2004 to be 5.78 per cent. The above value differs from that in Summary Table S44 due to the need to calculate simulated values for the business sector as described previously in footnote 43.

places Canada at 100.0 per cent[49] of the U.S. level (Appendix Table 10). When the simulated level of non-ICT machinery and equipment as a share of GDP in Canada is compared to the actual U.S. value, the proportion decreases to 96.1 per cent.

[49] The benchmark value for the proportion of non-ICT machinery and equipment investment as a share of GDP in the Canadian business sector to that in the United States differs from the above value due to the need to calculate simu lated values for the business sector as described previously in footnote 43.

Appendix 4: Data Sources[50]

Canada

The source of data for total investment and capital stock used in this study is Statistics Canada's Fixed Capital Flows and Stocks Program. This Program provides annual estimates of gross and net non-residential capital stock in current and Fisher chained 1997 dollars for 1955-2004 by industry based on the North American Industry Classification System (NAICS), and by major capital asset type (*i.e.* building construction, engineering construction, and machinery and equipment).

This study uses a special run of ICT investment and capital stock data carried out by Statistics Canada's Investment and Capital Stock Division. The special run provides estimates of ICT investment and capital stock by sector (*i.e.* business sector and non-business sector), by NAICS industry, and by each the three components of ICT (*i.e.* computers, communications and software) in current and Fisher chained 1997 dollars for the period of 1980-2004 (estimates of software investment and capital stock were only available from 1981). However, data on the three ICT components are not available for the health care and social services sector due to confidentiality, nor the business sector total for each component. Consequently, business sector estimates at the ICT component level are defined and calculated as total economy minus the public administration and educational services sectors. The health care and social assistance sector is therefore included in the business sector total at the component level. In 2004, total ICT investment in health care and social assistance in Canada was $613 million or 2.4 per cent of business sector ICT investment. Given that this total is relatively small, its inclusion in business sector ICT investment at the three component level does not significantly raise ICT investment for the three components in Canada relative to the United States.

There are two sources of data on employment. The first is the Labour Force Survey (LFS), from which employment estimates for the total economy and twenty industries are produced for the period 1976-2004 produced by Statistics Canada. The second is the Productivity Program, with estimates of employment for the business sector available for 1987-2004. Because we calculate total ICT business sector estimates at the component level by including the estimate of health care and social assistance, as mentioned above, data on ICT per worker for the three ICT components in this report is slightly overestimated for the Canadian business sector.

GDP data is generally drawn from the National Income and Expenditure Accounts (NIEA), which provide estimates of nominal and real GDP for the total economy and by NAICS industries. The chained type NIEA data are currently available for the period 1981-2004. But current dollar NIEA data by industry are only available to 2001, so Canada-US industry level comparisons of ICT investment as a share of GDP end in that year. This study has drawn business sector nominal GDP data from Statistics Canada's

[50] Data available at www.csls.ca.

Productivity Measures, which contains estimates of nominal GDP for the business sector from 1981-2004, and makes the Canada-U.S. business sector comparison available to 2004.

In order to compare data in levels measured in domestic currencies between Canada and the United States, this report has converted all Canadian dollar figures into US dollars using two approaches. The first approach employs Statistics Canada's Purchasing Power Parity (PPP) estimates, which are only available for the period of 1992-2001.[51] The second approach is to use the Bank of Canada's annual average exchange rate, which is available to 2004. Exchange rates may diverge from purchasing power parities for many reasons including the imperfect mobility of goods and some factors of production (labour and capital) across borders.

United States

The source of US business sector investment and capital stock data is the Standard Fixed Assets Tables of the Bureau of Economic Analysis (BEA). These tables provide estimates of private non-residential capital stock and investment by industry on a current-cost basis and in chain-type quantity indexes for the period 1987-2004. However, the chain-type quantity indexes use 2000 as a base year, which is not consistent with Canada's base year, 1997. Therefore, in this study US chain-type quantity indexes have been re-indexed to 1997.

ICT data come from BEA's Detailed Fixed Assets Tables, which provide estimates of net stocks and investment by type of asset (computers, communications and software) and by NAICS industries for private residential and non-residential fixed assets. Total ICT data are calculated by summing the three components in both current cost and chain-type prices.[52]

There are two sources of data on US employment. One is the Bureau of Labour Statistics' (BLS) Current Population Survey (CPS), which provides estimates of employment by industry for the period 2000-2004 based on NAICS. Another is an unpublished BLS series, which provides estimates of employment in the business sector available from 1948 to 2004.

GDP data are drawn from the BEA National Income and Products Accounts (NIPA) Tables. These tables provide estimates of real and nominal GDP for business sector and by NAICS industries for the period 1947-2004.

