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WHAT EXPLAINS THE CANADA-U.S. SOFTWARE INVESTMENT INTENSITY GAP?

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What Explains the Canada-U.S. Software Per Worker Gap?

Abstract

In 2012, business sector software investment per worker in Canada was 40.7 per cent of that in the United States. The objective of this report is to deepen our understanding of the reasons for which Canadian businesses invest substantially less in software than their U.S. counterparts. The report reviews the state of the software investment landscape in Canada, discusses the views of industry experts obtained through key informant interviews, and assesses possible explanations for the software gap. About one-third of the gap can be assigned to differences in labour productivity, industry structure, and measurement methodologies between the two countries. The remaining two-thirds are more difficult to explain.

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What Explains the Canada-U.S. Software Per Worker Gap?

Executive Summary

The objective of this report is to deepen our understanding of the reasons for which Canadian businesses invest substantially less in software than their U.S. counterparts. The report is organized into four sections. The first section reviews the state of ICT investment in Canada and tracks its evolution over time. The second section discusses the results of key informant interviews with software vendors and major software users. The third section examines possible explanations for the software gap. The fourth section summarizes our key findings and discusses their implications for policy.

I. An Overview of Trends in Software Investment

The Canada-U.S. business sector ICT investment per worker gap, or relative, has fluctuated over time, although there has been little change between 1987 and 2012, the first and most recent year for which data are currently available. Canada was 58.2 per cent of the U.S. level in 1987 and 56.9 per cent in 2012.

What has changed significantly are the relatives for the three ICT components (computers, communications equipment and software). Computer investment per worker in Canada has risen from 61.5 per cent of that in the United States in 1987 to 110.5 per cent in 2012, while communications investment has risen from 54.9 to 61.8 per cent of the U.S. level. In contrast, software investment has fallen from 58.5 to 40.7 per cent of the U.S. level.

The very large Canada-U.S. software gap (59.3 points) means that this ICT component in 2012 accounted for 85.4 per cent of the overall Canada-U.S. ICT investment gap. With higher investment in Canada than the United States, computers made a negative contribution to the gap.

In the last five years the software gap has increased significantly. Software investment per worker fell 6.4 per cent between 2007 and 2012 in Canada, while surging 21.4 per cent in the United States. These trends resulted in the Canada-U.S. software investment *relative* falling from 52.8 per cent in 2007 to 40.7 per cent in 2012 (or the Canada-U.S. software investment *gap* rising from 47.2 per cent in 2007 to 59.3 per cent in 2012).

International Comparisons of Software Investment

- Canada's software investment share of GDP was 76.9 per cent of that in the United States. Compared with OECD countries, Canada is in the middle of the pack in terms of

software investment as a share of GDP, ahead of Italy, Austria and Germany, comparable to countries such as the UK, Japan and the Netherlands, and lower than the United States and the Nordic countries.

Provincial Comparison of Software Investment

- Within Canada, Ontario is consistently the province with the highest level of software investment, while Newfoundland and Labrador, Saskatchewan, Nova Scotia and Manitoba are the four provinces with the weakest software investment levels in terms of software investment relative to GDP, software investment per worker, and net capital software stocks per worker.

Software Investment by Component

- The three software components are: pre-packaged (also called 'general' or 'off-the-shelf') software; custom software; and own-account software. Custom software is the most important, accounting for 46.5 per cent of business sector software investment in Canada in 2009, followed by own-account at 34 per cent and pre-packaged at 19.4 per cent. In 2009, custom software investment in Canada was 59.0 per cent of the U.S. level, followed by own-account (35.6 per cent) and general (26.4 per cent).

- Own account software and general software are the most important contributors to the software gap, accounting for 39.6 and 34.8 per cent of the software gap, respectively. Custom software accounted for 20.8 per cent.

Software Investment by Industry: Canada-U.S. Comparisons

- There are vast differences in software investment intensity between industries in both Canada and the United States.

- The greatest software investment gap between Canada and the United States was in information and cultural industries, where Canadian investment (at $3,398 per worker) was just 15.8 per cent of the U.S. level. Measurement issues may account for part of this difference. On the other hand, Canadian software investment per worker is greater for transportation and warehousing, educational services, and accommodation and food services.

- Together, information and cultural services, management of companies and enterprises and professional, scientific and technical services accounted for 61.9 per cent of the software investment gap between Canada and the United States.

International Perspective on Software Investment Intensity by Sector

- There is also significant variation between different industry sectors in software investment per worker across countries. In a comparison of thirteen countries, Canada ranked highly in real estate, renting and business activities sector, but quite poorly in construction and transportation sectors. Canada ranked seventh overall.

II. Synthesis of Key Informant Findings

There was no consensus among the key informant interviews with persons knowledgeable about software investments issues that could explain the software investment gap. Explanations that were put forward include: organizational and cultural factors; estimation and reporting considerations related to measurement, outsourcing and cloud services; open source software; and industrial structure. In addition, skills, education and training policies and software variety and awareness were all cited as potential causes of the software investment gap.

III. Explanations of the Canada-U.S. Software Investment Intensity Gap

Three explanations for the Canada-U.S. software investment gap can be quantified:

- Holding constant ICT investment as a share of GDP, a country with higher labour productivity will have a higher level of ICT investment per worker compared to a country with a lower labour productivity level because it will have higher income and investment since income is a key determinant of investment. Canada's lower productivity level accounts for about 13 percentage points of the software gap.

- Industry structure is another factor influencing software investment. Software-intensive industries are slightly less important in relative terms in Canada accounting for 1 percentage point of the gap.

- Wages are the key component of own-account software investment. Lower wages for software developments in Canada result in lower software investment levels as recorded by statistical offices. This difference accounts for 4 percentage points of the gap.

Taken together, these three factors account for about 18 percentage points, or about one-third, of the gap. Other explanations of the gap are more difficult to quantify.

The availability of cloud computer services has proliferated in recent years. Such services are offered by an off-site service provider through a subscription or pay-per-use basis. It has been suggested that a large volume of cloud services are offered to Canadian firms by U.S.

providers. The software investment needed to provide these services will be allocated to the United States even though the services are being provided. This has been put forward as a factor boosting software investment in the United States, and reducing it in Canada. Unfortunately, sufficient data were not available to assess this hypothesis.

The price of software can influence the investment; if prices are higher in Canada, expenditure on software will be lower. Unfortunately, there exists no price level series comparing Canada and the United States, although anecdotal evidence suggests that prices are higher in Canada.

It is often asserted that business culture differs between Canada and the United States. A number of key informants argued that the strategic orientation of Canadian firms is complacent relative to U.S. firms, and thus Canadian firms are less likely to invest in software. On the other hand, surveys of business leaders in both countries have shown similar attitudes toward risk.

Finally, issues such as software piracy and the use of open-source software play a role in the software investment gap. The rate of software piracy is much greater in Canada than in the United States (27 per cent versus 19 per cent in 2011), and maximum penalties for corporate software infringement are less severe. This may reduce recoded software investment in Canada.

There are no relevant data on open-source or freeware use in Canada and the United States so their role in the gap is difficult to ascertain. Foreign ownership has been suggested as a contributing factor to the software investment gap: if a foreign firm purchases software in its home country and distributes it to subsidiaries without a transaction, software spending may be underestimated.

IV. Summary, Policy Implications and Conclusion

The importance of a nuanced examination of the software investment gap must be emphasized, taking into account varied landscape of software investment in terms of measurement, industry, and geography. A discussion of this gap must keep in mind the fact that a significant part of the software gap can be explained by productivity differences and measurement issues, and that, many OECD countries invest less in software than the United States, and Canada is in the middle of the pack, even out-performing countries like Germany. Furthermore, seven of seventeen Canadian industries actually invest more per worker in software than their U.S. counterparts. In fact, the gap is largely concentrated in one sector (information and cultural industries), suggesting that the gap may to a considerable extent be an industry-specific issue. Thus, the realities of the software investment gap cannot simply be summarized by noting that Canadian firms only spend 40 per cent on software of what U.S.

firms do. The software investment per worker gap is not a broad, macroeconomic phenomenon, but rather appears primarily the result of industry-specific factors.

