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CENTRE FOR  
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## THE CANADA-U.S. ICT INVESTMENT GAP IN 2010: THE WIDENING CONTINUES

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# The Canada-U.S. ICT Investment Gap in 2010: The Widening Continues

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# The Canada-U.S. ICT Investment Gap in 2010: The Widening Continues

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## Executive Summary

This report examines trends and developments in information and communications technology (ICT) investment in Canada and the United States up to 2010, based on the update of the Centre for the Study of Living Standards Information and Communication Technology database. The paper focuses on nominal and real ICT investment growth in the business sector and the effect of these indicators on the Canada-U.S. ICT investment gap. The key findings are highlighted below.

- Nominal ICT investment growth in Canada in 2010 was 3.1 per cent, well below the 7.1 per cent rise in the United States. All three ICT investment components experienced slower growth in Canada. This weaker ICT investment performance occurred despite the fact that total nominal investment growth in Canada was stronger than in the United States (4.4 per cent versus 3.2 per cent).
- After a year of increasing ICT prices in Canada in 2009, ICT prices decreased once more in 2010 due to an appreciation of the Canadian dollar (up 10.8 per cent). ICT prices for all three ICT components (in both countries) decreased in 2010, with Canada's prices falling faster than those in the United States (in aggregate, 6.7 per cent versus 2.3 per cent).
- Real ICT investment growth was greater in Canada (10.5 per cent) than in the United States (9.6 per cent) in 2010. This performance reversal under 'real' valuations is due to the greater decline in ICT prices experienced in Canada in 2010.
- In 2010, business sector employment continued to contract in the United States, falling 1.2 per cent. In contrast, employment increased 0.7 per cent in Canada. For this reason, the United States performed considerably better on 'per worker' indicators whereas Canada performed relatively better on aggregate indicators.
- Nominal business sector GDP increased 6.3 per cent in Canada but only 5.2 per cent in the United States in 2010, in contrast to the higher rate of nominal business sector ICT investment in the United States. As such, nominal ICT investment growth outpaced nominal GDP growth in the United States in 2010, resulting in an increase in the ICT share of business sector GDP. In Canada, the ICT investment share in business sector GDP decreased because nominal GDP growth exceeded nominal ICT investment.

- Nominal business sector ICT investment growth in Canada was outperformed by overall investment growth in 2010. Therefore, the ICT investment share in total investment decreased. The opposite occurred in the United States. This effect led directly to the widening of the Canada-U.S. ICT investment gap as a share of total investment.
- In 2010, nominal ICT investment per worker in Canada was 53.0 per cent of that in the United States, a gap of 47.0 percentage points. This represented a 0.5 percentage points increase in the gap from 2009.
- Three factors determine trends in the Canada-U.S. nominal ICT investment per worker gap: the relative ICT investment growth ratio, changes in the machinery and equipment purchasing power parity (PPP), and relative business sector employment growth. The most important factor leading to the widening of the gap in 2010 was the considerably slower nominal ICT investment growth in Canada compared to that of the United States (3.1 per cent versus 7.1 per cent). The stronger employment growth in Canada (1.2 per cent versus 0.7 per cent) also contributed somewhat. In contrast, the 4 per cent appreciation of the PPP for machinery and equipment from 0.83 U.S. to 0.87 U.S. increased the quantity of Canadian ICT investment, expressed in U.S. dollars, and offset much of the widening from the other two sources.
- The sensitivity of the results to whether the gap is expressed in nominal or real terms is minimal.

# The Canada-U.S. ICT Investment Gap in 2010: The Widening Continues

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This report examines key developments in business sector ICT investment in Canada and the United States in 2010, with particular attention to trends in the ICT investment per worker gap between the two countries.<sup>1</sup> Canada has historically had a large gap in the level of ICT investment per worker relative to the United States. This situation is often seen as a factor explaining both our lower labour productivity level and weaker labour productivity growth. It is consequently important to monitor (and explain) developments in this gap as part of an overall analysis of Canada's productivity performance.

## I. Data

The data in this report are drawn from the recent update to 2010 of the Information and Communication Technology database for Canada and the United States, developed and maintained by the Centre for the Study of Living Standards (CSLS).<sup>2</sup> The database provides estimates of ICT investment and capital stock in nominal and real (chained 2002 dollars) terms. It provides data for total ICT investment/capital stock, as well as for the three ICT components (software, communications equipment, and computers) for Canada (1981-2010) and the United States (1987-2010). The estimates are broken down by 20 sectors of the North American Industry Classification System (NAICS). The database is based on information collected primarily from Statistics Canada's CANSIM tables and the Bureau of Economic Analysis's (BEA) fixed asset tables.

In 2011, the BEA changed the methodology used to calculate fixed assets and investment by industry and revised its series back to 1997 through a new benchmarking procedure (Bennett, Glenn, and Wasshausen, 2011: 27).<sup>3</sup> This change sometimes resulted in a dramatic shift in ICT investment and capital stock by industry.<sup>4</sup> Rates of ICT investment growth at the industry level prior to 1997 were not affected and business sector ICT investment estimates for all years remained unchanged.

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<sup>1</sup> For an analysis of ICT investment trends in Canada only in 2010, see Sharpe and Moeller (2011).

<sup>2</sup> The CSLS ICT database is freely accessible at <http://www.csls.ca/data/ict.asp>

<sup>3</sup> For more information concerning the change in US data, please see Bennett, Glenn, and Wasshausen (2011).

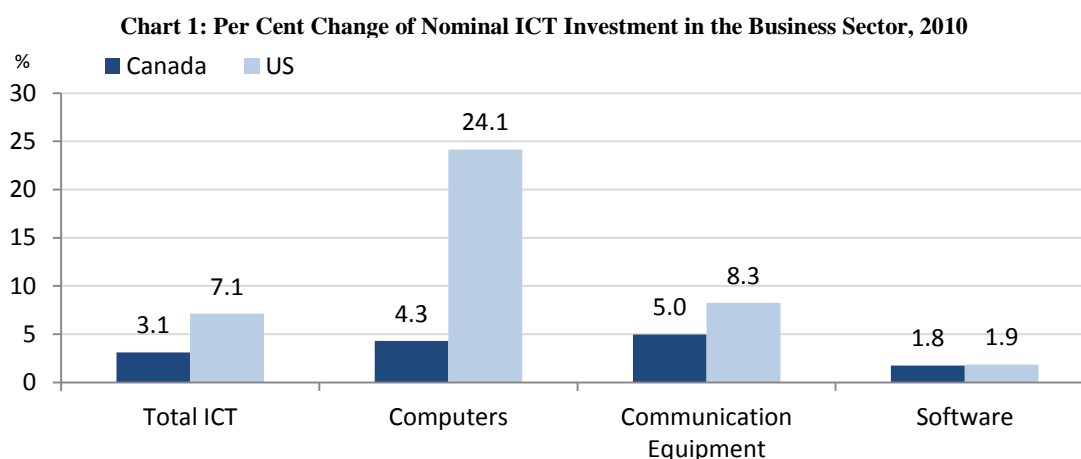
<sup>4</sup> For example, BEA detailed fixed assets tables previously estimated that total ICT investment in the mining sector was \$2,602 million in the United States in 2000. With the revision the new estimate was \$2,167 million.

## II. ICT Investment in Canada and the United States

### A. Nominal ICT Investment Growth

In 2010, business sector nominal ICT investment<sup>5</sup> growth was 3.1 per cent in Canada and 7.1 per cent in the United States (Chart 1, Table 1). In 2009, business sector nominal ICT investment fell 7.2 per cent in Canada and 5.7 per cent in the United States (Charts 2 and 3). Therefore, developments in 2010 represent a large resurgence in ICT investment in both countries, indicating recovery from the financial crisis.

Total nominal investment growth for the business sector in 2010 was 4.4 per cent in Canada versus 3.2 per cent in the United States. The superior total investment performance in Canada than in the United States lies in contrary to our weaker ICT investment growth.



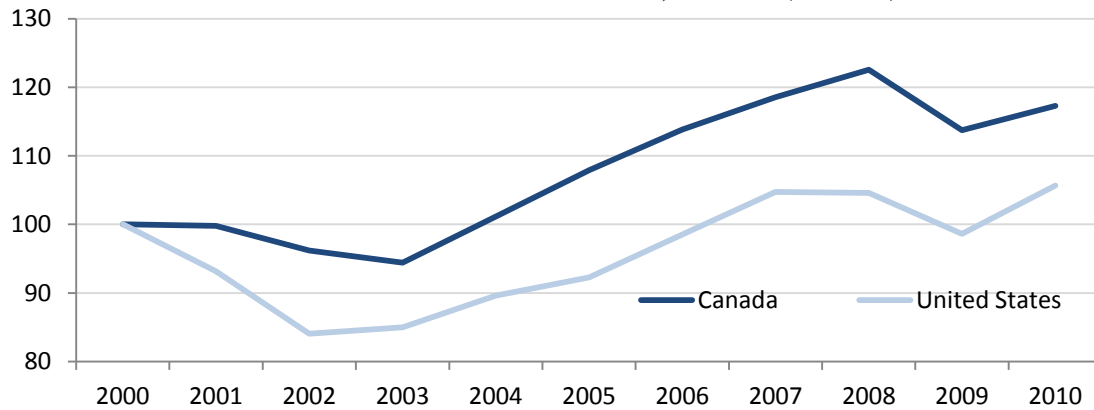
Source: CSLS ICT Database, Tables 1 to 4 and 18 to 21.

The slower pace of ICT spending in Canada occurred across all three components of business sector ICT investment. Nominal investment growth in computers in the United States was 24.1 per cent while in Canada it was much lower, at 4.3 per cent. Communications equipment nominal investment growth was 8.3 per cent in the United States and 5.0 per cent in Canada. Finally, the software nominal investment growth rate was 1.9 per cent and 1.8 per cent, respectively.

Over the 2000-2010 period, Canada outperformed the United States in terms of nominal ICT investment growth (1.6 per cent per year versus 0.6 per cent), due to the fall in ICT investment in the United States from 2000 to 2005 (Charts 2 and 3). In the 2005-2010 period however, ICT investment in the United States rebounded and outperformed that of Canada: 2.8 per cent per year versus 1.7 per cent.

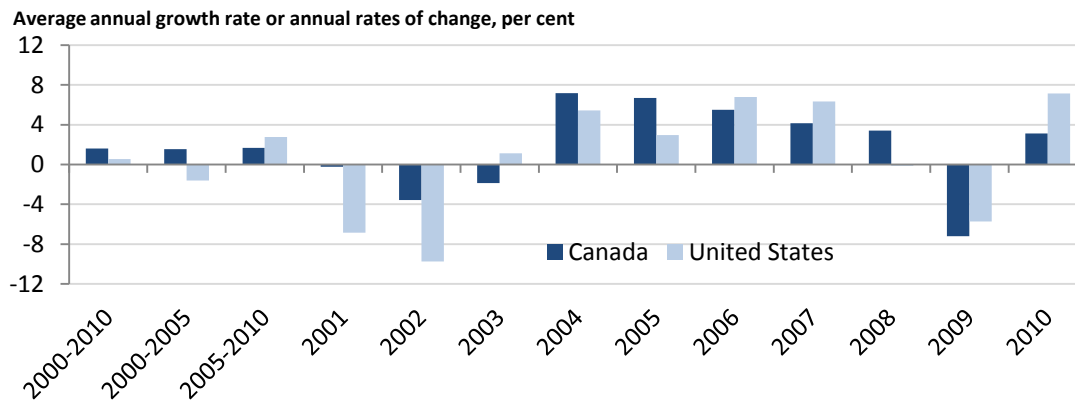
<sup>5</sup> In this paper, all references to aggregate 'investment' values are assumed to mean 'business sector fixed, non-residential, investment' unless otherwise noted.