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[51] See Statistics Canada, Purchasing Power Parities and Real Expenditures, United States and Canada, Item Catalogue no. 13-604-MIB no.39, 2002.

[52] This report focuses on level comparison expressed in current dollars, and seldom uses data in chained dollars. Although chained-dollar data for series adjusted using different deflators cannot be summed in periods other than the base year, this report sums the three ICT components to show the total ICT growth rate.

Appendix Table 4: Reasons for Adopting ICT as Identified by Businesses, per cent of all businesses in each country, 2004

	Canada	United Kingdom	France	Germany	Italy	Sweden	Ireland	United States	Australia	Japan	South Korea	Average (excluding Canada)
Increased efficiency	22	22	13	14	8	21	22	14	25	49	23	21
Reduced cost	15	13	n.a.	29	8	35	11	13	16	11	10	16
Customer communication	13	18	18	24	16	27	19	13	17	8	5	17
Speed of access to information	13	10	23	32	23	n.a.	14	17	11	4	11	16
Keep up with progress	12	15	27	20	31	24	17	20	21	48	18	24
Improve quality of service	8	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	6	n.a.	n.a.	n.a.	6
Staff communication	8	8	10	14	n.a.	13	n.a.	7	9	4	n.a.	9
Enable more information to be shared	6	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	7	n.a.	7
Customer demands	n.a.	9	9	n.a.	n.a.	10	7	n.a.	n.a.	n.a.	4	8
Integral to my type of business	n.a.	8	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	8
Simplify process	n.a.	n.a.	9	14	11	13	8	n.a.	11	n.a.	34	14
Supplier communication	n.a.	n.a.	9	17	12	15	n.a.	n.a.	11	3	n.a.	11
Keep up with competitiors	n.a.	n.a.	n.a.	n.a.	14	n.a.	8	7	n.a.	n.a.	5	9

Source: "Business in the Information Age: The International Benchmarking Study 2004", Department of Trade and Industry, United Kingdom, Figure 8.3e.
Question posed to 2,716 businesses in the United Kingdom and 500 businesses in each other country: "What were the main reasons for adopting the online technologies you currently have?" and "which of these reasons have been realised?"

Note (i): Data are available only for the top eight overall drivers of ICT adoption in each country as identified by businesses in each respective country; therefore, a value of "n.a." indicates that the particular driver of ICT adoption did not rank in the top eight most important drivers of ICT adoption for the respective country.

Note (ii): Data are also available for the percentage of businesses in each country that were able to realize their stated goal for ICT adoption. In Canada, the per cent of businesses that achieved their goal is essentially identical to the per cent of businesses that listed each respective goal as a driver in ICT adoption. Only businesses in Australia, France, Germany, Italy, and Sweden diverged significantly (more than 10 per cent overall) from the above figures, in that a lower percentage of businesses were successful in achieving each goal than the percentage of businesses that listed the respective goal as a driver in adopting ICT.

Appendix Table 5: Employment Share by Employment Size of Enterprise (in percent) in Business Sector in Canada and the United States, by industry, 2002

	Number of Employees											
	Less than 20		20-99		100-499		20-499		Less than 500		500 and Over	
	Canada	US	Canada	US	Canada	US	Canada	US	Canada	US	Canada	US
Total Business Sector	22.7	18.3	20.6	17.7	15.9	14.2	36.5	31.8	59.1	50.1	40.9	49.9
Agriculture, forestry, fishing, & hunting	40.3	47.6	19.8	26.6	..	..	..	..	..	..	..	..
Mining	14.0	14.0	13.3	16.5	15.6	13.3	28.9	29.8	42.9	43.9	57.1	56.1
Utilities	2.1	3.7	4.5	6.1	8.2	7.2	12.6	13.3	14.7	17.1	85.3	82.9
Construction	50.1	38.3	27.4	30.8	10.9	15.8	38.3	46.7	88.4	85.0	11.6	15.0
Manufacturing	10.8	8.6	21.0	16.5	23.7	17.3	44.8	33.8	55.6	42.3	44.4	57.7
Wholesale trade	27.2	22.1	28.8	24.2	19.3	16.4	48.1	40.6	75.3	62.8	24.7	37.2
Retail Trade	26.4	19.5	24.1	14.9	10.8	8.6	34.9	23.4	61.3	42.9	38.7	57.1
Transportation & Warehousing	18.7	14.4	16.7	15.5	14.6	11.7	31.3	27.2	50.0	41.6	50.0	58.4
Information	10.0	7.4	11.8	9.0	13.6	9.2	25.4	18.2	35.3	25.6	64.7	74.4
Finance & insurance	11.8	11.1	11.7	9.4	10.6	10.2	22.3	19.5	34.1	30.6	65.9	69.4
Real estate & rental & leasing	39.9	35.4	22.5	18.6	14.9	14.7	37.4	33.4	77.3	68.8	22.7	31.2
Professional, scientific, & technical services	39.1	30.4	21.8	19.8	15.1	14.1	37.0	33.8	76.1	64.2	23.9	35.8
Management of companies & enterprises	30.3	0.7	19.6	2.6	..	9.6	..	12.3	..	13.0	..	87.0
Administrative & support & waste management	23.0	11.0	19.8	12.4	22.2	16.2	42.0	28.6	65.1	39.6	34.9	60.4
Educational services	3.3	8.3	4.6	19.1	9.2	19.8	13.7	38.9	17.0	47.2	83.0	52.8
Health care & social assistance	19.5	15.8	13.4	13.8	17.4	18.3	30.9	32.2	50.4	48.0	49.6	52.0
Arts, entertainment, & recreation	22.6	17.5	28.5	27.6	21.1	21.1	49.7	48.7	72.3	66.2	27.7	33.8
Accommodation & foodservices	29.2	18.2	39.3	28.3	16.4	14.1	55.7	42.4	84.9	60.6	15.1	39.4
Other services (except public administration)	52.2	47.0	21.5	27.3	13.0	11.8	34.4	39.2	86.7	86.2	13.3	13.8