Despite these observations, there can be no doubt that software investment in Canada is weaker than in the United States, and that a reduction of this gap could boost productivity growth. Canadian firms must keep pace with the IT transformation of economy and society, with SMEs having the largest software gap. However, the role of public policy in affecting private sector ICT investment may be limited. First, to the degree that the gap reflects the fact that Canadian firms are less strategic than U.S. firms toward innovation, and less interested in using software, it may be difficult for government to affect firm behaviour. Second, the policy environment for software investment in Canada is favourable with low tax rates.

It has been noted that the ICT adoption problem is particularly a SME problem. This suggests that the greatest potential for government to contribute to an increase in business sector software investment is by working with SMEs In this light, a national adoption strategy, such as the Smart Tech service created by the Business Development Bank of Canada, could help assist SMEs to identify and adopt new, productivity-enhancing software products might be the most effective public policy in this area.

What Explains the Canada-U.S. Software Per Worker Gap?[1]

Introduction

In 2013, the Centre for the Study of Living Standards (CSLS) produced a detailed report for Industry Canada entitled *Can Measurement Issues Explain the Canada-U.S. ICT Investment Gap?* The report concluded that differences in measurement methodologies between Canada and the United States explain only a small part of the ICT investment intensity gap and that it is real differences in software investment that primarily account for the gap. Indeed, in 2012 software investment per worker in the Canadian business sector was only $1,025 in PPP adjusted U.S. dollars, 40.7 per cent of the $2,517 per worker spent in the U.S. business sector. This gap of $1,492 U.S. accounted for 85 per cent of the overall ICT investment per worker gap of $1,748.

The objective of this report is twofold: first to deepen our understanding of the reasons why Canadian businesses invest substantially less in software than their U.S. counterparts, and second to develop recommendations for business action and public policy that would boost business investment in software.

The report is organized into four major sections reflecting the objectives of the study. The first section briefly reviews the state of the total ICT investment and software investment landscape in Canada in 2012 and how it has evolved over time. The three software sub-components (own account, customized and prepackaged) will be carefully defined and spending levels and trends in each component will be examined by industry and province. The software intensity of industries will be calculated. Trends in nominal software spending, software spending in real terms, and software prices will be examined for total software and for the three sub-components. Differences and similarities between the nature of software investment between Canada and the United States will be highlighted.

The second section of the study will report on the results of key informant interviews on software investment in Canada with both vendors of software and major software users.

The third section will discuss possible explanations of the software gap. In addition to standard determinants of investment such as interest rates, profits, industrial structure, and prices of capital goods, more qualitative factors will be discussed. These factors, which take into consideration the perspective of both the ICT-sector producers of software and the industries that adopt the software, include: the willingness of businesses to assume risk; the level of general

[1] The Centre for the Study of Living Standards would like to thank the Digital Policy Branch of Industry Canada for financial support for this study. The author thanks the CSLS staff who contributed to this study (Razan Sharaf, Tania Bigai, Even Capeluck and Moyosola Medu); the ICT experts who agreed to serve as key informants; and Josie Brocca, Sofia Civettini and participants in the Industry Canada seminar on May 22, 2014 for comments.

education; the availability of specific human capital needed to effectively use advanced software programs; the level of managerial education of the business decision-makers; knowledge of best practice software, both nationally and internationally, by vendors and users; the competitive intensity of the software vendor marketplace; the availability of domestic and foreign software; and degree of desire on the part of businesses to be an early technology adopter, given the perceived benefits and costs associated with such a strategy; and linkages between industries and macroeconomic drivers of software spending. An example of this last factor is the respective roles of the defense departments in Canada and the United States in influencing business sector software investment.

The fourth and final section will summarize the key findings and discuss their policy implications.

The ICT investment estimates in this report are from the CSLS ICT database maintained by the Centre for the Study of Living Standards posted at http://www.csls.ca/data/ict.asp. This database contains estimates of ICT investment and capital stock broken down by component and industry for Canada and the United States for the 1987-2012 period. Data are taken from Statistics Canada and the U.S. Bureau of Economic Analysis.

I. An Overview of Trends in Software Investment

This section of the report provides an overview of trends in software investment in Canada, the United States and OECD countries. The first part presents data on investment in software per worker in the Canadian and U.S. business sectors, in absolute and relative terms, up to 2012, the contribution of software to the overall ICT investment per worker gap between Canada and the United States, and trends in the software investment as a share of GDP. The second section provides an international perspective on software use, reporting on absolute and relative software investment per worker for thirteen OECD countries. The third section looks at the software investment in Canada and the United States by component. The fourth section examines software investment per worker for the twenty two-digit NAICS sectors in Canada and the United States, sector or industry contributions to the Canada-U.S. software gap, and software investment per worker in thirteen OECD countries.

A. Canada-U.S. Software Investment Trends

i. Absolute trends in software investment per worker

It is well known that ICT investment intensity, defined as ICT investment per worker, is considerably lower in Canada than in the United States. The Canada-U.S. ICT investment per worker gap has fluctuated over time, but has not changed substantially over the 1987-2012 period.[2] Business sector ICT investment per worker was 58.2 per cent of the U.S. level in 1987; 25 years later in 2012 is was almost the same at 56.9 per cent.

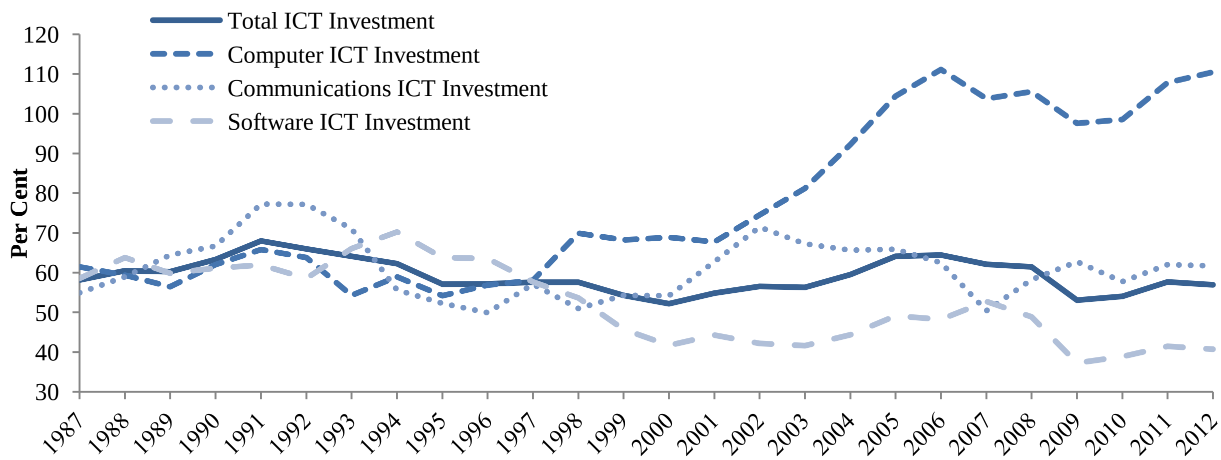
This constancy at the total or all-components level masks massive changes at the component level. In 1987, the Canada-U.S. ICT investment intensity relative (defined as one minus the gap) for all three ICT components was around 60 per cent. But by 2012, software investment per worker relative for Canada had fallen to 40.7 per cent of the U.S. level, while communications equipment investment per worker was relatively unchanged at 61.8 per cent, and computer investment per worker had nearly doubled to 110.5 per cent of the U.S. level.