**Chart 2: Nominal ICT Investment Levels, 2000-2010 (2000=100)**



Source: CSLS ICT Database, Summary Table S9

**Chart 3: Nominal ICT Investment Growth, 2000-2010**



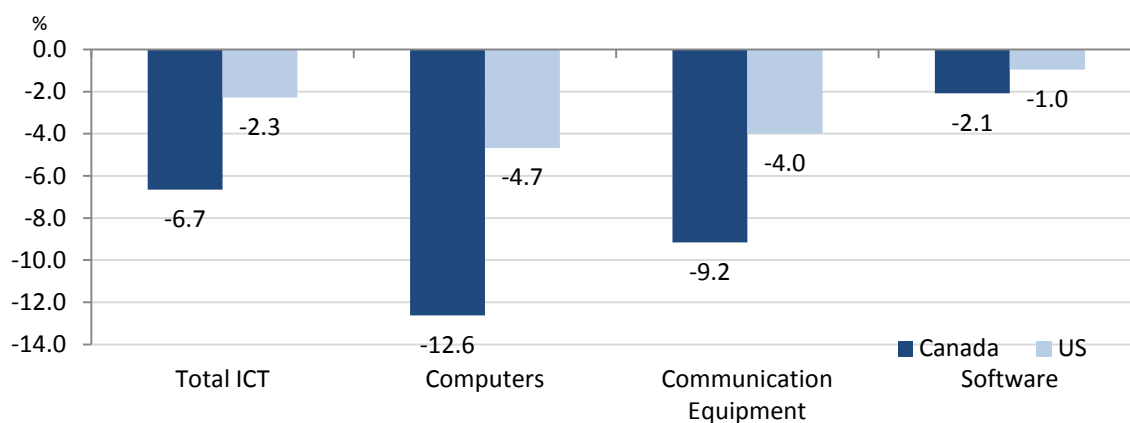
Source: CSLS ICT Database, Summary Table S9

## B. ICT Prices

In 2010, ICT investment prices decreased 6.7 per cent in Canada and 2.3 per cent in the United States (Chart 4). This development occurred after ICT prices increased 3.7 per cent in Canada and decreased 3.3 per cent in the United States in 2009 (Chart 5). This represents a return to the trend for Canada, which had a history of falling ICT prices prior to 2009 (Sharpe and De Avillez, 2010: 6).

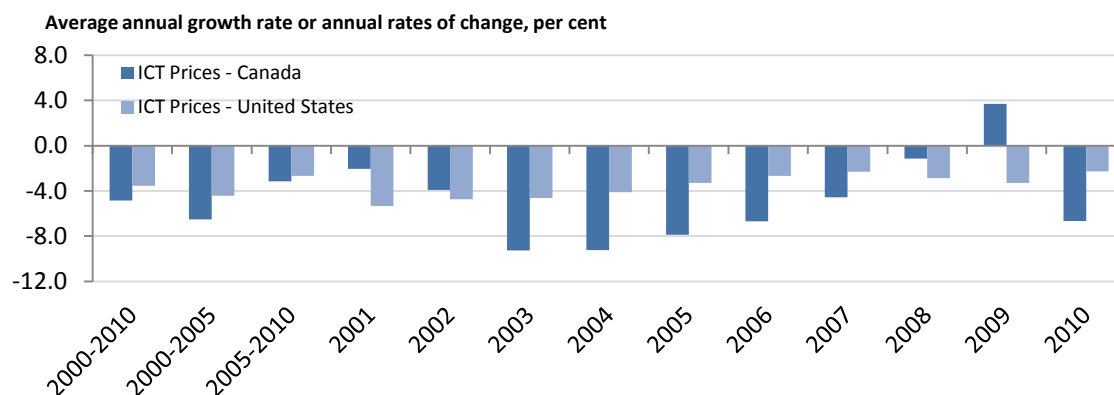
Prices fell in Canada in 2010 at a greater rate than in the United States for all three ICT investment components (Charts 6, 7, 8). In computers, Canadian prices fell 12.6 per cent while American prices fell 4.7 per cent. In communications equipment, Canadian prices fell 9.2 per cent while American prices fell 4.0 per cent. In software, the decline of 2.1 per cent in Canadian prices exceeded that of 1.0 per cent in the United States.

**Chart 4: Change in ICT Prices in 2010**



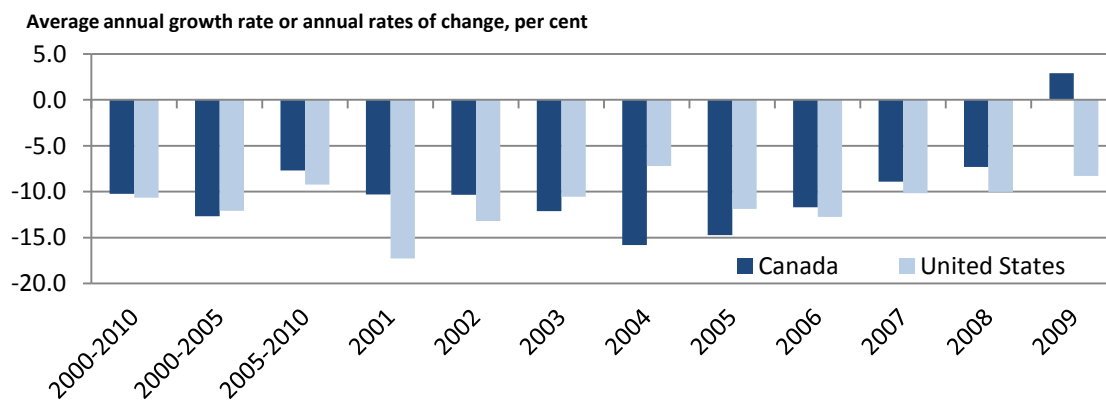
Source: CSLS ICT Database, Tables 17 and 34.

**Chart 5: Total ICT Prices Growth in Canada and the United States, 2000-2010**



Source: CSLS ICT Database, Tables 34v (US) and 17v (Canada)

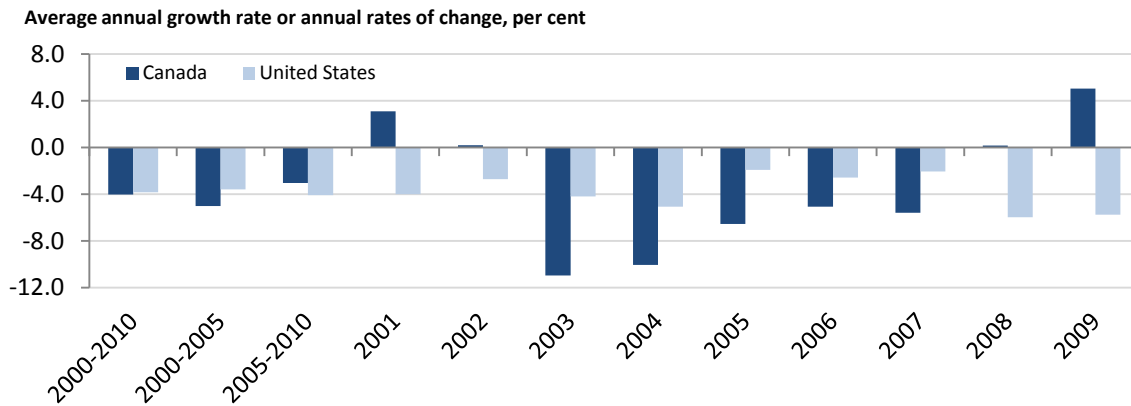
**Chart 6: Computer ICT Prices Growth in Canada and the United States, 2000-2010**



Source: CSLS ICT Database, Tables 34v (US) and 17v (Canada)

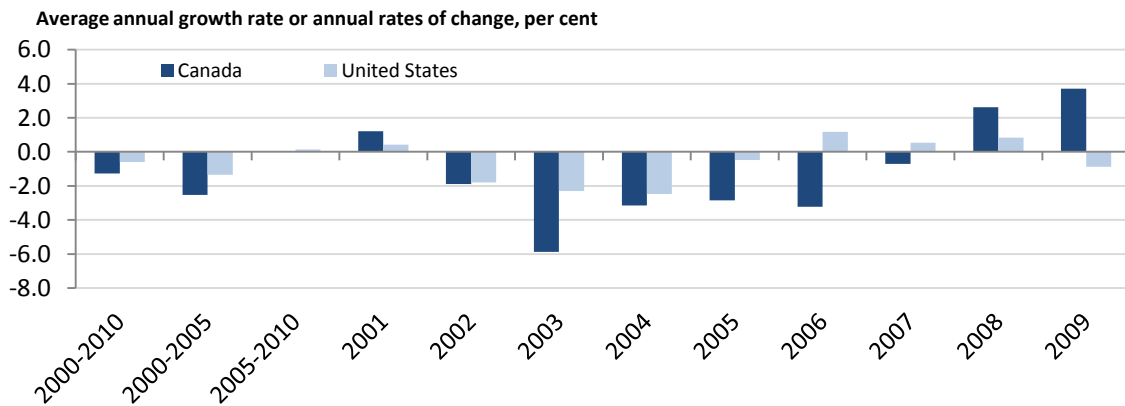


**Chart 7: Communications ICT Prices Growth in Canada and the United States, 2000-2010**



Source: CSLS ICT Database, Tables 34v (US) and 17v (Canada)

**Chart 8: Software ICT Prices Growth in Canada and the United States, 2000-2010**



Source: CSLS ICT Database, Tables 34v (US) and 17v (Canada)

Sharpe and De Avillez (2010: 7) note that the increase in Canadian prices in 2009 “can be at least partially explained by the weakening of the Canadian dollar in 2009, which depreciated 6.5 per cent...” In turn, the decrease in Canadian ICT prices in 2010 can be explained by the recent strengthening of the Canadian dollar, which appreciated 10.8 per cent that year.<sup>6</sup> Furthermore, Sharpe and De Avillez also note that the changing valuation of the Canadian dollar should have a smaller effect on software prices, given imports play a smaller role in the software market than in the market for the other two ICT components. This holds true, as the decline in ICT prices in 2010 was least significant for the software component.

<sup>6</sup> In general, the per cent appreciation of the Canadian dollar relative to the United States dollar is moderately negatively correlated (correlation coefficient = -0.58) with the per cent change in ICT prices in Canada for 1988-2010. It should be noted that correlation does not necessarily imply causation but rather indicates coincident movement.

## C. Real ICT Investment Growth

In general, falling ICT investment prices in Canada and the United States has led to relatively robust real ICT investment growth (Charts 9 and 10).<sup>7</sup> This trend continued into 2010, as Canada's real ICT investment growth of 10.5 per cent outpaced its nominal ICT investment growth of 3.1 per cent, reflecting the 6.7 per cent fall in ICT prices. Similarly, the real ICT investment growth of 9.6 per cent for the United States was larger than its nominal ICT investment growth of 7.1 per cent. The larger difference between Canada and the United States can be explained by ICT prices falling more rapidly in this country (-6.7 per cent versus -2.3 per cent) (Table 1).