Source: US Bureau of the Census, 2002 Economic Census, from http://www.census.gov/csd/susb/susb02.htm, and Statistic Canada, CANSIM II Table 282-0042.

Notes:
1. Data on number of employees working in enterprise having 100 and more emplyees in Canadian agriculture, forestry,fishing and hunting, management of companies and enterprises and in US agriculture, forestry, fishing and hunting are not available.
2. Data on Canadian business sector exclude persons in public administrations sector to be consistent with data on US business sector, which exclude self-employed persons, government establishments and other industries such as postal service and railroads.

Appendix Table 6: Decomposition of the Canada-U.S Business ICT Investment per Worker Gap, 1987-2004

	Canada-U.S. Ratios, per cent				
	Total Non-Residential Investment as a Share of GDP	Total ICT Investment as a Share of Total Non-Residential Investment	GDP per Worker	ICT PPP over GDP PPP	ICT Investment per worker
	A	B	C	D	A*B*C*D
1987	112.7	65.7	87.3	93.5	60.4
1988	119.8	57.5	87.2	101.8	61.1
1989	120.6	57.3	86.0	106.5	63.3
1990	120.3	60.4	84.2	107.4	65.7
1991	122.6	58.5	82.8	108.8	64.6
1992	115.0	66.2	80.5	102.1	62.6
1993	105.8	69.8	81.5	94.5	56.9
1994	108.9	68.7	83.5	88.2	55.1
1995	101.1	66.2	85.3	87.8	50.1
1996	99.4	66.4	84.8	87.3	48.8
1997	110.7	61.0	84.5	86.0	49.0
1998	110.6	65.0	84.7	78.4	47.7
1999	105.5	62.7	84.1	79.2	44.0
2000	98.3	61.7	86.0	80.1	41.8
2001	104.4	63.0	86.0	76.0	42.9
2002	110.6	63.6	83.7	74.6	44.0
2003	108.6	60.1	81.4	84.7	45.0
2004	101.5	60.7	79.6	92.0	45.1
Average 87-04	109.8	63.0	84.1	90.5	52.7

	Percentage point contribution to the gap*				
	Total Non-Residential Investment as a Share of GDP	Total ICT Investment as a Share of Total Non-Residential Investment	GDP per Worker	ICT PPP over GDP PPP	ICT Investment per worker gap
	A	B	C	D	A+B+C+D
1987	-9.4	33.0	10.7	5.3	39.6
1988	-14.3	43.7	10.8	-1.4	38.9
1989	-15.0	44.6	12.1	-5.1	36.7
1990	-15.1	41.2	14.1	-5.8	34.3
1991	-16.5	43.4	15.3	-6.8	35.4
1992	-11.2	32.9	17.4	-1.7	37.4
1993	-4.3	27.5	15.6	4.3	43.1
1994	-6.4	28.2	13.6	9.4	44.9
1995	-0.8	29.8	11.5	9.4	49.9
1996	0.4	29.2	11.8	9.7	51.2
1997	-7.3	35.4	12.0	10.8	51.0
1998	-7.1	30.5	11.7	17.2	52.3
1999	-3.6	31.9	11.8	15.9	56.0
2000	1.1	32.2	10.0	14.8	58.2
2001	-2.9	31.2	10.2	18.6	57.1
2002	-6.9	30.8	12.1	20.0	56.0
2003	-5.7	35.0	14.2	11.5	55.0
2004	-1.0	34.4	15.7	5.8	54.9
Average 87-04	-7.0	34.2	12.8	7.3	47.3