Figure 1 shows trends in software investment per worker in the business sector in Canada and the United States over the 1987-2012 period. Between 1987 and 2007, the United States only slightly outpaced Canada. But since 2007 the index has fallen in absolute terms in Canada

[2] For a detailed report on the state of the Canada-U.S. ICT investment per worker gap up to 2011, see Capeluck (2013a). See Capeluck (2013b) for a detailed discussion of ICT investment in Canada in 2012. See Sharpe and Rai (2013) for detailed discussion of Canada-US ICT investment trends up to 2011.

while it has forged ahead in the United States. Indeed, the absolute level of software investment, based on the data in Table 1 and
Appendix Table 1, fell 6.4 per cent from $1,095 in 2007 to $1,025 in 2012 in Canada. In contrast in the United States, software investment surged 21.4 per cent between 2007 and 2012 and even increased 5.3 per cent in the recessionary year of 2009. Despite the many similarities between the Canadian and American economies, firm behaviour in relation to software investment appears to have diverged.

Figure 1: ICT Investment per Worker in Canada Relative to the United States, Per Cent, Business Sector, 1987-2012



Source: CSLS ICT Investment Tables S1-4

We also note that the ICT investment per worker gap in 1987 was very similar across all three components, as shown in Figure 1, but this is no longer the case at all. Since 1987, relative to the United States, investment in software has declined significantly, from 58.5 per cent in 1987 and a peak of 70.3 per cent of the U.S. level in 1994, to 40.7 per cent of the U.S. level in 2012. At the same time, computer investment, which was 61.5 per cent the U.S. level in 1987, increased to 110.5 per cent of the U.S. level over the period 1987-2012. Investment in communications equipment has only increased somewhat, from 54.9 per cent of the U.S. level in 1987 to 61.8 per cent of the U.S. level in 2012.

These large shifts in the relative performance of the ICT components have for the most part offset each other; total ICT investment per worker in Canada relative to the United States has exhibited less variation than its individual components, remaining within the range of 52 to 64 per cent stable between 1987 and 2012. The relative level in 2012 at 56.9 per cent was very similar to the 1987 figure of 58.2 per cent.

The divergence in the relative ICT investment per worker gap by component begins in the mid-1990s, and continued to 2012. As noted, this is a very dramatic shift in the composition of the ICT investment per worker gap, from a relatively uniform gap across all components, to an extremely large gap in software investment per worker, no gap at all in computer investment per worker, and a substantial but comparatively small gap in communications equipment investment per worker.

Table 1: ICT Investment Per Worker, Canada and the United States, Business Sector, Current U.S. Dollars, 1987 and 2000-2012

	Total ICT Investment per worker		Computer investment per worker		Communications investment per worker		Software Investment per worker	
	CAN	U.S.	CAN	U.S.	CAN	U.S.	CAN	U.S.
1987	656	1,127	238	388	233	425	184	314
…								
2000	1,859	3,560	609	884	581	1,072	669	1,604
2001	1,834	3,343	509	751	600	956	725	1,636
2002	1,746	3,086	518	695	536	750	692	1,640
2003	1,766	3,137	554	683	497	739	715	1,716
2004	1,949	3,273	647	701	495	753	808	1,819
2005	2,131	3,320	704	674	496	754	930	1,892
2006	2,251	3,493	794	714	513	821	944	1,958
2007	2,296	3,696	747	720	455	902	1,095	2,074
2008	2,306	3,750	737	698	480	824	1,089	2,228
2009	1,993	3,752	662	678	456	726	875	2,347
2010	2,097	3,877	716	726	474	821	907	2,330
2011	2,273	3,938	752	697	510	822	1,011	2,439
2012	2,310	4,058	756	684	529	856	1,025	2,517
				Annual Average Growth Rate				
1987-2012	5.16	5.26	4.73	2.29	3.33	2.84	7.11	8.68
1987-2000	8.34	9.25	7.49	6.54	7.28	7.38	10.44	13.37
2000-2012	1.83	1.10	1.82	-2.11	-0.78	-1.86	3.62	3.83

Source: CSLS ICT Database Tables S1-4

Note: Figures for Canada converted to U.S. dollars using PPP for machinery and equipment available in CANSIM 380-0057

Because of the large software investment gap, software made the largest contribution of the three ICT components to the overall ICT investment gap. Table 1 shows that in 2012 software accounted for 44.4 per cent of total ICT investment in Canada (vs. 62.0 per cent in the United States), but was responsible for 85.4 per cent of the Canada-U.S. ICT investment gap (Table 2). Communications equipment was responsible for 18.7 per cent of the gap and computers made a negative contribution of 4.1 per cent, given that investment per worker in this ICT component was higher in Canada than in the United States.

Table 2: Decomposition of the Canada-U.S. ICT Investment gap by Component, Canada and the United States, Business Sector, 2012

	Canada ($PPP adjusted)	United States (U.S.$)	Canada relative to the United States	Difference	Relative contribution to gap (per cent)
	A	B	C = A/B	D = A - B	E = D/-1748
Computers	756	684	1.11	72	-4.1
Software	1,025	2,517	0.41	-1,492	85.4
Communications	529	856	0.62	-327	18.7
Total	2,310	4,058	0.57	-1,748	100

Source: Calculations based on CSLS ICT Investment Database Tables S1-4

Figure 2: Trends in Software Investment Intensity in the Canadian and U.S. Business Sectors, 1987-2012