**Table 1: Growth in ICT Investment in the Business Sector in Canada and the United States, 2000-2010**

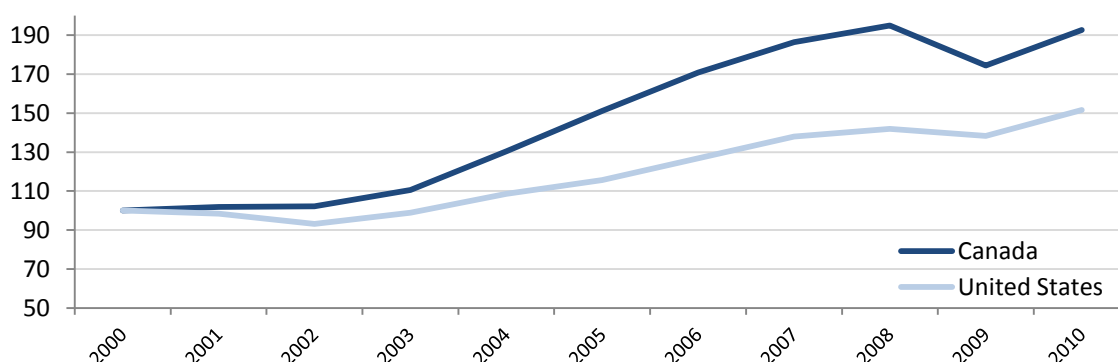
Canada					United States			
	Total	Computers	Communication Equipment	Software	Total	Computers	Communication Equipment	Software
Nominal ICT investment growth, domestic currencies (annual or average annual, %)								
2009	-7.2	-13.2	-3.2	-5.0	-5.7	-11.0	-12.8	-1.6
2010	3.1	4.3	5.0	1.8	7.1	24.1	8.3	1.9
2000-2010	1.6	0.1	-2.2	4.8	0.6	-1.1	-3.8	3.4
2005-2010	1.7	-1.3	0.6	4.1	2.8	3.5	0.1	3.4
Nominal ICT investment per worker growth, domestic currencies (annual or average annual, %)								
2009	-4.8	-10.9	-0.6	-2.5	0.0	-5.7	-7.6	4.4
2010	2.4	3.6	4.2	1.0	8.4	25.7	9.6	3.1
2000-2010	0.5	-0.9	-3.3	3.7	1.2	-0.5	-3.2	4.1
2005-2010	1.1	-1.8	0.0	3.6	4.0	4.8	1.4	4.7
Growth in ICT prices (annual or average annual, %)								
2009	3.7	2.9	5.1	3.7	-3.3	-8.3	-5.7	-0.9
2010	-6.7	-12.6	-9.2	-2.1	-2.3	-4.7	-4.0	-1.0
2000-2010	-4.8	-10.2	-4.0	-1.3	-3.6	-10.7	-3.8	-0.6
2005-2010	-3.1	-7.7	-3.0	0.0	-2.7	-9.2	-4.1	0.1
Real ICT investment growth, domestic currencies (annual or average annual, %)								
2009	-10.5	-15.7	-7.8	-8.4	-2.5	-3.0	-7.5	-0.7
2010	10.5	19.4	15.5	3.9	9.6	30.2	12.7	2.8
2000-2010	6.8	11.6	1.9	6.1	4.3	10.7	0.0	4.0
2005-2010	5.0	7.0	3.7	4.1	5.6	14.0	4.4	3.3
Real ICT investment per worker growth, domestic currencies (annual or average annual, %)								
2009	-8.2	-13.4	-5.4	-6.0	3.4	2.9	-1.9	5.3
2010	9.7	18.5	14.7	3.2	11.0	31.8	14.1	4.1
2000-2010	5.6	10.3	0.8	5.0	4.9	11.4	0.7	4.7
2005-2010	4.4	6.3	3.1	3.5	6.9	15.4	5.7	4.5
United States Dollar per Canadian Dollar								
Exchange rate appreciation (annual or average annual, %)								
2009					-6.5			
2010					10.8			
2000-2010					3.3			
2005-2010					3.7			
Canada					United States			
Business Sector Employment (annual or average annual, %)								
2009					-5.7			
2010					-1.2			
2000-2010					-0.6			
2005-2010					-1.2			

Source: CSLS ICT Database, Summary Tables

<sup>7</sup> The exception was in Canada when ICT prices rose (Sharpe and De Avillez, 2010: 8).

ICT growth was greater in Canada in 2010 than in the United States for real communications investment (15.5 per cent versus 12.7 per cent) and software investment (3.9 per cent versus 2.8 per cent). However, computer investment growth has much stronger in the United States: 30.2 per cent versus 19.4 per cent (Chart 11).

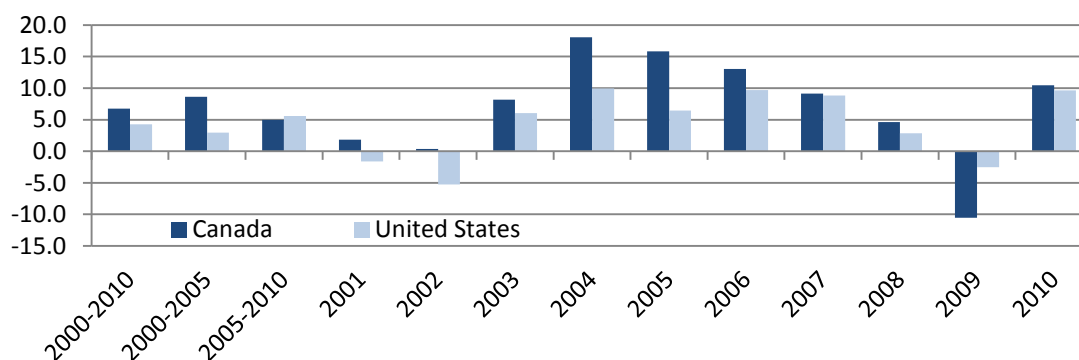
**Chart 9: Real ICT Investment for Canada and the United States (Chained 2002 \$, 2000-2010, 2000=100)**



Source: CSLS ICT Database, Tables 22v (US) and 5v (Canada)

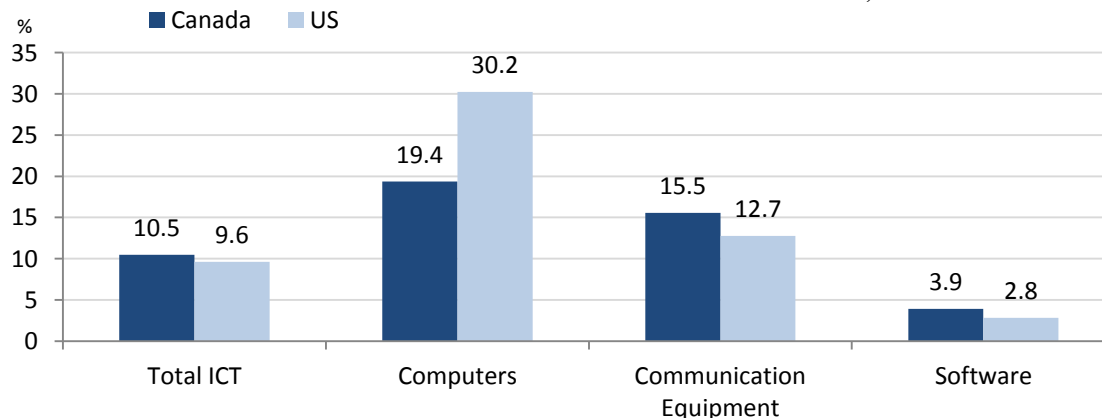
**Chart 10: Real ICT Investment Growth for Canada and the United States, 2000-2010**

Average annual growth rate or annual rates of change, per cent



Source: CSLS ICT Database, Tables 22v (US) and 5v (Canada)

**Chart 11: Growth of Real ICT Investment in the Business Sector, 2010**

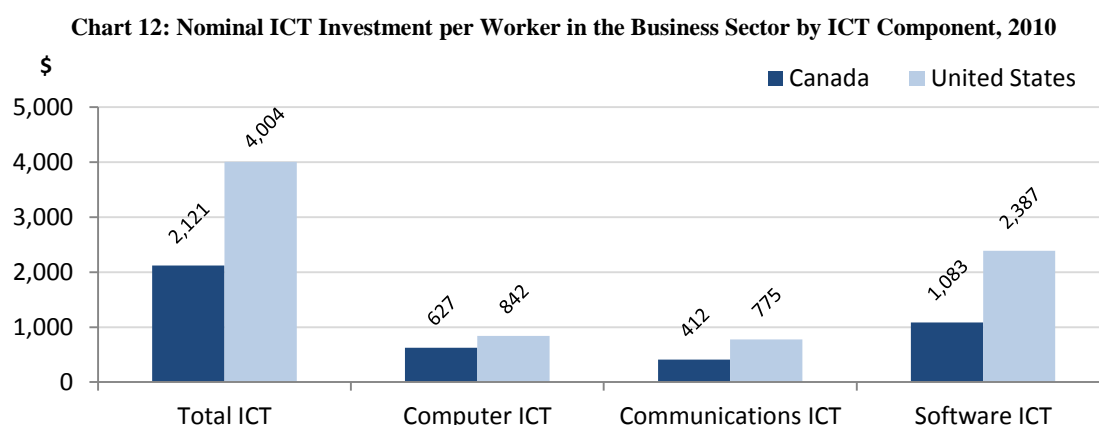


Source: CSLS ICT Database, Tables 5 to 8, and 22 to 25.

## D. Nominal ICT Investment per Worker

In 2010, nominal ICT investment per worker was \$2,121 in Canada compared to \$4,004 in the United States (Chart 12). Thus ICT investment intensity in Canada was only 53.0 per cent that of the United States. The largest component of ICT investment per worker in 2010 in both countries was software: \$1,083 in Canada and \$2,387 in the United States. Computer investment per worker was \$627 in Canada and \$842 in the United States. Communications equipment was the least important component of ICT investment per worker in both countries: \$412 in Canada and \$775 in the United States.

Business sector employment in Canada increased 0.7 per cent in 2010, compared to a fall of 1.2 per cent in the United States (Table 1). For this reason, nominal ICT investment per worker growth was lower than ICT investment growth in Canada, while the opposite was true in the United States. These employment trends resulted in a larger gap in nominal ICT investment per worker growth between the two countries (8.4 per cent in the United States versus 2.4 per cent in Canada) compared to nominal ICT investment (7.1 per cent versus 3.1 per cent)

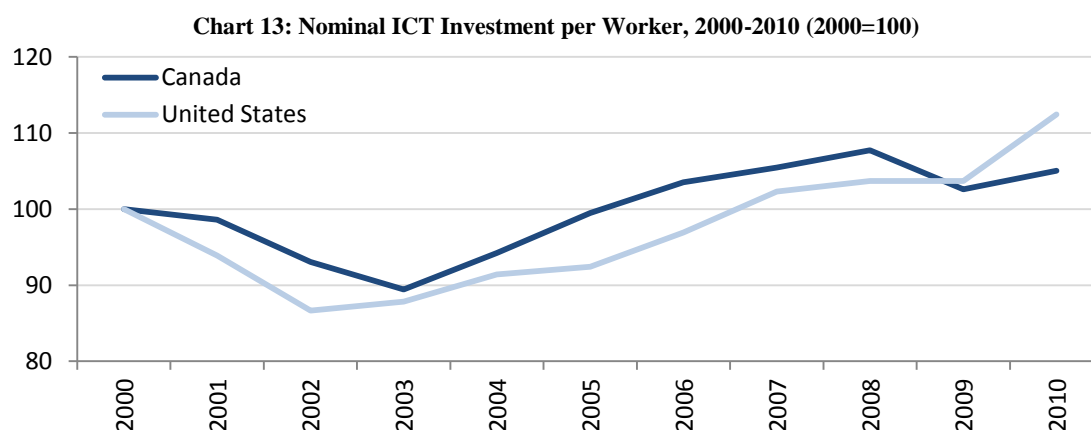


Source: CSLS ICT Database Summary Tables 1-4

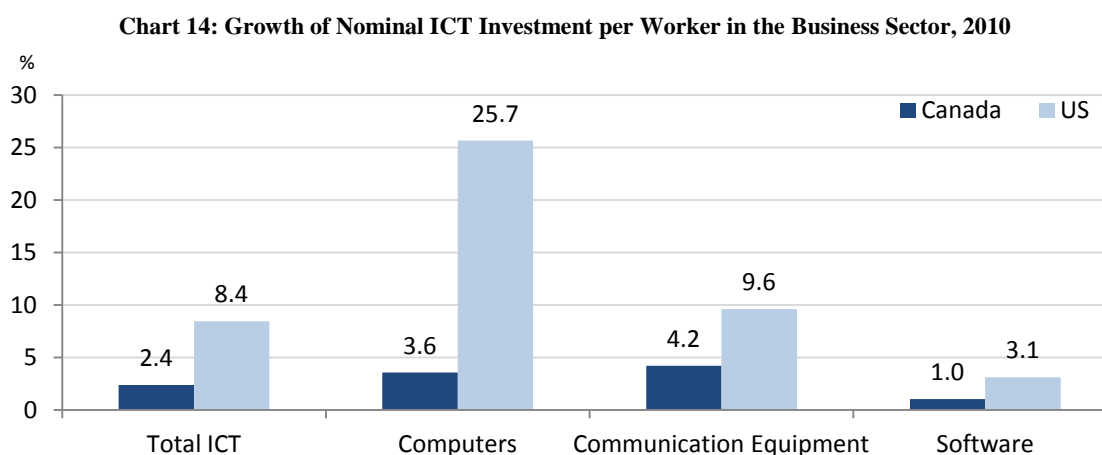
The United States also outperformed Canada in terms of nominal ICT investment per worker growth over the 2000-2010 period: 1.2 per cent per year versus 0.5 per cent (Charts 13 and 14). As nominal ICT investment growth was stronger in Canada over the period, this situation is explained by the worse employment performance in the United States: -0.6 per cent per year versus 1.1 per cent

As noted earlier, the United States outperformed Canada in all three components of nominal ICT investment growth in 2010. Due to the divergent paths of business sector employment growth, this lead widened when adjusted per worker (Chart 13 and Table 1). Computer investment per worker in the United States grew 25.7 per cent versus 3.6 per cent in Canada. Communications investment per worker advanced 9.6 per cent in the United States and

only 4.2 per cent in Canada. Finally, software investment per worker growth was 3.1 per cent in the United States and 1.0 per cent in Canada.