*The formula used to calculate contributions is presented in Appendix 2

	Percent contribution to the gap				
	Total Non-Residential Investment as a Share of GDP	Total ICT Investment as a Share of Total Non-Residential Investment	GDP per Worker	ICT PPP over GDP PPP	ICT Investment per worker
	A	B	C	D	A+B+C+D
1987	-23.6	83.2	27.0	13.4	100.0
1988	-36.6	112.4	27.7	-3.5	100.0
1989	-40.9	121.7	33.1	-13.9	100.0
1990	-43.9	119.9	40.9	-17.0	100.0
1991	-46.5	122.6	43.2	-19.3	100.0
1992	-29.8	88.0	46.4	-4.5	100.0
1993	-10.0	63.7	36.3	10.0	100.0
1994	-14.3	63.0	30.2	21.1	100.0
1995	-1.6	59.7	23.0	18.8	100.0
1996	0.9	57.1	23.1	18.9	100.0
1997	-14.2	69.4	23.6	21.2	100.0
1998	-13.6	58.2	22.5	32.9	100.0
1999	-6.5	57.0	21.1	28.4	100.0
2000	2.0	55.3	17.3	25.4	100.0
2001	-5.1	54.7	17.9	32.5	100.0
2002	-12.2	55.0	21.6	35.6	100.0
2003	-10.3	63.6	25.8	20.8	100.0
2004	-1.9	62.7	28.6	10.5	100.0
Average 87-04	-17.1	76.0	28.3	12.9	100.0

Appendix Table 7: Simulation Scenario of Total ICT Investment in Canada Weighted by U.S. Industry Employment Shares, current U.S. dollars, 2004

	Canada (Actual)				**United States (Actual)**				**Canada (Simulation Scenario -- ICT Investment in Canada Weighted by U.S. Industry Employment Shares)**			
	Total ICT Investment, thousands of current US dollars	Employment, thousands of workers	ICT Investment per worker	Industry Employment Weight Relative to Business Sector	Total ICT Investment, thousdands	Employment, thousands of workers	ICT Investment per worker	Industry Employment Weight Relative to Business Sector	Difference Between U.S. and Canadian Industry Employment Weight Relative to Business Sector	Total ICT Investment Weighted by U.S.-Canada Industry Employment Shares, thousands	Difference Between Total ICT Investment Weighted by U.S.-Canada Industry Employment Shares and Actual Total ICT Investment, thousands	Relative Contribution to Increase in Total ICT Investment when Weighted by U.S. Industry Employment Shares
	A	B	C = A ÷ B	D = (B ÷ Business Sector Total) x 100	E	F	G = E ÷ F	H = (F ÷ Business Sector Total) x 100	I = H - D	J = A x (H ÷ D)	K = J - A	L = K ÷ 947,739
Agriculture, Forestry, Fishing and Hunting [11]	100,764	423	221	3.42	744,000	2232	333	2.14	-1.28	63,088	-37,677	-4.0
Mining and Oil and Gas Extraction [21]	117,455	187	561	1.52	2,216,000	539	4,111	0.52	-1.00	40,037	-77,418	-8.2
Utilities [22]	1,111,028	133	8,354	1.08	9,837,000	1168	8,422	1.12	0.04	1,156,344	45,316	4.8
Construction [23]	204,209	953	214	7.72	8,224,000	10768	764	10.34	2.62	273,514	69,305	7.3
Manufacturing [31-33]	1,816,878	2,297	791	18.61	44,814,000	16484	2,719	15.82	-2.78	1,545,248	-271,630	-28.7
Wholesale Trade [41]	1,686,407	581	2,628	4.71	17,494,000	4600	3,803	4.42	-0.29	1,581,306	-105,101	-11.1
Retail Trade [44-45]	1,092,253	1,922	568	15.57	11,937,000	16269	734	15.62	0.05	1,095,611	3,358	0.4
Transportation and Warehousing [48-49]	1,326,053	809	1,638	6.56	27,095,000	5844	4,636	5.61	-0.95	1,134,694	-191,359	-20.2
Information and Cultural Industries [51]	4,617,378	377	12,244	**3.05**	60,099,000	3463	17,355	**3.32**	**0.27**	5,025,303	407,925	**43.0**
Finance and Insurance [52]	2,742,146	678	4,043	**5.49**	41,810,000	6940	6,024	**6.66**	**1.17**	3,325,547	583,401	**61.6**
Real Estate and Rental and Leasing [53]	1,447,896	277	5,233	**2.24**	17,943,000	3029	5,924	**2.91**	**0.67**	1,878,444	430,548	**45.4**
Professional, scientific and technical services [54]	1,759,781	1,010	1,742	8.18	64,264,000	8386	7,663	8.05	-0.13	1,731,490	-28,291	-3.0
Management of companies and enterprises [55]	91,202	3	35,078	0.02	19,454,000	35	555,829	0.03	0.01	145,503	54,301	5.7
Administrative and support, waste management and remediatiation services [56]	360,249	628	574	5.08	13,072,000	5687	2,299	5.46	0.38	386,940	26,691	2.8
Arts, entertainment and recreation [71]	352,803	356	992	2.88	1,385,000	2690	515	2.58	-0.30	316,296	-36,507	-3.9
Accomodation and food services [72]	98,916	1,007	98	8.16	3,225,000	9131	353	8.77	0.61	106,319	7,403	0.8
Other services (except public admin) [81]	421,009	705	597	5.71	3,373,000	6903	489	6.63	0.92	488,482	67,474	7.1
Business Sector (Industry Totals):	**19,346,428**	12,345	**1,567**	100	**346,986,000**	104,168	**3,331**	100	0	**20,294,167**	**947,739**	100