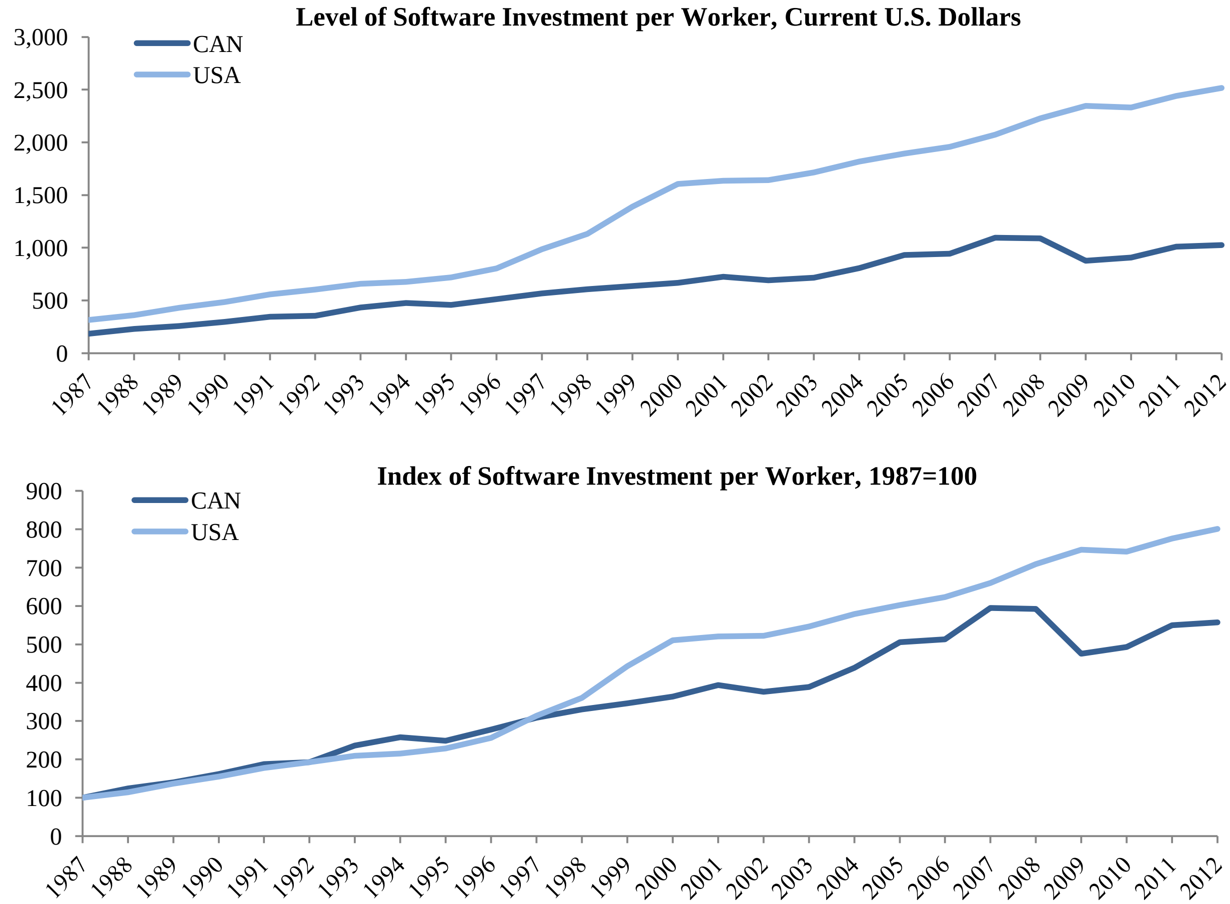
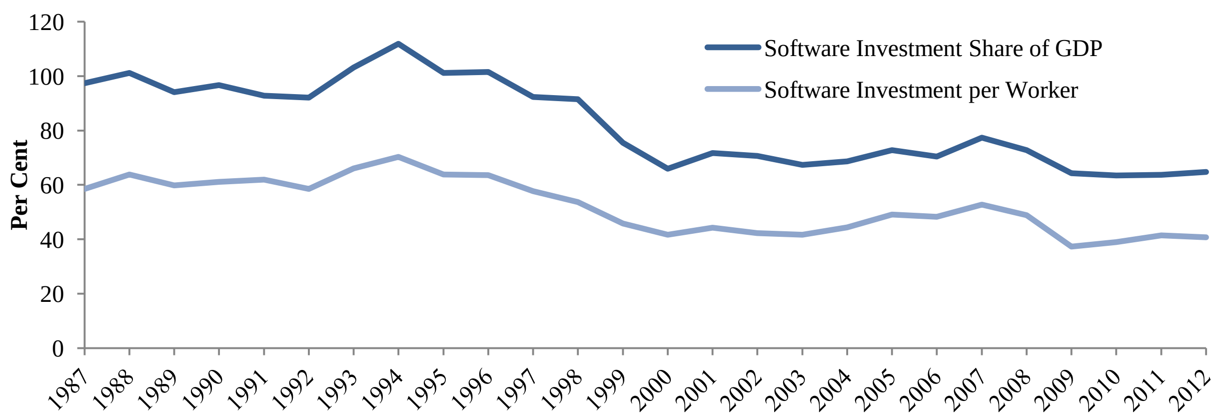


Figure 3: Canada Relative to the United States, Business Sector Software ICT Investment Shares of GDP and Per Worker, Per Cent 1987-2012



Source: CSLS Database sheets S4 and S12.
Note: Shares always estimated in current dollars.

In addition to trends in investment per worker, the investment intensity can be measured in terms of investment as a share of nominal GDP. The advantage of this measure is that it is purely relative and abstracts from the absolute level of investment, which varies across countries because of international differences in productivity and income levels. Figure 3 shows that in 2012 software investment as a share of GDP in the Canadian business sector was 65 per cent of that in the United States. This indicates a better performance than the relative software investment per worker, at just 41 per cent of U.S. levels. However, the massive deterioration of Canada’s relative software performance is very evident from Figure 3, considering that in 1987 Canada's investment in software as a share of GDP was the virtually same as the United States.

B. International Comparisons of Software Investment

The issue of Canada’s software investment gap with the United States must be placed in an international context. If all developed countries experience a similar gap, then Canada’s gap can be considered a normal characteristic of a developed country that is not the world IT leader. On the other hand, if most other developed countries have a much smaller gap than Canada, then this country is an outlier, and the issue assumes greater importance. Canada would have a particular problem that does not affect other developed countries. This section sheds light on this situation.

This section provides a comparison of international software investment in selected OECD countries in order to situate Canada's performance within a larger group of countries. Each country's performance is assessed using two indicators: software investment as a share of GDP and software investment per worker. Data for all countries (except for Canada) are from the EU KLEMS database and the OECD Database; Canadian estimates are from Statistics Canada. For reasons of confidentiality and data availability, these measures are only available for thirteen OECD countries for 1990, 2000, and 2007. Estimates for 1990 and 2000 are in the Appendix. All measures are based on data for the total economy.

Figure 4 presents the ranking of selected OECD countries based on the first indicator, software investment as a share of GDP. From the figure, it can be seen that Canada ranked in the middle of the pack, seventh out of thirteen countries at 1.45 per cent.[3] In other words, Canada's software investment (as a proportion of its GDP) was: higher than countries at the bottom of the distribution such as Italy, Austria, and perhaps surprisingly, Germany; comparable to other countries such as the United Kingdom, Japan and Netherlands; and lower than countries at the top of the distribution such as the three Nordic countries (Finland, Denmark, and Sweden).[4]

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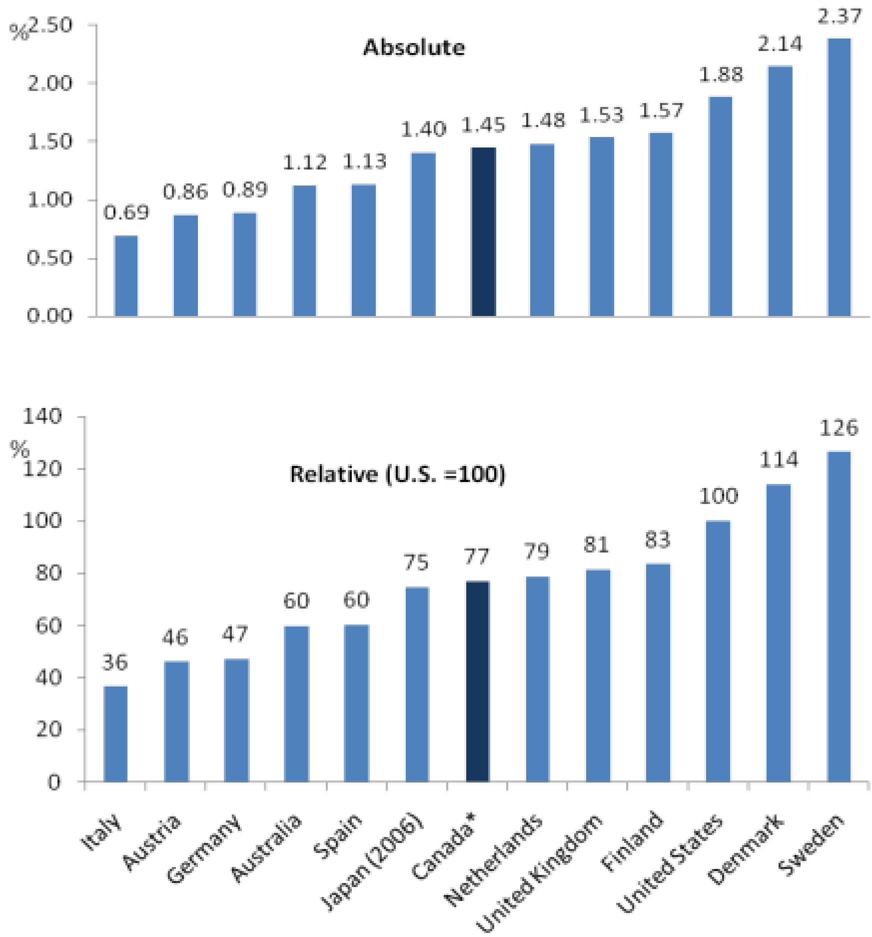
[3] Canada’s performance appears to have improved slightly over time. Using the same indicator, Canada ranked eighth out of thirteen countries in 2000 and 1990.