Source: CSLS ICT Database, Summary Table S1



Source: CSLS ICT Database, Tables 9 to 12, and 26 to 29.

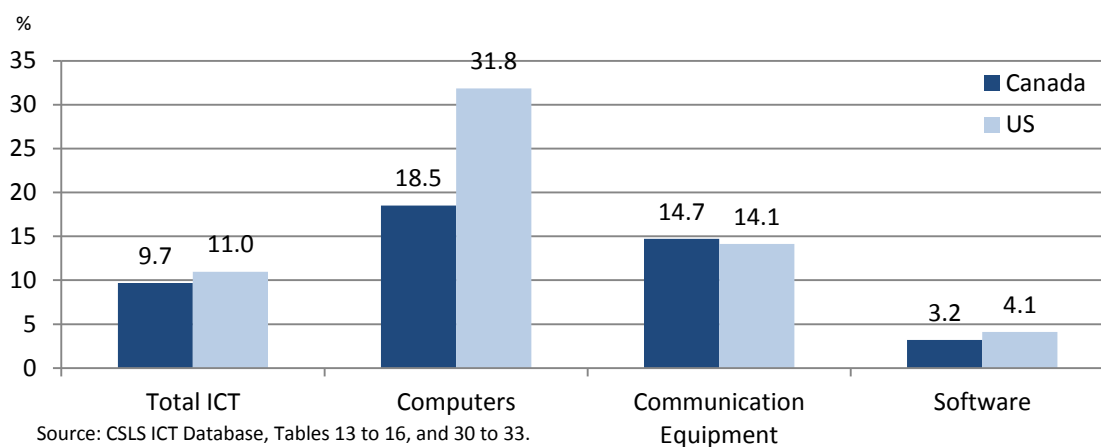
## E. Real ICT Investment per Worker

Real ICT investment per worker growth is a direct consequence of real ICT investment growth and business sector employment growth. As noted in section C, real ICT investment grew at a rate of 10.5 per cent in Canada and 9.6 per cent in the United States in 2010 (Table 1). This was largely due to ICT prices falling in Canada at almost three times the rate seen in the United States (-6.7 per cent compared to -2.3 per cent). In 2010, business sector employment growth in Canada (0.7 per cent) also outpaced that seen in the United States (-1.2 per cent). These have opposite effects; therefore, real ICT investment per worker growth in Canada should be less than real ICT investment growth, and the opposite holds for the United States. Indeed, the real ICT investment per worker grew 9.7 per cent in Canada and 11.0 per cent in the United States in 2010 (Chart 15 and Table 1). Despite Canada's lead in terms of real ICT investment growth, the United States outperforms Canada when the figures are adjusted on a per worker basis.

The above result is also obtained for two of the three ICT components in 2010. For real computer investment per worker, the United States advanced 31.8 per cent compared to 18.5 per cent in Canada. Similarly, in software, the United States had a growth rate of 4.1 per cent while Canada had a growth rate of 3.2 per cent. On the other hand, in communications it was Canada, with a growth rate of 14.7 per cent, which led the United States, which had a growth rate of 14.1 per cent.

Interestingly, Canada experienced greater growth in real ICT investment per worker than the United States over the 2000-2010 period: 5.6 per cent per year versus 4.9 per cent per annum (Table 1). This can be explained by Canada's 6.8 per cent per year growth of real ICT investment compared to the 4.3 per cent in the United States, which, in turn, was caused by significantly faster contraction of ICT prices in Canada than in the United States over the same period. For these reasons, Canada also led in long-run (2000-2010) growth in two of the three ICT components: communications (0.8 per cent versus 0.7 per cent) and software (5.0 per cent versus 4.7 per cent). Real computer investment per worker growth was stronger in the United States (11.4 per cent versus 10.3 per cent).

**Chart 15: Growth of Real ICT Investment per Worker in the Business Sector, 2010**



## F. ICT Investment Shares in Nominal Business Sector GDP

In 2010, the recovery of nominal business sector GDP from the recession in Canada outpaced that seen in the United States: 6.3 per cent versus 5.2 per cent. Nominal ICT investment, on the other hand, increased 3.1 per cent in Canada and 7.1 per cent in the United States, partially due to the effect of rapidly decreasing ICT prices in Canada (Table 1). As a result, the ICT investment share in nominal business sector GDP increased in the United States but decreased in Canada due to the relative growth rates of the two variables (Table 2). In Canada, the share fell from 2.52 per cent in 2009 to 2.45 per cent in 2010. In the United States, this share increased from 3.91 to 3.98 per cent.

## G. ICT Investment Shares in Total Nominal Investment

ICT investment shares in total nominal investment (business sector fixed, non-residential investment) succinctly describe the evolving importance of ICT investment in the overall investment decision of firms. As noted previously in section A, ICT investment did not fall as rapidly as overall investment in both countries through the recession in 2009. Furthermore, although Canadian aggregate investment growth exceeded that of the United States in 2010, Canadian ICT investment growth was weaker and even failed to surpass aggregate Canadian investment growth. For this reason, the Canadian ICT investment share decreased from 17.58 per cent in 2009 to 17.36 per cent in 2010, while the American ICT investment share increased from 30.16 to 31.32 per cent (Table 2).

**Table 2: Current Dollar ICT Investment Shares in the Business Sector in Canada and the United States, 2000-2010**

	Canada				United States			
	Total	Computers	Communication Equipment	Software	Total	Computers	Communication Equipment	Software
<b>ICT investment as a share of GDP (level and percentage point change)</b>								
<b>2000</b>	3.16	1.08	0.90	1.18	5.31	1.32	1.60	2.39
<b>2008</b>	2.59	0.81	0.47	1.31	3.97	0.76	0.82	2.38
<b>2009</b>	2.52	0.74	0.48	1.31	3.91	0.71	0.75	2.45
<b>2010</b>	2.45	0.72	0.48	1.25	3.98	0.84	0.77	2.37
<b>Δ 2000-2010</b>	-0.71	-0.36	-0.42	0.07	-1.33	-0.48	-0.83	-0.02
<b>Δ 2009</b>	-0.06	-0.07	0.01	0.00	-0.06	-0.05	-0.07	0.06
<b>Δ 2010</b>	-0.07	-0.01	-0.01	-0.06	0.07	0.13	0.02	-0.08
<b>ICT investment as a share of total investment (level and percentage point change)</b>								
<b>2000</b>	20.08	6.85	5.71	7.51	32.62	8.10	9.82	14.70
<b>2008</b>	15.85	4.95	2.90	8.00	26.04	5.01	5.40	15.64
<b>2009</b>	17.58	5.13	3.35	9.09	30.16	5.47	5.78	18.91
<b>2010</b>	17.36	5.13	3.37	8.86	31.32	6.59	6.07	18.67
<b>Δ 2000-2010</b>	-2.72	-1.72	-2.34	1.35	-1.30	-1.51	-3.75	3.97
<b>Δ 2009</b>	1.72	0.18	0.46	1.09	4.11	0.46	0.38	3.27
<b>Δ 2010</b>	-0.22	0.00	0.02	-0.23	1.16	1.11	0.29	-0.24
<b>ICT component share of total ICT investment (level and percentage point change)</b>								
<b>2000</b>	100.0	34.1	28.5	37.4	100.0	24.8	30.1	45.1
<b>2008</b>	100.0	31.2	18.3	50.5	100.0	19.2	20.7	60.0
<b>2009</b>	100.0	29.2	19.1	51.7	100.0	18.1	19.2	62.7
<b>2010</b>	100.0	29.5	19.4	51.0	100.0	21.0	19.4	59.6
<b>Δ 2000-2010</b>	0.0	-4.6	-9.0	13.6	0.0	-3.8	-10.7	14.5
<b>Δ 2009</b>	0.0	-2.0	0.8	1.2	0.0	-1.1	-1.6	2.7
<b>Δ 2010</b>	0.0	0.3	0.3	-0.7	0.0	2.9	0.2	-3.1

Source: CSLS ICT Database, Summary Tables

## III. Canada-U.S. ICT Investment Gap

The Canada-U.S. ICT investment gap is considered a key factor behind the Canada-U.S. labour productivity gap. This paper details the trends and developments in the Canada-U.S. gap in ICT investment per worker, ICT investment as a share of nominal GDP, and ICT investment

as a share of total investment. We find that the gap for all three indicators increased in 2010 due to the relatively poor recovery of ICT investment in Canada compared to the United States.

### **A. Canada-U.S. Nominal ICT Investment per Worker Gap**

Three factors determine trends in the Canada-U.S. nominal ICT investment per worker gap: the relative ICT investment growth between the two countries (expressed as the ratio of Canadian ICT investment to U.S. investment), relative business sector employment growth (expressed as the ratio of Canadian employment to U.S. employment) and changes in the machinery and equipment (M&E) purchasing power parity (PPP). The annual PPP for M&E produced by Statistics Canada is applied to Canadian nominal ICT investment to obtain estimates expressed in U.S. dollars and hence comparable with the U.S. figures.

The Canada-U.S. nominal ICT investment per worker gap continued to widen in 2010, after a large increase in 2009. Canada's ICT investment per worker was 53.0 per cent that of the United States (Table 3), down 0.5 percentage points from 53.5 per cent in 2009. This continues the downward trend in the investment worker gap that began in 2006, when Canada's ICT investment per worker was 62.7 per cent of that of the United States (Charts 16, 17, 18, 19, and 20).

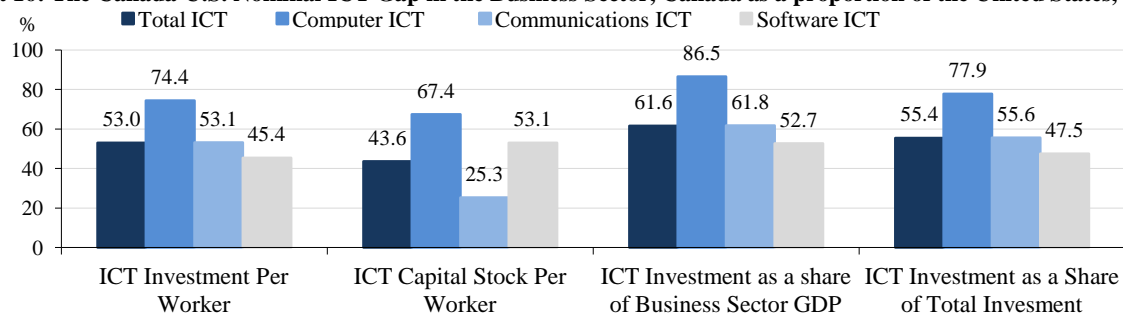
The widening of the ICT investment per worker gap in 2010 was driven by trends in the computer component of ICT investment. Nominal computer investment per worker in Canada in 2010 was 74.4 per cent of that in the United States, down from 86.1 per cent in 2009. There was little change in the investment per worker gap for communications equipment and the gap actually fell for software, although this ICT component had by far the largest absolute gap (45.4 per cent of the U.S. level in 2010).

The main factor driving the widening of the gap in 2009 was the 6.5 per cent fall in the Canada-U.S. PPP for M&E (Sharpe and De Avillez, 2010: 14). In 2010, in contrast, the PPP rose 5 per cent from \$0.83 U.S. to \$0.88 U.S., a development that should have closed the gap, everything else being equal.

The increase in the gap in 2010 is therefore explained by the much faster growth in nominal ICT investment per worker in the United States relative to Canada: 8.4 per cent versus 2.4 per cent.