Source: CSLS database of ICT investment and capital stock trends.

Note: The business sector is defined as the summation of all of the above industries, so that industry employment weights relative to the business sector are calculated by dividing the employment level for each respective industry by the summation of the employment values for all the industries listed. Employment values include both business and public sector components for each industry. In all of the industries listed above, the porportion of public sector employees in total employment is marginal. Public administration, educational services and healthcare and social assistance industries have been excluded from the above analysis since a significant proportion of the total employment values for these industries are public sector employees.

Appendix Table 8: Simulation Scenario of Total ICT Investment in Canada Weighted by U.S. Industry Employment Shares, current domestic currency, 2004

	Canada (Actual), current Canadian dollars			United States (Actual), current U.S. dollars			Canada (Simulation Scenario -- ICT Investment in Canada Weighted by U.S. Industry Employment Shares), current Canadian dollars			
	Total ICT Investment, thousands	Employment, thousands of workers	Industry Employment Weight Relative to Business Sector	Total ICT Investment, thousdands	Employment, thousands of workers	Industry Employment Weight Relative to Business Sector	Difference Between U.S. and Canadian Industry Employment Weight Relative to Business Sector	Total ICT Investment Weighted by U.S.-Canada Industry Employment Shares, thousands	Difference Between Total ICT Investment Weighted by U.S.-Canada Industry Employment Shares and Actual Total ICT Investment, thousands	Relative Contribution to Increase in Total ICT Investment when Weighted by U.S. Industry Employment Shares
	A	B	D = (B ÷ Business Sector Total) x 100	E	F	H = (F ÷ Business Sector Total) x 100	I = H - D	J = A x (H ÷ D)	K = J - A	L = K ÷ 1,649.808
Agriculture, Forestry, Fishing and Hunting [11]	131,124	423	3.42	744,000	2,232	2.14	-1.28	82,096	-49,028	-4.0
Mining and Oil and Gas Extraction [21]	152,843	187	1.52	2,216,000	539	0.52	-1.00	52,100	-100,743	-8.2
Utilities [22]	1,445,772	133	1.08	9,837,000	1,168	1.12	0.04	1,504,741	58,969	4.8
Construction [23]	265,736	953	7.72	8,224,000	10,768	10.34	2.62	355,922	90,186	7.3
Manufacturing [31-33]	2,364,288	2,297	18.61	44,814,000	16,484	15.82	-2.78	2,010,818	-353,470	-28.7
Wholesale Trade [41]	2,194,507	581	4.71	17,494,000	4,600	4.42	-0.29	2,057,741	-136,766	-11.1
Retail Trade [44-45]	1,421,340	1,922	15.57	11,937,000	16,269	15.62	0.05	1,425,710	4,370	0.4
Transportation and Warehousing [48-49]	1,725,582	809	6.56	27,095,000	5,844	5.61	-0.95	1,476,568	-249,014	-20.2
Information and Cultural Industries [51]	6,008,556	377	**3.05**	60,099,000	3,463	**3.32**	**0.27**	6,539,385	530,829	**43.0**
Finance and Insurance [52]	3,568,332	678	**5.49**	41,810,000	6,940	**6.66**	**1.17**	4,327,507	759,175	**61.6**
Real Estate and Rental and Leasing [53]	1,884,135	277	**2.24**	17,943,000	3,029	**2.91**	**0.67**	2,444,404	560,269	**45.4**
Professional, scientific and technical services [54]	2,289,988	1,010	8.18	64,264,000	8,386	8.05	-0.13	2,253,173	-36,815	-3.0
Management of companies and enterprises [55]	118,681	3	0.02	19,454,000	35	0.03	0.01	189,342	70,661	5.7
Administrative and support, waste management and remediatiation services [56]	468,789	628	5.08	13,072,000	5,687	5.46	0.38	503,521	34,732	2.8
Arts, entertainment and recreation [71]	459,099	356	2.88	1,385,000	2,690	2.58	-0.30	411,593	-47,506	-3.9
Accomodation and food services [72]	128,718	1,007	8.16	3,225,000	9,131	8.77	0.61	138,352	9,634	0.8
Other services (except public admin) [81]	547,855	705	5.71	3,373,000	6,903	6.63	0.92	635,658	87,803	7.1
Business Sector (Industry Totals):	**25,175,345**	12,345	100	**346,986,000**	104,168	100	0	**26,408,630**	**1,233,285**	100