[4] Note that data for Japan are for 2006 as 2007 data are unavailable.

Relative to the United States, Canada's software investment share of GDP represented 76.9 per cent of the U.S. software investment share of GDP.[5] Only two countries, Denmark and Sweden, had a software investment share of GDP higher than the United States.

Figure 4: Software Investment as a Share of GDP (percent) for Selected OECD Countries, 2007



Sources: For Canada: Investment and net stock figures from Statistics Canada, CANSIM Table 031-0003; GDP data also from Statistics Canada, CANSIM Table 379-0023. For other countries: EU KLEMS Database, 2009 release; OECD Statistics, National Accounts /Main Aggregates (Series: B1_GA). Data for Japan for 2007 is unavailable, presented data for the country is from 2006.

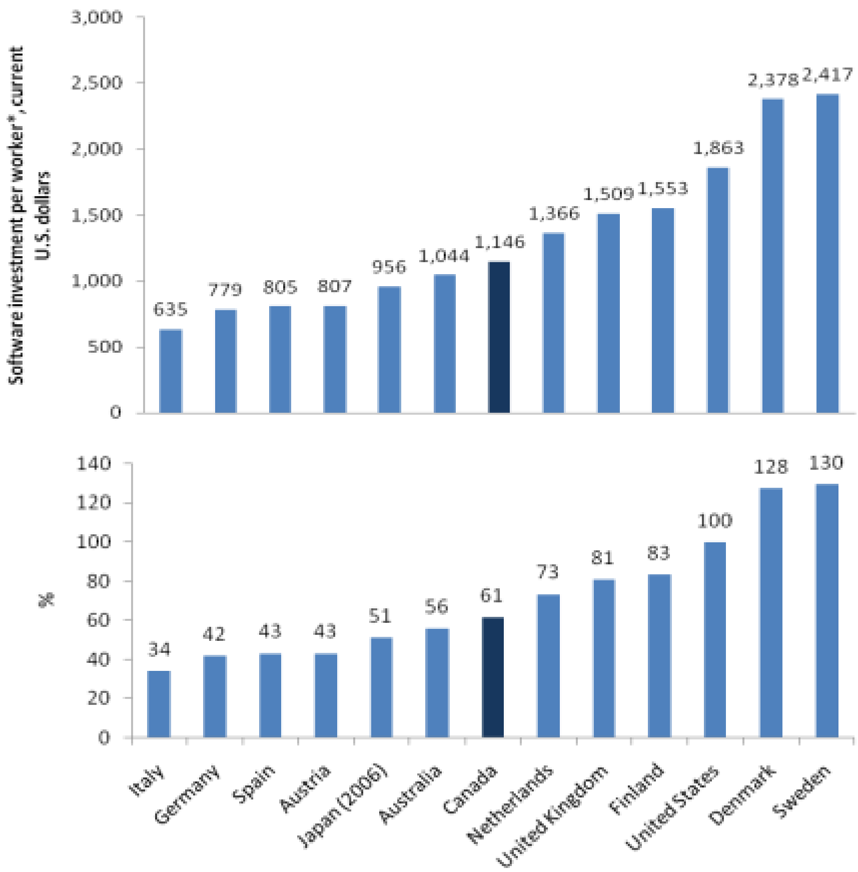
Figure 5 presents the performance of the selected OECD countries using the second indicator, software investment per worker.[6] According to the results, Canada's software

[5] In 2000, Canada's software investment as a share of GDP was 60 per cent of the U.S. software investment share of GDP while in 1990, Canada's software investment as a share of GDP was 78 per cent of the U.S. level.

[6] Note the distinction in definition of employed persons. Statistics Canada defines employed persons as those 15 years and over who during the reference week, worked for pay or profit, or performed unpaid family work or had a job but were not at work due to own illness or disability, personal or family responsibilities, labour dispute, vacation, or other reason. On the other hand, OECD defines persons in civilian employment as those (ages 15 to 64 in most OECD countries) who during a specified brief period, either one week or one day, were in the following categories: *i)* paid employment; *ii)* employers and self-employed; *iii)* unpaid family workers.

investment per worker in 2007 was $1,146 U.S., ranking the country seventh out of the thirteen OECD countries, the same as the ranking for ratio of software to GDP. In other words, Canada's software investment per worker is higher than countries at the bottom of the distribution such as Italy and Germany but lower than countries at the top of the distribution such as Denmark and Sweden. Compared to the United States, the results show that Canada's software investment per worker was 61 per cent of the U.S. software investment per worker. One notes that this is lower than the figure for software investment relative to GDP of 77 per cent, but higher than the 52.8 per cent figure for software investment per worker reported in Figure 1 for 2007. In absolute terms, the two software investment per worker estimates are $1,146 U.S and $1,045 U.S. The latter figure is based on the business sector, not the total economy. In addition to this coverage issue, measurement issues may also contribute to the difference.