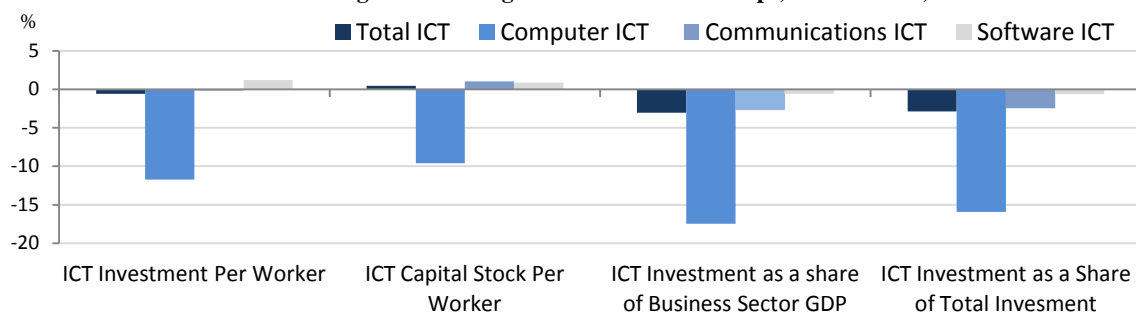


**Chart 16: The Canada-U.S. Nominal ICT Gap in the Business Sector, Canada as a proportion of the United States, 2010**



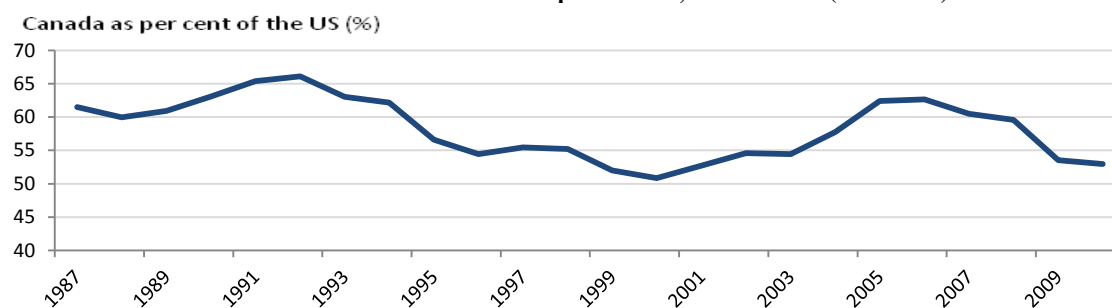
Source : CSLS ICT Database, Summary Tables S1 to S16.

**Chart 17: Percentage Point Change in ICT Investment Gaps, Canada-U.S., 2010**



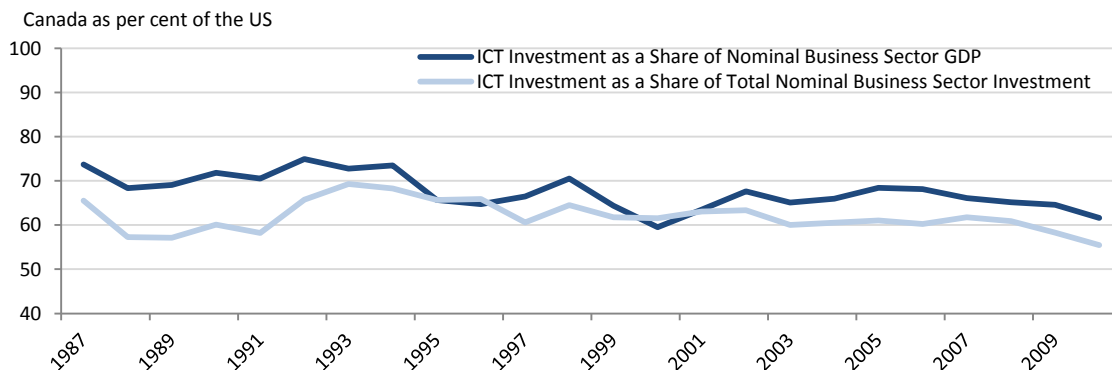
Source: CSLS ICT Database, Summary Tables S1-S16

**Chart 18: Nominal ICT Investment per Worker, Canada-U.S. (1987-2010)**

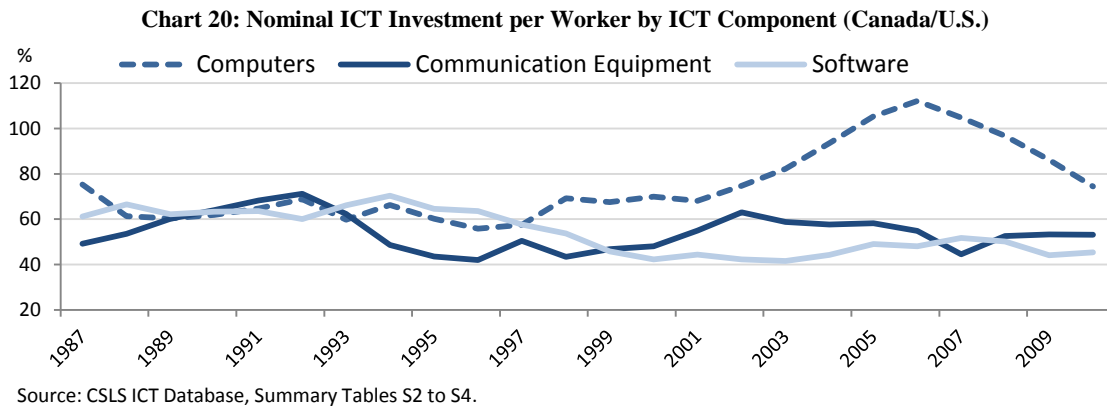


Source: CSLS ICT Database, Summary Table S1

**Chart 19: The Canada-United States ICT Investment Gap by Indicator (Canada/U.S.)**



Source: CSLS ICT Database, Summary Tables S9 and S13.



Appendix A develops a methodology to decompose changes in the Canada-U.S. nominal ICT per worker gap into three components: relative rates of growth of nominal ICT investment, relative rate of growth of employment, and changes in the PPP for ICT investment (proxied by the PPP for machinery and equipment). In addition it develops a methodology for estimating the contributions to the change in terms of their relative importance.

In 2010, the growth in the Canada-U.S. nominal ICT investment ratio contributed 36.5 per cent, the change in PPP contributed 45.0 per cent, and the growth in the Canada-U.S. business sector employment ratio contributed 18.5 per cent to the overall change in the Canada-U.S. nominal ICT investment per worker gap. Although the effect of PPP was largest and contributed to the narrowing of the ICT investment per worker gap, it was outweighed by the effect of the increasing business sector employment ratio and the decreasing nominal ICT investment ratio, which contributed to the widening of the gap. The net result was the slight (0.5 percentage point) expansion of the gap.

## B. Canada-U.S. Relative ICT Investment Intensity

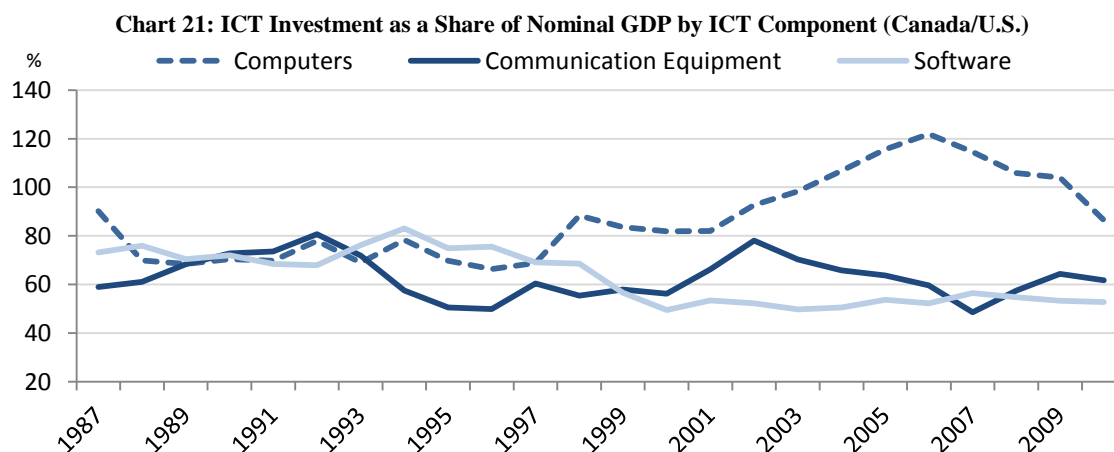
Unlike the Canada-U.S. comparisons of investment per worker, the calculation of relative ICT investment intensity requires only data on ICT investment and GDP. In 2010, nominal business sector GDP increased 6.3 per cent in Canada and 5.2 per cent in the United States. But ICT investment growth was much faster in Canada than the United States: 7.1 per cent versus 3.1 per cent. Consequently, ICT investment intensity increased in the United States from 3.91 per cent in 2009 to 3.98 per cent in 2010 while it fell in Canada from 2.52 per cent to 2.45 per cent (Chart 21 and Table 3).

These trends resulted in the widening of the ICT investment intensity gap between the two countries. Canada's intensity fell from 64.6 per cent of that of the United States in 2009 to 61.6 per cent in 2010; however, this gap remains a slight improvement from 59.5 per cent in 2000.

**Table 3: Canada-United States ICT Investment Gap in the Business Sector, 2000-2010**

<b>Canada</b>				
	Total	Computers	Communication Equipment	Software
<b>Nominal ICT investment per worker in Canada as a share of nominal ICT investment per worker in the United States (%)</b>				
	<b>PPP adjusted (%)</b>			
<b>2000</b>	50.8	69.9	48.0	42.2
<b>2008</b>	59.6	96.7	52.6	50.1
<b>2009</b>	53.5	86.1	53.3	44.2
<b>2010</b>	53.0	74.4	53.1	45.4
<b>Percentage points change</b>				
Δ 2009	-6.1	-10.6	0.7	-6.0
Δ 2010	-0.6	-11.7	-0.2	1.2
<b>ICT investment as a share of nominal GDP in Canada as a proportion of that of the United States (%)</b>				
<b>2000</b>	59.5	81.8	56.3	49.5
<b>2008</b>	65.2	105.8	57.5	54.8
<b>2009</b>	64.6	104.0	64.3	53.3
<b>2010</b>	61.6	86.5	61.8	52.7
<b>Percentage point change</b>				
Δ 2009	-0.6	-1.8	6.8	-1.5
Δ 2010	-3.0	-17.5	-2.6	-0.6
<b>ICT investment as a share of nominal total investment in Canada as a proportion of that of the United States (%)</b>				
<b>2000</b>	61.6	84.6	58.2	51.1
<b>2008</b>	60.9	98.8	53.7	51.2
<b>2009</b>	58.3	93.8	58.0	48.1
<b>2010</b>	55.4	77.9	55.6	47.5
<b>Percentage points change</b>				
Δ 2009	-2.6	-5.0	4.3	-3.1
Δ 2010	-2.9	-15.9	-2.4	-0.6

Source: CSLS ICT Database, Summary Tables

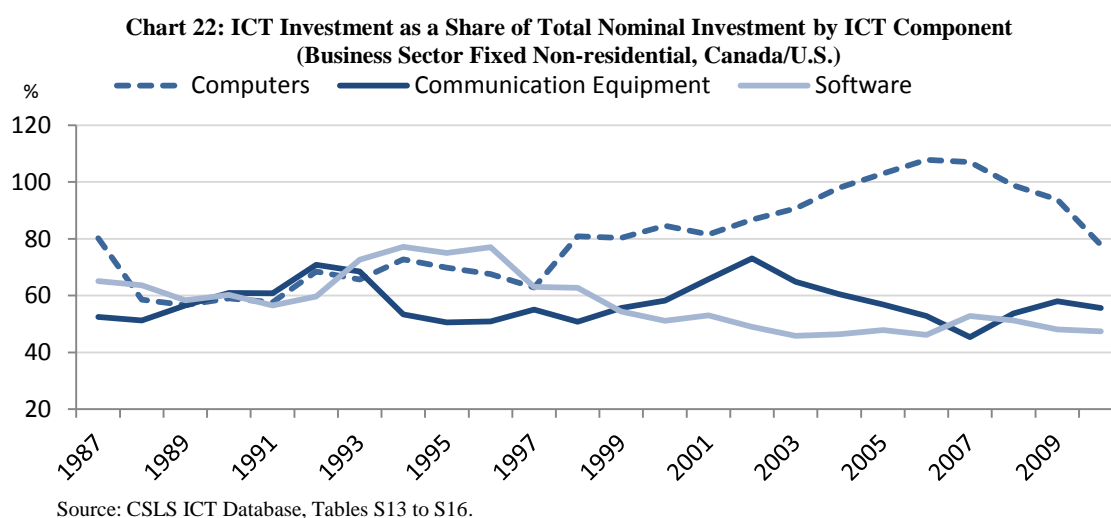


### C. Canada-U.S. ICT Investment as a Share of Total Investment

This indicator of relative Canada-U.S. ICT investment performance requires only estimates of business sector ICT and total investment for the two countries. In 2010, total investment growth outpaced ICT growth in Canada, leading to a fall in the share of ICT investment in total investment to 8 per cent from 8.5 per cent in 2009. In contrast, in the United

States ICT investment outpaced total investment resulting in an increase in the relative importance of ICT in total investment from 7 per cent in 2009 to 7.1 per cent in 2010. As a result, the Canada-U.S. ICT investment as a share of total investment gap widened – the Canada as a percentage of U.S. share fell from 58.3 in 2009 to 55.4 in 2010.