	Actual Total ICT Investment, thousands	Simulated Total ICT Investment, thousands	Business Sector GDP (millions)	Proportion of Actual Total ICT Investment to GDP	Proportion of Simulated Total ICT Investment to GDP
	X	Y	Z	(X ÷ Z) x 100	(Y ÷ Z) x 100
Canada (current Canadian dollars)	25,175,345	26,408,630	1,003,868	**2.51**	**2.63**
United States (current U.S. dollars)	346,986,000	n.a.	8,137,300	**4.26**	n.a.

Proportion of Canadian to U.S. Business Sector ICT Investment to GDP (using Actual Total ICT Investment in Canada)	=	**58.8**
Proportion of Canadian to U.S. Business Sector ICT Investment to GDP (using Simulated Total ICT Investment in Canada)	=	**61.7**

Source: CSLS database of ICT investment and capital stock trends.

Note: The business sector is defined as the summation of all of the above industries, so that industry employment weights relative to the business sector are calculated by dividing the employment level for each respective industry by the summation of the employment values for all the industries listed. Employment values include both business and public sector components for each industry. In all of the industries listed above, the porportion of public sector employees in total employment is marginal. Public administration, educational services and healthcare and social assistance industries have been excluded from the above analysis since a significant proportion of the total employment values for these industries are public sector employees.

Note: The business sector GDP value utilized for Canada is that reported by Statistics Canada, which naturally excludes most of the GDP of the educational services and healthcare and social assistance industries as these industries are largely comprised of public and not private sector. Additionally, current dollar values for Canada for 2004 only exists for the business sector as a whole and not for individual industries. The business sector GDP value utilized for the United States is that reported by the Bureau of Economic Activity minus the GDP values for the educational services and healthcare and social assitance industries, for consistency.

Appendix Table 9: Simulation Scenario of Total Machinery and Equipment Investment in the Business Sector, current dollars, 2004