Figure 5: Software Investment per Worker for Selected OECD Countries, 2007



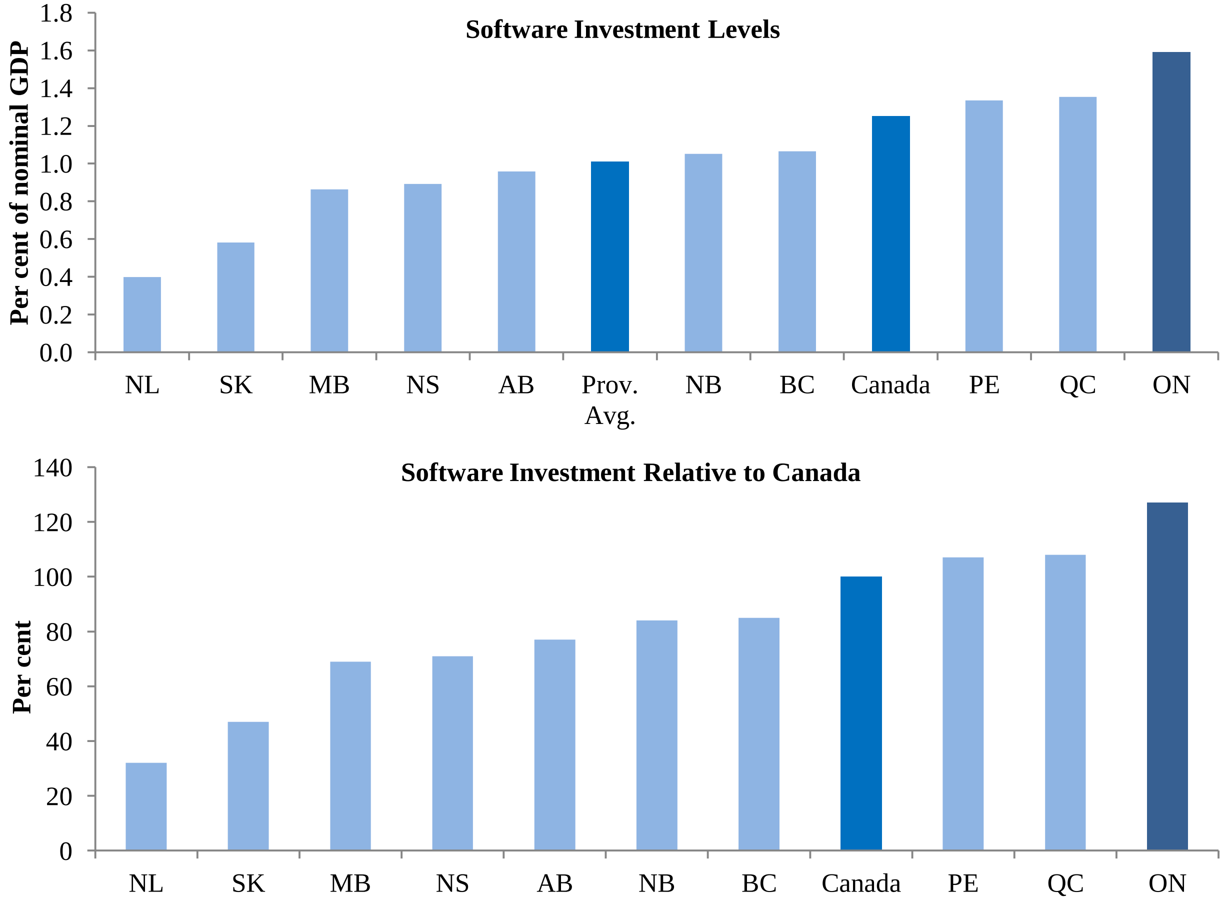
*See Footnote 4

Sources: For Canada: Investment and net stock figures from Statistics Canada, CANSIM Table 031-0003; number of workers from Statistics Canada Labour Force Survey, CANSIM Table 282-0008; Exchange rate from CANSIM Table 176-0049. For other countries: EU KLEMS Database, 2009 release; OECD Statistics.

C. Provincial Comparisons of Software Investment

Software investment varies significantly between Canada's provinces. Ontario is consistently the province with the highest level of software investment, while Newfoundland and Labrador, Saskatchewan, Nova Scotia, and Manitoba are the four provinces with the weakest investment in software, as shown in Figure 6.

Figure 6: Software Investment as Per Cent of Nominal GDP for Canada and the Provinces, 2012



In terms of software investment as a percentage of nominal GDP, all provinces have increased their level of investment since 1981; however, between 2000 and 2012[7], Alberta, Manitoba, Saskatchewan and Newfoundland and Labrador all saw a fall in the share of software investment as a per cent of nominal GDP. Saskatchewan, the province with the most drastic decrease, fell from 70 per cent of the (weighted) average of all the provinces to just under half (Figure 7). Conversely, PEI grew faster than all provinces but Ontario, dedicating 1.3 per cent of nominal GDP in software investment in 2012, compared with 1.56 per cent in Ontario.

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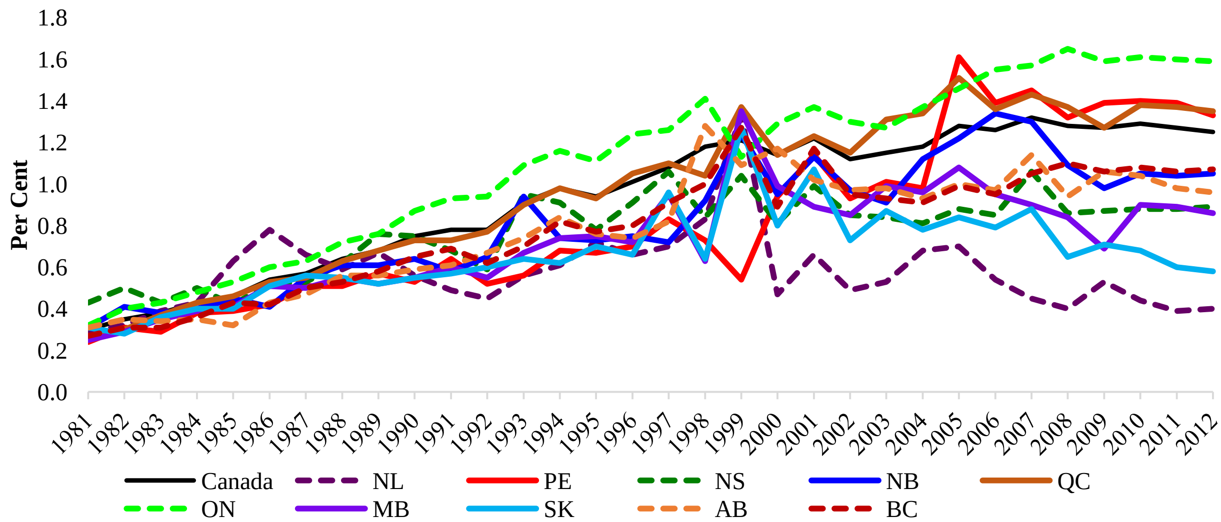
[7] Since 2013 nominal GDP figures are not yet available, figures for software investment relative to nominal GDP only go up to the year 2012; for software investment per worker, however, the most recent data do include 2013.

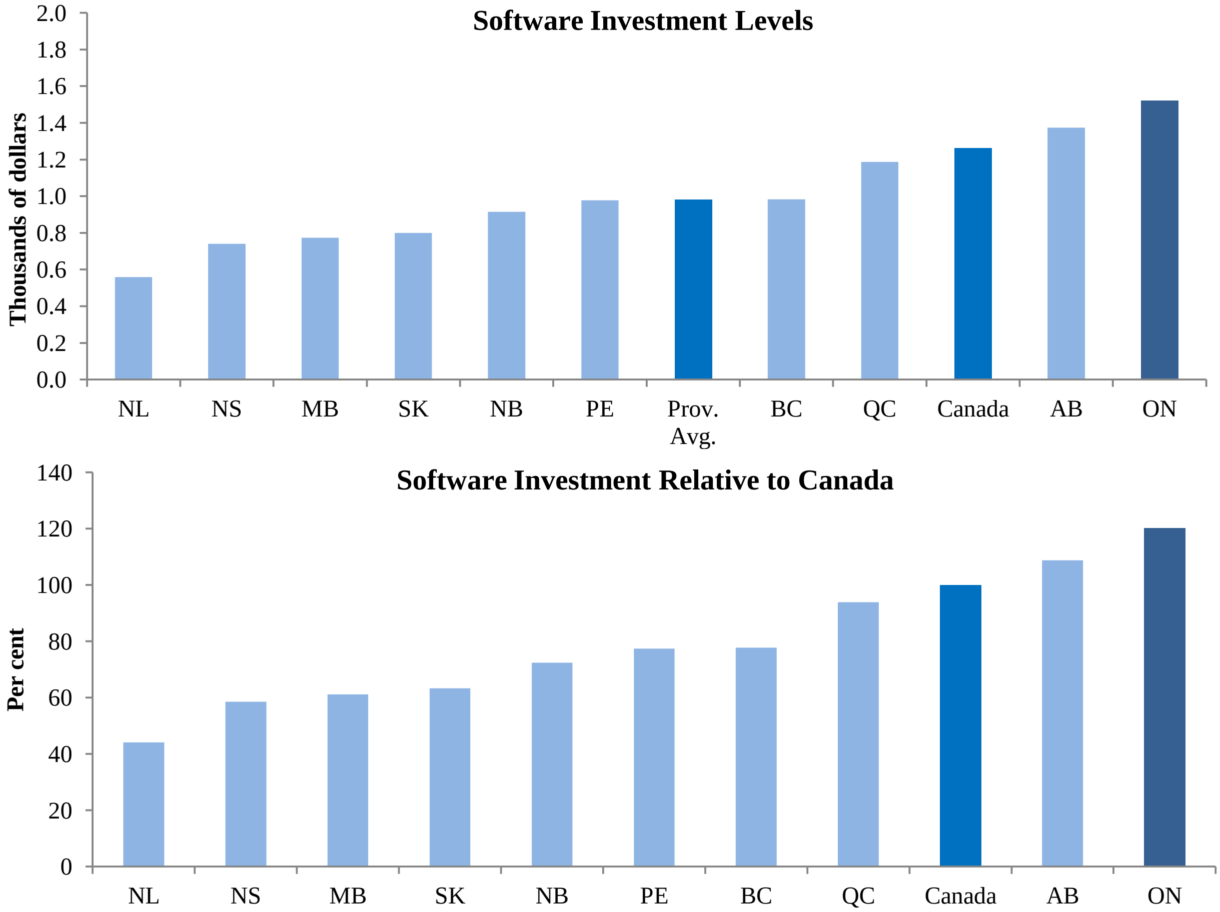
For Canada as a whole, it is interesting to note that the increase in software investment as a percentage of nominal GDP was far greater between 1981 and 2000 than it was between 2000 and 2012, increasing by 0.8 per cent of nominal GDP in the former period and just 0.1 per cent for the latter period. This trend is visible in Figure 7.