This effect was seen across all three components of ICT investment, although it was most significant in computers investment (Chart 22). In 2009, the ICT investment as a share of total investment Canada-U.S. ratio was 93.8 per cent for computers, 58.0 per cent for communications equipment, and 48.1 per cent for software. These gaps increased in 2010 – the Canada as a percentage of U.S. ratio fell to 77.9, 55.6, and 47.5 per cent, respectively. Although computers investment experienced the largest increase in the size of the gap, this component continues to have the smallest gap, whereas software has the largest.



#### IV. Canada-U.S. Real ICT Investment per Worker Gap

As noted previously, the relative performance of ICT investment in Canada and the United States depends upon the type of indicator being examined. Due to positive employment growth in Canada and negative employment growth in the United States in 2010, the United States performs relatively better in per worker variables. Further, due to the more severe decline in ICT prices in Canada, the growth of nominal ICT indicators in Canada perform relatively worse than the growth of real ICT indicators to an extent far greater than the difference in nominal and real indicators for the United States. For this reason, Canada performs worse than the United States on some nominal variables for which Canada performs better than the United States when adjusted for prices (real indicators) (Table 5).<sup>8</sup> Traditionally nominal ICT

<sup>8</sup> For example, nominal ICT investment growth in 2010 was 3.1 per cent in Canada and 7.1 per cent in the United States. At the same time, real ICT investment growth was 10.5 per cent in Canada and 9.6 per cent in the United States.

investment gaps might therefore underestimate Canada's performance relative to the United States.<sup>9</sup>

**Table 5: Canada-United States Real ICT Investment per Worker Gap in the Business Sector, 2000-2010**

Canada				
	Total	Computers	Communication Equipment	Software
Real ICT investment per worker in Canada as a share of real ICT investment per worker in the united states (%) 2002 PPP adjusted (%)				
<b>2000</b>	53.1	78.3	53.1	42.5
<b>2008</b>	64.6	94.1	55.5	49.5
<b>2009</b>	57.4	79.2	53.5	44.2
<b>2010</b>	56.7	71.2	53.8	43.8
<b>Percentage points change</b>				
<b>Δ 2009</b>	-7.2	-14.9	-2.0	-5.3
<b>Δ 2010</b>	-0.7	-8.0	0.3	-0.4

Source: CSL ICT Database for Canada Tables (13-16)v and CSL ICT Database for the United States Tables (30-33)t&v

Real ICT investment per worker in Canada as a percentage of U.S. ICT investment per worker share in 2010 was 56.7 per cent compared to 53.0 per cent in nominal terms (Chart 23). The gap was therefore slightly larger in nominal terms than real terms. The real Canada-U.S. ICT investment per worker gap also presented an alternative interpretation of the change in the gap for 2010. Recall that in nominal terms, the investment per worker gap widened 0.6 per cent in 2010. The real investment per worker gap actually indicates a larger widening of 0.7 per cent for 2010. The larger decrease in ICT prices in Canada compared to the United States has been more than completely offset by an increase in the PPP for machinery and equipment from 0.78 in 2002 to 0.87 in 2010. Therefore, the choice of real or nominal Canada-U.S. ICT investment gap indicators does not appear to affect the Canada-U.S. real ICT investment per worker gap in terms of level or growth.

At the ICT component level, the Canada-U.S. real ICT investment per worker gap in 2010 was greater than the nominal gap for communications equipment ICT, but not for computers or software ICT (Chart 23). For computers ICT, the Canada-U.S. ratio in real terms was 71.2 per cent in 2010, less than the ratio observed in nominal terms (74.4 per cent). For communications equipment, the Canada-U.S. ration in real terms was 53.8 per cent in 2010, more than the ration observed in nominal terms (53.1 per cent). Finally, for software ICT, the Canada-U.S. ratio in real terms was 43.8 per cent, less than the ratio observed in nominal terms (45.4 per cent). In all cases, the effect of a change from nominal to real indicators on the gap was minimal.

<sup>9</sup> The real indices used are chained in 2002 dollars. As such, the nominal and real Canada-US ICT investment gaps are equivalent in 2002.

**Table 4: Purchasing Power Parity (PPP) Estimates for Machinery and Equipment (M&E), 1986-2010**

	Canada				United States				PPP for M&E, U.S. dollar per Canadian dollar			
	M&E Investment, millions of current Canadian dollars	M&E Investment, millions of 2002 chained Canadian dollars	Implicit M&E Price Deflator	Per Cent Change	M&E Investment, millions of current U.S. dollars	M&E Investment, millions of 2005 chained U.S. dollars	Implicit M&E Price Deflator	Per Cent Change	Official PPP Values*	Official PPP Change	Implicit PPP Change	Exchange Rate, U.S dollar per Canadian dollar
	A	B	C=A/B*100	D=100*(C <sub>t</sub> /C <sub>t-1</sub> -1)	D	E	F=D/E*100	D=100*(C <sub>t</sub> /C <sub>t-1</sub> -1)	G	H = (G <sub>t</sub> /G <sub>t-1</sub> - 1)*100	I=(F <sub>t</sub> /F <sub>t-1</sub> - C <sub>t</sub> /C <sub>t-1</sub> )*100	J
1986	38,647	37,334	103.5	n.a.	343,300	283,779	121.0	n.a.	<b>0.73</b>	-	-	-
1987	43,013	42,348	101.6	-1.9	349,925	287,671	121.6	0.6	<b>0.74</b>	-	2.4	0.75
1988	49,915	49,922	100.0	-1.6	381,000	309,365	123.2	1.2	<b>0.77</b>	-	2.8	0.81
1989	54,092	54,202	99.8	-0.2	414,025	332,034	124.7	1.2	<b>0.78</b>	-	1.4	0.84
1990	52,418	52,405	100.0	0.2	419,525	332,134	126.3	1.3	<b>0.79</b>	-	1.1	0.86
1991	49,140	52,061	94.4	-5.6	414,575	323,602	128.1	1.4	<b>0.84</b>	-	7.1	0.87
1992	48,676	51,249	95.0	0.6	439,550	347,187	126.6	-1.2	0.83	-	-1.8	0.83
1993	48,811	50,233	97.2	2.3	489,400	390,524	125.3	-1.0	0.81	-2.4	-3.3	0.78
1994	54,505	54,979	99.1	2.0	544,650	437,097	124.6	-0.6	0.78	-3.7	-2.6	0.73
1995	58,370	58,116	100.4	1.3	602,750	489,405	123.2	-1.2	0.78	0.0	-2.5	0.73
1996	60,986	61,048	99.9	-0.5	650,775	541,424	120.2	-2.4	0.77	-1.3	-1.9	0.73
1997	73,490	73,160	100.5	0.6	718,350	615,873	116.6	-3.0	0.77	0.0	-3.5	0.72
1998	80,510	79,211	101.6	1.2	786,000	705,235	111.5	-4.4	0.74	-3.9	-5.6	0.67
1999	87,155	87,775	99.3	-2.3	870,950	804,992	108.2	-2.9	0.76	2.7	-0.6	0.67
2000	92,085	93,158	98.8	-0.4	950,550	889,248	106.9	-1.2	0.78	2.6	-0.8	0.67
2001	91,082	91,340	99.7	0.9	898,125	860,555	104.4	-2.4	0.77	-1.3	-3.2	0.65
2002	89,315	89,315	100.0	0.3	842,675	824,227	102.2	-2.0	0.78	1.3	-2.3	0.64
2003	90,899	97,748	93.0	-7.0	853,825	849,992	100.5	-1.7	0.82	5.1	5.3	0.71
2004	94,931	107,899	88.0	-5.4	916,375	917,303	99.9	-0.5	0.86	4.9	4.8	0.77
2005	104,627	123,931	84.4	-4.0	995,575	995,575	100.0	0.1	0.89	3.5	4.1	0.83
2006	111,748	137,262	81.4	-3.6	1,071,675	1,071,139	100.1	0.1	0.90	1.1	3.6	0.88
2007	113,752	143,415	79.3	-2.6	1,112,550	1,106,761	100.5	0.5	0.90	0.0	3.0	0.93
2008	114,915	143,381	80.1	1.0	1,069,975	1,059,401	101.0	0.5	0.88	-2.2	-0.6	0.94
2009	100,132	118,281	84.7	5.6	903,025	889,716	101.5	0.5	0.83	-5.7	-5.1	0.88
2010	104,916	132,249	79.3	-6.3	1,015,650	1,019,399	99.6	-1.8	0.87	4.8	4.5	0.97

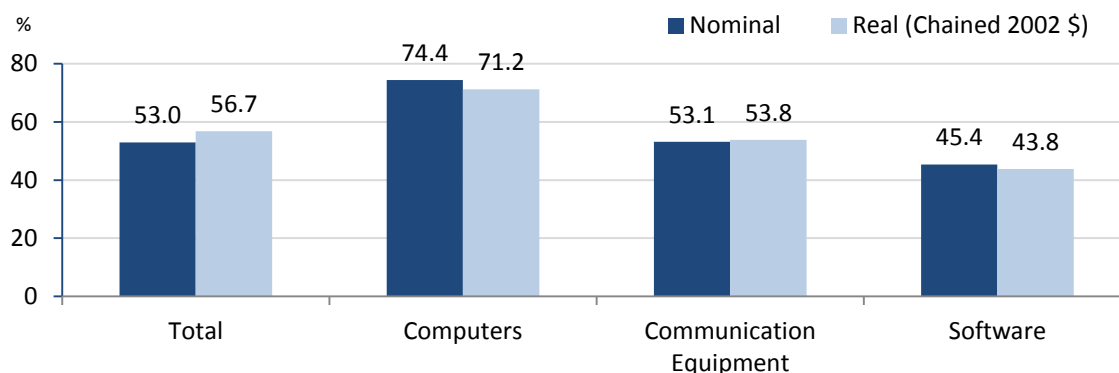
Source: PPP from Statistics Canada, CANSIM Table 380-0057, V13930596

M&E data from Statistics Canada CANSIM II series v1070249 and v4419816 and Bureau of Economic Analysis NIPA Tables 5.3.5 and 5.2.3.

\* Official PPP values for 1992-2010. For 1987-1991, the PPP estimate is obtained by applying the implicit PPP growth rate (U.S.-Canada difference in M&E price deflator growth).

Exchange rate from Statistics Canada, CANSIM II Table 16-0049 V37694.

**Chart 23: The Canada-U.S. Real ICT Investment per Worker Gap in the Business Sector by ICT Component, Canada/U.S., 2010**



Sources: CSLS ICT Database Summary Tables 1-4, CSLS ICT Database for Canada Tables (13-16)v, and CSLS ICT Database for the United States Tables (30-33)t&v.

The real ICT investment gaps are all narrower than the nominal ICT investment gaps – for all ICT components. The only variable affecting these results are interactions in ICT prices, overall prices, and investment prices, in Canada and the United States. The traditional nominal ICT investment gaps are used in the analysis of potential labour productivity; however, fluctuations in price levels affect changes in these gaps to a large degree. It may therefore be desirable to compare the nominal and real ICT investment gaps when analyzing potential consequences of these indicators.

## V. Conclusion

The Canada-U.S. ICT investment per worker gap continued to widen in 2010. Weak nominal ICT investment growth and strong employment growth in Canada's business sector contributed to this widening while a rising PPP dampened this effect. The net result was a slight widening of the Canada-U.S. nominal ICT investment per worker gap from 46.5 per cent in 2009 to 47.0 per cent in 2010. Largely due to rapidly falling ICT prices, Canadian real ICT investment growth outpaces real U.S. ICT investment growth; however, the opposing forces of a PPP increase and more rapidly decreasing ICT prices in Canada than in the United States offset one another. The effect on the Canada-U.S. ICT investment per worker gap was therefore minimal.

This paper therefore focuses on traditional nominal ICT investment gaps. Nominal and per worker investment growth is greater in the United States due to faltering business sector employment in the United States and a greater rate of decrease in ICT prices in Canada than in the United States. Furthermore, whereas Canadian ICT investment growth is not as large as total investment growth, U.S. ICT investment growth exceeds total investment growth. For these reasons, the gap in nominal ICT investment as a share of nominal business sector GDP and the gap in nominal ICT investment as a share of nominal total investment between Canada and the

United States widened as well. Despite a greater economic recovery in Canada and an appreciating machinery and equipment PPP exchange rate, the Canada-U.S. ICT investment per worker gap widened once more due primarily to the weak increase of nominal ICT investment spending in Canada.