	Canada, actual					United States, actual				Scenario			
	M&E investment, millions of CAD	**M&E investment, millions of US**	**Employment, thousands**	**M&E investment per worker, US**	**Employment weight relative to business sector total, percent**	**M&E investment, millions of USD**	**Employment, thousands**	**M&E investment per worker, USD**	**Employment weight relative to business sector total, percent**	**Difference Between U.S. and Canadian Industry Employment Weights Relative to Business Sector**	**Total M&E Investment Weighted by U.S.-Canada Industry Employment Shares, millions of US**	**Difference Between M&E Investment Weighted by U.S.-Canada Industry Employment Shares and Actual M&E Investment, millions of US**	**Relative Contribution to Decrease in M&E Investment when Weighted by U.S. Industry Employment Shares**
	A	B	C	D = (B*1,000/C)	E = (B/12,133)*100	F	G	H = (F*1,000/G)	I = (G/103,234)*100	J = I - E	K = B x (I ÷ E)	L = K - B	M = (L ÷ (-237)) x 100
Business Sector Total (sum of all industries below)	85,159	65,442	12,345	5,301	100.00	833,100	104,168	7,998	100.00	-	64,598	-844	100
Agriculture, Forestry, Fishing and Hunting [11]	3,196	2,456	423	5,814	3.42	34,600	2,232	15,502	2.14	-1.28	1,538	-918	109
Mining and Oil and Gas Extraction [21]	6,117	4,701	187	25,084	1.52	16,600	539	30,798	0.52	-1.00	1,602	-3,098	367
Utilities [22]	4,166	3,202	133	24,072	1.08	38,100	1,168	32,620	1.12	0.04	3,332	131	-15
Construction [23]	3,681	2,829	953	2,969	7.72	35,000	10,768	3,250	10.34	2.62	3,789	960	-114
Manufacturing [31-33]	16,630	12,780	2,297	5,564	18.61	148,800	16,484	9,027	15.82	-2.78	10,869	-1,911	226
Wholesale Trade [41]	3,371	2,590	581	4,455	4.71	56,600	4,600	12,304	4.42	-0.29	2,429	-161	19
Retail Trade [44-45]	3,907	3,002	1,922	1,562	15.57	35,800	16,269	2,201	15.62	0.05	3,011	9	-1
Transportation and Warehousing [48-49]	7,128	5,477	809	6,767	6.56	55,800	5,844	9,548	5.61	-0.95	4,687	-790	94
Information and Cultural Industries [51]	6,565	5,045	377	13,379	3.05	70,800	3,463	20,445	3.32	0.27	5,491	446	-53
Finance and Insurance [52]	14,464	11,115	678	16,389	5.49	91,800	6,940	13,228	6.66	1.17	13,480	2,365	-280
Real Estate and Rental and Leasing [53]	8,414	6,466	277	23,368	2.24	73,400	3,029	24,232	2.91	0.67	8,389	1,923	-228
Professional, scientific and technical services [54]	3,253	2,500	1,010	2,475	8.18	79,000	8,386	9,420	8.05	-0.13	2,460	-40	5
Management of companies and enterprises [55]	140	108	3	41,438	0.02	26,600	35	760,000	0.03	0.01	172	64	-8
Administrative and support, waste management and remediatiation services [56]	927	712	628	1,135	5.08	25,600	5,687	4,501	5.46	0.38	765	53	-6
Arts, entertainment and recreation [71]	969	744	356	2,093	2.88	8,600	2,690	3,197	2.58	-0.30	667	-77	9
Accomodation and food services [72]	1,095	841	1,007	836	8.16	26,100	9,131	2,858	8.77	0.61	904	63	-7
Other services (except public admin) [81]	1,136	873	705	1,238	5.71	9,900	6,903	1,434	6.63	0.92	1,013	140	-17

Source:
Canadian data from CANSIM II Table 310002, series v1070281,v1070473,v1071273,v1071401,v1071433,v1075337,v1075657,v1076073,v1076457,v1076617,v1076809,v1077097,v1077417,v1077449,v1077961,v1078089,v1078185.
United States data from BEA Fixed Asset Table 3.7.E Historical Cost Private Investment in Equipment and Software by Industry
Exchange rate from Statistics Canada, CANSIM II Table 16-0049 V37694.
Notes:
Here the business sector is defined to be all sectors excluding sector [61] 'Eduational services' and sector [62] 'Health care and social assistance'.
All business sector values are the summation of the sector value listed above.

Exchange rate used 0.71377 US dollars per Canadian dollar

Appendix Table 10: Summary of Results for Simulation Scenarios of M&E, ICT, and non-ICT M&E Investment in the Business Sector in Canada Weighted by U.S. Industry Employment Shares, current U.S. dollars, 2004

		Canada		United States	Proportion of Actual Canadian Values to U.S. Values	Proportion of Simulated Canadian Values to U.S. Values
		Actual	Simulated			
		A	B	C	(A ÷ C) x 100	(B ÷ C) x 100
D	Total M&E Investment (millions)	65,442	64,598	833,100	7.86	7.75
E	ICT Investment (millions)	19,346	20,294	346,986	5.58	5.85
F	Non-ICT M&E Investment (millions)	46,095	44,304	486,114	9.48	9.11
G	Employment (thousands)	12,345	12,345	104,168	11.85	11.85
H	GDP (millions)	771,440	771,440	8,137,300	9.48	9.48
		((D or E or F) x 1,000) ÷ G				
	Total M&E Investment per Worker	5,301	5,233	7,998	**66.3**	**65.4**
	ICT Investment per Worker	1,567	1,644	3,331	**47.0**	**49.4**
	Non-ICT M&E Investment per Worker	3,734	3,589	4,667	**80.0**	**76.9**
		(D or E or F) ÷ H				
	Proportion of Total M&E Investment to GDP	8.48	8.37	10.24	**82.9**	**81.8**
	Proportion of ICT Investment to GDP	2.51	2.63	4.26	**58.8**	**61.7**
	Proportion of non-ICT M&E Investment to GDP	5.98	5.74	5.97	**100.0**	**96.1**

Source: CSLS database of ICT investment and capital stock trends.

Note: The business sector GDP value utilized for Canada is that reported by Statistics Canada, which naturally excludes most of the GDP of the educational services and healthcare and social assistance industries as these industries are largely comprised of public and not private sector. Additionally, current dollar values for Canada for 2004 only exists for the business sector as a whole and not for individual industries. The business sector GDP value utilized for the United States is that reported by the Bureau of Economic Activity minus the GDP values for the educational services and healthcare and social assitance industries, for consistency.