Figure 7: Software Investment Relative to Nominal GDP by Province Relative to Canada, Per Cent, 1981-2012



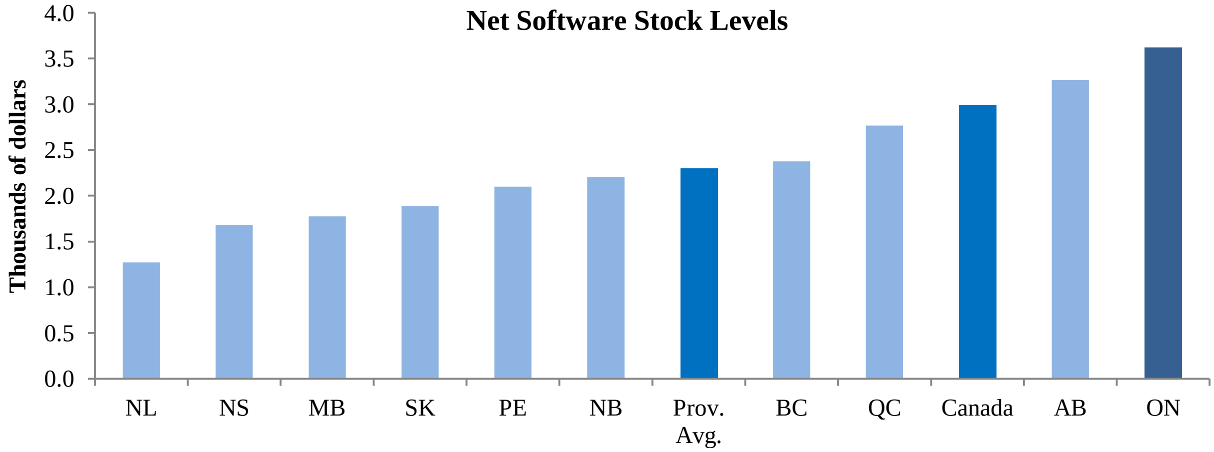
Software investment per worker follows understandably similar trends, in that Newfoundland and Labrador, Nova Scotia, Manitoba and Saskatchewan are the four provinces with the lowest per-worker software investment, while Ontario is the highest, at $1,521 (chained 2007 dollars) per worker in 2013 (Figure 8). However, Alberta – which fell into the bottom half of provinces in terms of software investment as a percentage of nominal GDP (investing less than 1 per cent) – is actually the second-highest province in terms of software investment per worker. Although Alberta is clearly making meaningful investments in its workers ($1,374 per worker annually), its high GDP makes this software investment seem relatively low. Once again, growth in software investment per worker is significantly slower between 2000 and 2013 (4.9 per cent annually) than it was for 1981-2000 (14.1 per cent annually).

Figure 8: Software Investment per Worker for Canada and the Provinces, 2007 Chained dollars, 2013



Overall, Ontario has invested significantly more in software than other provinces since 1981, as evidenced by its total end-of-year net capital stocks of software per worker which, at $3,620 (chained 2007 dollars) in 2013, were fully $1,000 greater than the (non-weighted) provincial average (Figure 9).

Figure 9: Net Capital Software Stocks per Worker, Canada and the Provinces, 2007 Chained Dollars, 2013



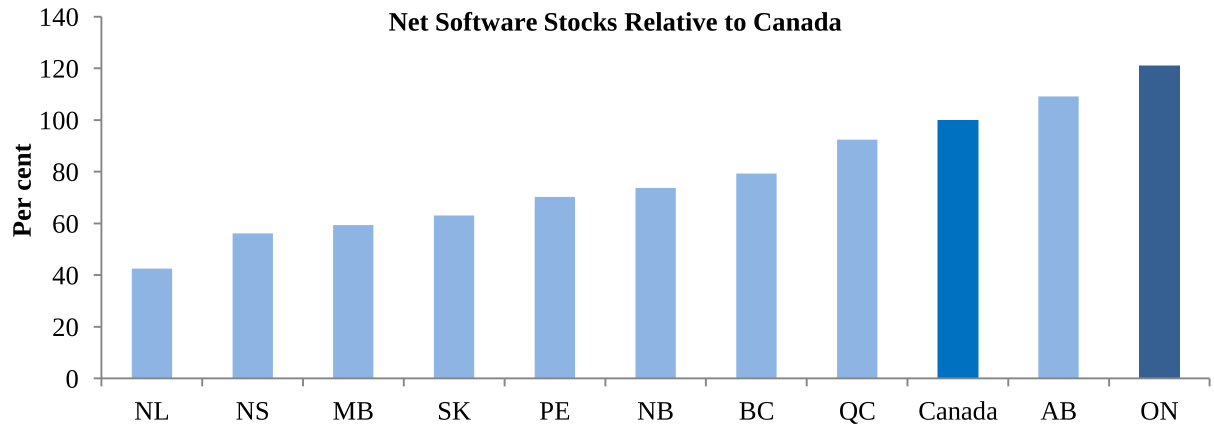
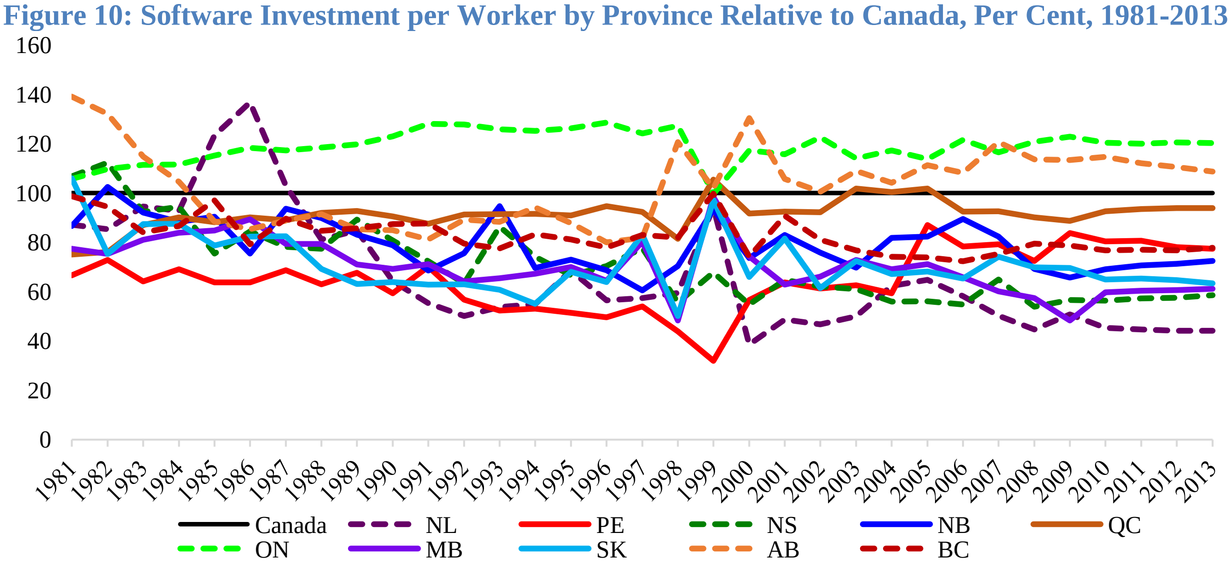


Figure 10: Software Investment per Worker by Province Relative to Canada, Per Cent, 1981-2013



D. Software Investment by Component

Software investment is made up of three components: pre-packaged (also known as 'general' or 'off-the-shelf') software; custom (or 'customized') software; and own-account software. Pre-packaged software is general software which is mass-produced by software developers and sold or licensed to organizations and individuals for daily operations. It is not specialized and can perform a standard set of functions.[8] Custom software is specialized software which is developed by a third party working under contract to address a specific need or problem for an organization. Custom software generally performs a function that is very specific to the organization. Own-account software is software which has been developed by a given organization for internal use and which addresses a need specific to the organization. It is similar to custom software in the sense that it performs organization-specific functions; however, it is not developed by a third party.