## References

- Bennett, Jennifer A., Michael D. Glenn, and David B. Wasshausen (2011) “Fixed Assets and Consumer Durable Goods for 1997-2010,” *Bureau of Economic Analysis*, available online at [http://www.bea.gov/scb/pdf/2011/09%20September/0911\\_fixed-assets.pdf](http://www.bea.gov/scb/pdf/2011/09%20September/0911_fixed-assets.pdf).
- Sharpe, Andrew and Dylan Moeller (2011) “Overview of Developments in ICT Investment in Canada, 2010: Rebounding from the Recession,” CSLS Research Note 2011-2, available online at <http://www.csls.ca/notes/Note2011-2.pdf>.
- Sharpe, Andrew and Ricardo De Avillez (2010) “Canada-U.S. ICT Investment in 2009: The ICT Investment per Worker Gap Widens,” CSLS Research Report 2010-08, available online at <http://www.csls.ca/reports/csls2010-08.pdf>.



## Appendix A: Decomposition of the Nominal ICT Investment per Worker Gap and the per cent Effect of Factors on its Growth

Let:

$N_C$  represent Nominal ICT investment in Canada

$N_S$  represent Nominal ICT investment in the United States

$E_C$  represent total business employment in Canada

$E_S$  represent total business employment in the United States

PPP represent the purchasing power parity exchange rate for machinery and equipment, United States dollar (USD) per Canadian dollar (CAD).

Then:

$W_C = N_C/E_C$  represents Nominal ICT investment per worker in Canada

$W_S = N_S/E_S$  represents Nominal ICT investment per worker in the United States

$R_N = N_C/N_S$  represents nominal ICT investment in Canada as a share of nominal ICT investment in the United States

$R_E = E_C/E_S$  represents total business employment in Canada as a share of total business employment in the United States

Then the nominal ICT investment per worker gap can be decomposed into the following equation for any given year:

$$\begin{aligned} & \frac{W_C * PPP}{W_S} \\ &= \frac{N_C * PPP}{E_C} \div \frac{N_S}{E_S} \\ &= \frac{N_C * PPP}{E_C} * \frac{E_S}{N_S} \\ &= \frac{N_C * PPP}{N_S} * \frac{E_S}{E_C} \\ &= \frac{N_C * PPP}{N_S} \div \frac{E_C}{E_S} \\ &= \frac{R_N}{R_E} * PPP \end{aligned}$$

This equation is multiplicative. The growth in this gap can therefore be approximated, where changes are small, by the change in the natural logarithm of the above expression from year to year, or the change in:

$$\begin{aligned} & \ln\left(\frac{R_N}{R_E} * PPP\right) \\ &= \ln(R_N) + \ln\left(\frac{1}{R_E}\right) + \ln(PPP) \end{aligned}$$

This new additive expression gives:

$$\Delta \ln\left(\frac{R_N}{R_E} * PPP\right) = \Delta \ln(R_N) + \Delta \ln\left(\frac{1}{R_E}\right) + \Delta \ln(PPP)$$

Therefore, the approximate percent effects of the Canada-U.S. nominal ICT investment ratio, Canada-U.S. aggregate employment ratio, and the PPP, are, respectively:

$$\frac{\Delta \ln(R_N)}{\Delta \ln\left(\frac{R_N}{R_E} * PPP\right)}$$

$$\frac{\Delta \ln\left(\frac{1}{R_E}\right)}{\Delta \ln\left(\frac{R_N}{R_E} * PPP\right)}$$

and

$$\frac{\Delta \ln(PPP)}{\Delta \ln\left(\frac{R_N}{R_E} * PPP\right)}$$

Or, if x represents the factor of interest:

$$\frac{\Delta \ln(x)}{\Delta \ln(\text{Canada-U.S. nominal ICT per worker Gap})}$$

Unfortunately, if these factors move in opposing directions, the percent effect of these factors can be quite large. For example if  $x_1$  changes by 11 units and  $x_2$  change by -10 units then the total change in y will be 1 for  $y = x_1 + x_2$ . This results in per cent effects of 1100 per cent for  $x_1$  and negative 1000 per cent for  $x_2$ . Although these sum to 100 per cent, these percentages do not give a strong intuition for the overall per cent of force each factor applies to the overall change in y. This ratio of force disregards directionality and focuses on the amount overall change in variable x – the absolute value of the change in x, or  $|\Delta x|$ . We can therefore standardize the percentages like any other set of weights using:

$$\frac{|\Delta x|}{\sum_{i=1}^n |\Delta x_i|}$$

Or, for this paper:

$$\frac{|\Delta \ln (x)|}{|\Delta \ln (R_N)| + |\Delta \ln (\frac{1}{R_E})| + |\Delta \ln (PPP)|}$$

This equation produces positive per cent effects which sum to 100. Furthermore, if one groups factors into groups with positive changes and groups with negative changes, the sum of the weights of each group applied to the sum of the changes in each group will sum to the total change in the dependent variable – the Canada-U.S. nominal ICT per worker gap.

For example, for PPP in 2010:

$$\begin{aligned} & \frac{|\Delta \ln (x)|}{|\Delta \ln (R_N)| + |\Delta \ln (\frac{1}{R_E})| + |\Delta \ln (PPP)|} \\ &= \frac{\ln(PPP_{2010}) - \ln(PPP_{2009})}{|\Delta \ln (R_N)| + |\Delta \ln (\frac{1}{R_E})| + |\Delta \ln (PPP)|} \\ &= \frac{|\ln(0.87) - \ln(0.83)|}{|\ln(0.87) - \ln(0.83)| + |\ln(8.42) - \ln(8.58)| + |\ln(0.07) - \ln(0.08)|} \\ &= \frac{|\ln(0.87) - \ln(0.83)|}{|\ln(0.87) - \ln(0.83)| + |\ln(8.42) - \ln(8.58)| + |\ln(0.07) - \ln(0.08)|} \\ &= 0.450 \end{aligned}$$

Therefore, the per cent effect of PPP was estimated to be 45.0 per cent in 2010.

Furthermore, the per cent effects of the Canada-U.S. nominal ICT ratio and Canada-U.S. employment ratio were estimated at 36.5 per cent and 18.5 per cent, respectively, of the change in Canada-U.S. nominal ICT investment per worker gap in 2010. As discussed in the paper, both of these factors had negative effects on the change in the gap whereas PPP offset most of this negative effect. Therefore, we group these variables together and note that there is a negative effect of 55.0 per cent and a positive effect of 45.0 per cent.

The natural logarithms of the Canada-U.S. nominal ICT investment ratio and the Canada-U.S. employment ratio decreased 0.038 and 0.019, respective. The sum of these decreases is 0.057. If we apply the weight of 55.0 per cent to this decrease and 45.0 per cent to the increase of 0.047 in the natural logarithm of PPP, we find a net decrease of 0.011. This is approximately equivalent to the change in the natural logarithm of the gap. These per cent effects therefore accurately approximate the force applied by each of the factors. The data from this table is presented in Chart 21 in the main text of this paper.

Appendix Table 1 compares the per cent effects determined in the above exercises to the absolute changes in each of the factors.

**Appendix Table 1: Comparison of Change in the Canada-U.S. Nominal ICT Investment Gap and Per Cent Effects to Absolute Changes in the Canada-U.S. Nominal ICT Investment Ratio, the Canada-U.S. Employment Ratio, and the PPP for Machinery and Equipment (USD per CAD)**

Investment ratio, the Canada-U.S. Employment ratio, and the PPP for Machinery and Equipment (USD per CAD)											
Canada-U.S. Ratio Value					Canada-U.S. Ratio, Absolute Change				Canada-U.S. Ratio, Per Cent Effect <sup>2</sup>		
Year	Gap ratio <sup>1</sup> B=(C/D)*	Nominal ICT	Employment	PPP	Nominal ICT	Employment	PPP	Nominal ICT	Employment	PPP	
		investment ratio	ratio		investment ratio	ratio		investment ratio	ratio		
A	E	C	D	E	F=B <sub>n</sub> - B <sub>(n-1)</sub>	G=C <sub>n</sub> -C <sub>(n-1)</sub>	H=D <sub>n</sub> -D <sub>(n-1)</sub>	I=E <sub>n</sub> - E <sub>(n-1)</sub>	J	K	L
1987	61.50	0.086	0.104	0.74	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1988	59.94	0.082	0.104	0.77	-1.55	-0.005	0.000	0.02	65.1	1.4	33.6
1989	60.90	0.082	0.104	0.78	0.96	0.000	0.000	0.01	6.8	2.1	91.1
1990	63.07	0.083	0.103	0.79	2.17	0.001	-0.001	0.01	46.4	22.9	30.8
1991	65.39	0.079	0.102	0.84	2.32	-0.004	-0.001	0.06	36.7	9.2	54.1
1992	66.11	0.080	0.101	0.83	0.73	0.001	-0.001	-0.01	33.6	28.2	38.2
1993	63.04	0.077	0.099	0.81	-3.08	-0.003	-0.002	-0.02	49.3	21.7	28.9
1994	62.16	0.078	0.098	0.78	-0.88	0.001	-0.001	-0.03	27.0	11.6	61.4
1995	56.59	0.071	0.098	0.78	-5.57	-0.007	0.000	0.00	95.1	4.9	0.0
1996	54.42	0.069	0.097	0.77	-2.17	-0.002	-0.001	-0.01	62.3	13.7	24.0
1997	55.46	0.070	0.097	0.77	1.03	0.002	0.000	0.00	88.5	11.5	0.0
1998	55.21	0.073	0.098	0.74	-0.25	0.003	0.001	-0.03	47.5	7.9	44.6
1999	52.00	0.068	0.099	0.76	-3.21	-0.005	0.001	0.02	66.1	10.3	23.6
2000	50.84	0.065	0.100	0.78	-1.16	-0.003	0.001	0.02	54.5	10.6	34.8
2001	52.70	0.070	0.102	0.77	1.86	0.005	0.002	-0.01	67.7	19.6	12.7
2002	54.59	0.075	0.107	0.78	1.89	0.005	0.005	0.01	53.8	35.7	10.5
2003	54.42	0.072	0.109	0.82	-0.17	-0.002	0.002	0.04	29.2	22.3	48.5
2004	57.78	0.074	0.109	0.86	3.36	0.001	0.000	0.04	23.9	6.0	70.1
2005	62.42	0.076	0.109	0.89	4.65	0.003	-0.001	0.03	46.1	9.5	44.3
2006	62.67	0.075	0.108	0.90	0.25	-0.001	-0.001	0.01	43.0	17.4	39.6
2007	60.47	0.074	0.110	0.90	-2.20	-0.002	0.002	0.00	58.3	41.7	0.0
2008	59.59	0.076	0.113	0.88	-0.88	0.003	0.003	-0.02	41.3	32.0	26.7
2009	53.53	0.075	0.117	0.83	-6.06	-0.001	0.004	-0.05	15.0	30.5	54.5
2010	52.97	0.072	0.119	0.87	-0.56	-0.003	0.002	0.04	36.5	18.5	45.0

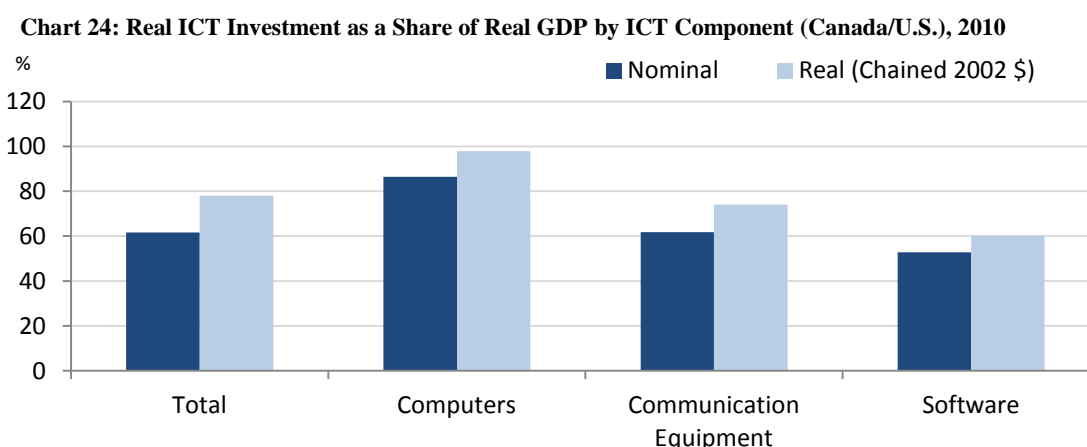
Source: CSLS ICT Database Summary Table 1, CSLS ICT Database for Canada Table 9v, and CSLS ICT Database for the United States Table 26t&v.