Appendix Table 11: Simulation Scenario of non-ICT Machinery and Equipment Investment in the Business Sector, current dollars, 2004

	Canada, actual					United States, actual				Scenario			
	Non-ICT M&E investment, millions of CAD	**Non-ICT M&E investment, millions of US**	**Employment, thousands**	**Non-ICT M&E investment per worker, US**	**Employment weight relative to business sector total, percent**	**Non-ICT M&E investment, millions of USD**	**Employment, thousands**	**Non-ICT M&E investment per worker, USD**	**Employment weight relative to business sector total, percent**	**Difference Between U.S. and Canadian Industry Employment Weights Relative to Business Sector**	**Total non-ICT M&E Investment Weighted by U.S.-Canada Industry Employment Shares, millions of US**	**Difference Between non-ICT M&E Investment Weighted by U.S.-Canada Industry Employment Shares and Actual non-ICT M&E Investment, millions of US**	**Relative Contribution to Decrease in M&E Investment when Weighted by U.S. Industry Employment Shares**
	A	B	C	D = (B*1,000/C)	E = (C/12,133)*100	F	G	H = (F*1,000/G)	I = (G/103,234)*100	J = I - E	K = B x (I ÷ E)	L = K - B	M = (L ÷ (-1,414)) x 100
Business Sector Total (sum of all industries below)	59,983	46,095	12,345	3,734	100.00	486,114	104,168	4,667	100.00	-	44,304	-1,791	100
Agriculture, Forestry, Fishing and Hunting [11]	3,065	2,355	423	5,575	3.42	33,856	2,232	15,168	2.14	-1.28	1,475	-881	49.17
Mining and Oil and Gas Extraction [21]	5,964	4,583	187	24,457	1.52	14,384	539	26,686	0.52	-1.00	1,562	-3,021	168.65
Utilities [22]	2,720	2,090	133	15,718	1.08	28,263	1,168	24,198	1.12	0.04	2,176	85	-4.76
Construction [23]	3,415	2,625	953	2,755	7.72	26,776	10,768	2,487	10.34	2.62	3,515	891	-49.73
Manufacturing [31-33]	14,266	10,963	2,297	4,773	18.61	103,986	16,484	6,308	15.82	-2.78	9,324	-1,639	91.50
Wholesale Trade [41]	1,176	904	581	1,555	4.71	39,106	4,600	8,501	4.42	-0.29	848	-56	3.14
Retail Trade [44-45]	2,485	1,910	1,922	994	15.57	23,863	16,269	1,467	15.62	0.05	1,916	6	-0.33
Transportation and Warehousing [48-49]	5,402	4,151	809	5,129	6.56	28,705	5,844	4,912	5.61	-0.95	3,552	-599	33.44
Information and Cultural Industries [51]	557	428	377	1,135	3.05	10,701	3,463	3,090	3.32	0.27	466	38	-2.11
Finance and Insurance [52]	10,895	8,373	678	12,346	5.49	49,990	6,940	7,203	6.66	1.17	10,154	1,781	-99.44
Real Estate and Rental and Leasing [53]	6,530	5,018	277	18,136	2.24	55,457	3,029	18,309	2.91	0.67	6,510	1,492	-83.30
Professional, scientific and technical services [54]	963	740	1,010	733	8.18	14,736	8,386	1,757	8.05	-0.13	728	-12	0.66
Management of companies and enterprises [55]	22	17	3	6,360	0.02	7,146	35	204,171	0.03	0.01	26	10	-0.55
Administrative and support, waste management and remediatiation services [56]	458	352	628	561	5.08	12,528	5,687	2,203	5.46	0.38	378	26	-1.46
Arts, entertainment and recreation [71]	510	392	356	1,101	2.88	7,215	2,690	2,682	2.58	-0.30	351	-41	2.26
Accomodation and food services [72]	966	742	1,007	737	8.16	22,875	9,131	2,505	8.77	0.61	798	56	-3.10
Other services (except public admin) [81]	588	452	705	641	5.71	6,527	6,903	946	6.63	0.92	524	72	-4.04

Source:
Canada and United States data calculated from Tables 1 and 2
Exchange rate from Statistics Canada, CANSIM II Table 16-0049 V37694.

Notes:
Here the business sector is defined to be all sectors excluding sector [61] 'Eduational services' and sector [62] 'Health care and social assistance'.
All business sector values are the summation of the sector value listed above.

Exchange rate used 0.71377 US dollars per Canadian dollar