<sup>1</sup> The 'gap ratio' is the ratio of Canada/U.S. for the indicator being studied. The gap itself is therefore equivalent to (1- 'gap ratio').

<sup>2</sup> The 'per cent effect' in this table represents the total contribution of force to the change in the gap, as described in the preceding text.

## Appendix B: Canada-U.S. Real ICT Investment as a Share of Real Business Sector GDP

The real ICT investment as a share of real GDP for Canada as a percentage of the United States ratio in 2010 was 78.0 per cent, an improvement of 0.8 per cent from 77.2 per cent in 2009 (Appendix Table 2 and Chart 24). Once again, this real indicator presented a much narrower Canada-U.S. ICT investment gap. In nominal terms, this indicator stood at 61.6 per cent in 2010. Therefore, the real gap was 16.4 percentage points smaller than the nominal gap. Furthermore, the real gap narrowed 0.8 per cent in 2010 whereas the nominal gap widened 3.0 per cent. This indicates that choice of nominal or real variables in ICT investment indicators is very important for this gap. ICT investment prices in Canada have fallen much more rapidly in Canada than in the United States (Table 1) and constitute a large portion of the movement in the Canada-U.S. ICT investment per worker gap (Appendix 1). The narrower real ICT investment as a share of real GDP gap in 2010 is also a result of a wider rapidly falling ICT prices in Canada; however, this gap is also contingent on the prices for the overall economy.

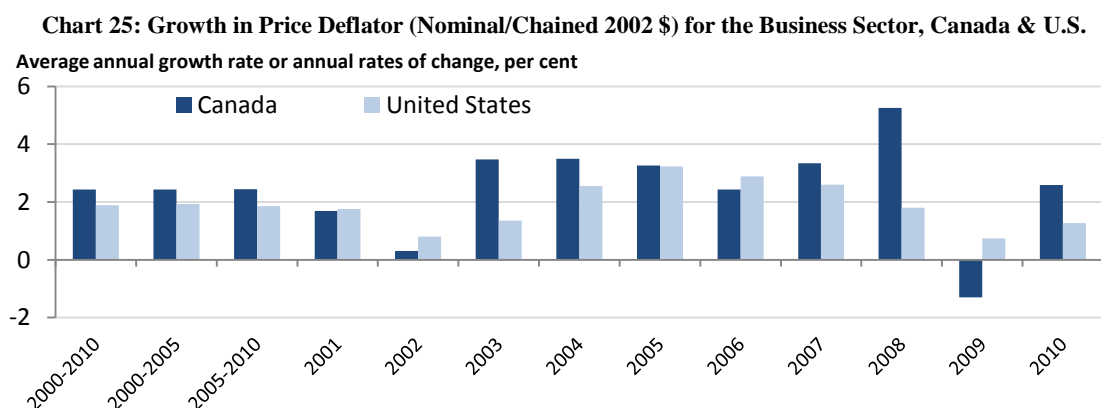


Source: CSLS ICT Database for Canada Tables (5-8)v and CSLS ICT Database for the United States Tables (22-25)v

In 2010, ICT prices in Canada fell more rapidly in Canada than in the United States (Table 1). On the other hand, prices in the business sector in Canada increased more rapidly in Canada than in the United States. For this reason, although nominal business sector GDP increased 6.25 per cent in Canada and only 5.23 per cent in the United States, real GDP increased 3.9 per cent in the United States and only 3.6 per cent in Canada (calculated from ICT database tables 5v and 22v, BEA NIPA Tables 1.3.6, and CANSIM Table 379-0027).

This effect, combined with rapidly decreasing ICT prices in Canada which result in greater real growth of ICT investment in Canada than in the United States (Section III.C), resulted in the improvement of the real ICT investment as a share of real GDP in both Canada and the United States in 2010. Furthermore, Canada's larger decreases in ICT prices and larger increase in overall prices led to a greater improvement of the ICT investment as a share of real

GDP in Canada than in the United States. For this reason, the real Canada-U.S. ICT investment as a share of real GDP gap was narrowed in 2010 by 0.8 per cent whereas the nominal gap widened 3.0 per cent. This trend of larger increases in overall prices and larger decreases in ICT prices in Canada has largely persisted since 2002 (Charts 25). As a result, the ICT investment as a share of GDP gap is much smaller under real values than under nominal values.



Source: Calculated from CSLS ICT Database for Canada, Tables 1v and 5v, CSLS ICT Database for the United States, Tables 18v and 22v.

In each of ICT components, the real ICT investment as a share of real GDP gap is narrower than the nominal ICT investment as a share of nominal GDP gap for Canada-U.S. In computer ICT, the real Canada-U.S. ratio was 97.9 per cent whereas the nominal ratio was 86.5 per cent. In communication equipment ICT, the Canada-U.S. real and nominal ratios were 74.0 and 61.8 per cent, respectively. The software ICT Canada-U.S. real ICT investment as a share of real GDP ratio was 60.2 per cent, while the gap under nominal figures was larger, and the nominal Canada as a percentage of United States share was 52.7 per cent.

**Appendix Table 2: Canada-United States Real ICT Investment as a Share of Real GDP Gap in the Business Sector, 2000-2010**

Canada				
	Total	Computers	Communication Equipment	Software
Real ICT investment as a share of real GDP in Canada as a proportion of that of the United States (%)				
2000	62.5	92.2	62.6	50.1
2008	85.2	124.1	73.2	65.2
2009	77.2	106.5	72.0	59.4
2010	78.0	97.9	74.0	60.2
Percentage point change				
Δ 2009	-8.0	-17.6	-1.2	-5.8
Δ 2010	0.8	-8.6	2.0	0.8

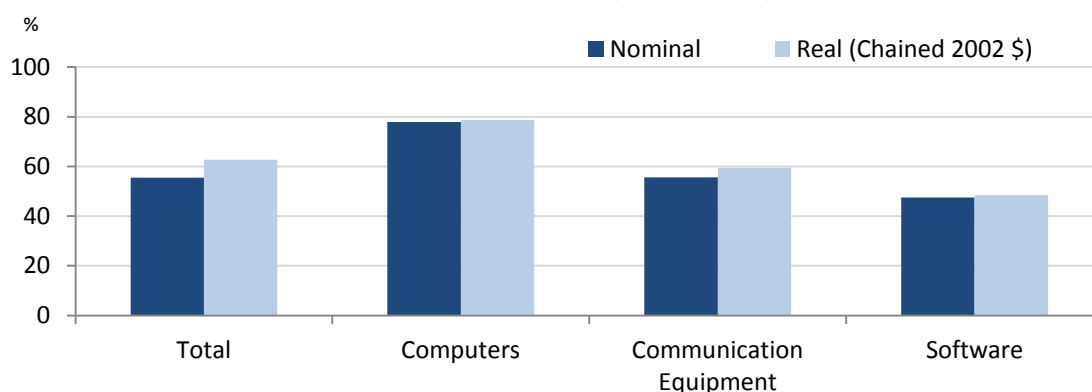
Source: CSLS ICT Database for Canada Tables (5-8)v and CSLS ICT Database for the United States Tables (22-25)v

## Appendix C: Canada-U.S. Real ICT Investment as a Share of Real Total Investment

The Canada-U.S. ICT investment as a share of total investment gap was once again narrower under real values than under nominal values. The real Canada per cent of United States share was 62.7 per cent whereas the nominal share was 55.4 per cent (Appendix Table 3 and Chart 26). Furthermore, the real gap widened only 0.8 per cent whereas the nominal gap widened 2.9 per cent. Similar to the ICT investment as a share of real GDP gap, these differences in real and nominal gaps can be explained by rapidly decreasing Canadian ICT prices relative to moderate decreases in United States ICT prices. Using the same logic, but using total investment in the business sector rather than business sector GDP, the root of the narrower real ICT investment as a share of real investment gap for Canada-U.S. can be determined.

ICT prices have dropped dramatically in Canada from 2000 to 2010. The average annual rate of decrease for this period was 4.8 and 3.6 per cent for Canada and the United States, respectively. On the other hand, overall investment prices increased more rapidly in the United States than in Canada over this time period. Indeed, whereas the average annual growth rate of U.S. investment prices for 2000-2010 was 0.91 per cent, the average annual growth rate for this period in Canada was 0.65 per cent (Chart 27). Therefore, the difference in growth rates for these variables in Canada exceeds the difference in growth rates in the United States (5.4 versus 4.5 per cent). The ICT investment as a share of total investment in real terms is therefore improving more rapidly in Canada than in the United States, relative to the nominal share. As a result, the real ICT investment as a share of total investment gap in real terms is narrower than the gap in nominal terms.

**Chart 26: Real ICT Investment as a Share of Real Investment by ICT Component  
(Business Sector Fixed Non-residential, Canada/U.S.), 2010**

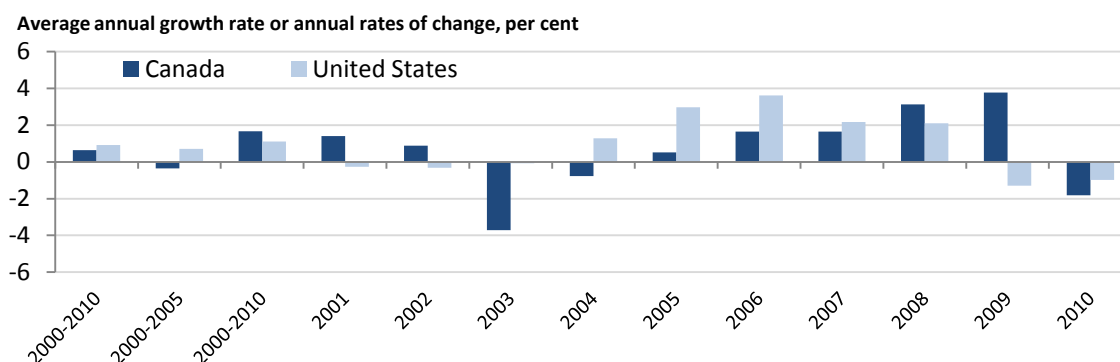


Source: CSLS ICT Database for Canada Tables (5-8)v and CSLS ICT Database for the United States Tables (22-25)v.

The three ICT components all exhibit larger Canada-U.S. ICT investment as a share of total investment gaps in nominal terms than in real terms. In computers ICT, Canada's real ICT

investment as a share of real total investment was 78.7 per cent of the U.S. share, whereas Canada's share in nominal terms was only 77.9 per cent of the U.S. share. For communications ICT investment, the real and nominal 'Canada as a share of U.S.' values were 59.4 and 55.6 per cent, respectively. The software real ICT share in Canada was 48.4 per cent the real share in the United States, while in nominal terms the Canadian share was only 47.5 per cent of the U.S. share.

**Chart 27: Growth in Investment Price Deflator (Nominal/Chained 2002 \$) for the Business Sector, Canada & U.S.**



Source: Calculated from CSLS ICT Database for Canada, Tables 1v and 5v, CSLS ICT Database for the United States, Tables 18v and 22v.

**Appendix Table 3:**  
**Canada-United States Real ICT Investment as a Share of Real Total Investment Gap in the Business Sector, 2000-2010**

Canada				
	Total	Computers	Communication Equipment	Software
Real ICT investment as a share of real total investment in Canada as a proportion of that of the United States (%)				
<b>2000</b>	62.4	92.1	62.5	50.0
<b>2008</b>	67.6	98.5	58.1	51.8
<b>2009</b>	63.5	87.6	59.2	48.9
<b>2010</b>	62.7	78.7	59.4	48.4
<b>Percentage points change</b>				
<b>Δ 2009</b>	-4.1	-10.9	1.1	-2.9
<b>Δ 2010</b>	-0.8	-8.9	0.2	-0.5

Source: CSLS ICT Database for Canada Tables (5-8)v and CSLS ICT Database for the United States Tables (22-25).