In 2009, the most recent year for which data on software components are available for Canada, custom software accounted for 46.5 per cent of total business sector software investment, followed by own-account software (34.0 per cent) and pre-packaged software (19.4 per cent). In the United States, custom software was much lower than in Canada at 33.7 per cent, which the other two components were higher, 38.6 per cent for own account software and 27.8 per cent for pre-packaged software. As Figure 11 shows, for all years over the 1998-2009 period custom software was relatively more important in Canada than in the United States while own-account and pre-packaged data were less important. Between 1998 and 2009, one observes a decline in the relative importance of general purpose software and an increase in the importance of own-account software in both countries.

[8] Source: Statistics Canada (2010).

Figure 11: Proportion of Total Software Investment by Software Investment Type, Canada and U.S., 1998-2009

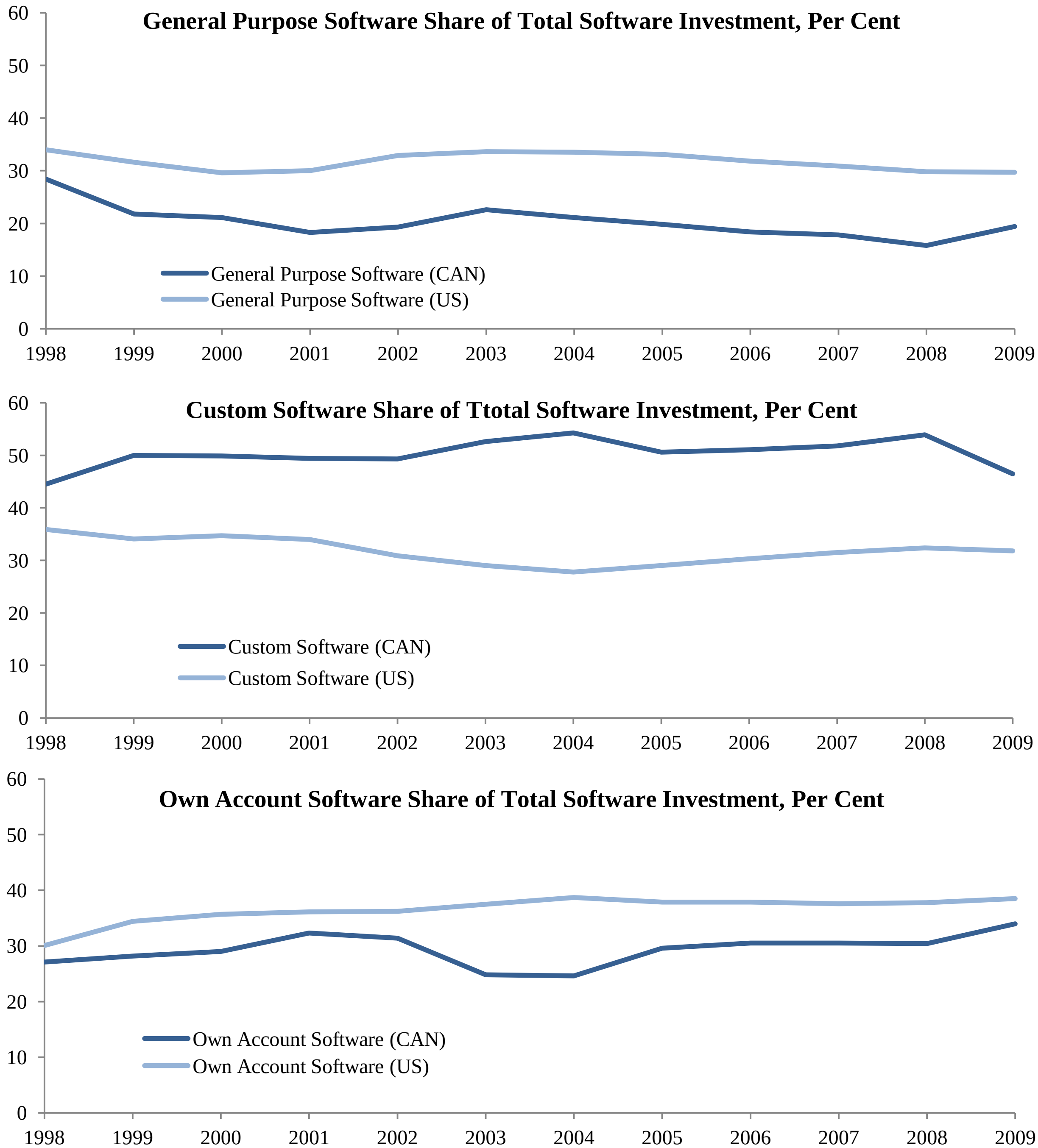


Table 3: Decomposition of the Canada-U.S. Software Investment gap by Software Component, Canada and the United States, Business Sector, 2009

	Canada ($PPP adjusted)	United States (U.S.$)	Canada relative to the United States (per cent)	Difference	Relative contribution to gap (per cent)
	A	B	C = A/B	D = A - B	E = D/[E6]
General Purpose Software	184	697	26.4	-513	34.8
Custom Software	440	746	59.0	-306	20.8
Own Account Software	322	905	35.6	-583	39.6
Total Software	875	2348	37.3	-1473	100.0

Source: CANSIM Table 031-0003 for total software (Fixed Capital Flows and Stocks); CANSIM Table 381-0023 for software components for 2009, unpublished data from CANSIM Table 381-00023 for software components for 1998-2008 obtained from Statistics Canada (Input-Output Tables); BEA Detailed Fixed Asset Table 2.5 for U.S. data; CSLS ICT Investment Database Table S4

Table 3 shows investment per worker in Canada and the United States in current U.S. dollars for each type of software investment, and Canada's investment as a share of U.S. investment. In 2009, the total software investment per worker in Canada was 37.3 per cent of the U.S. level. Canada performed best in relative terms in custom software investment at 59.0 per cent of the U.S. level, followed by own-account software (35.6 per cent) and general software (26.4 per cent). In terms of contribution to the overall Canada-U.S. software investment per worker gap of $1,473 U.S. in 2009, own account software accounted for 39.6 per cent, general software 34.8 per cent, and custom software 20.8 per cent.

E. Software Investment by industry

i. Canada-U.S. Comparisons

Figure 12 shows the total software investment per worker by industry in Canada and the United States for eighteen two-digit industries in 2012.[9] The most salient observation from the figure is the existence of very large differences in software investment intensity across industries. In Canada, software investment per worker ranged from a high of $7,086 in utilities to a low of $42 in accommodation and food services. Seven of the eighteen sectors had software investment per worker less than one half the business sector average of $1,141: Construction ($45), accommodation and food ($112), agriculture, forestry, fishing and hunting ($118), health care and social assistance ($361), other services ($464), retail trade ($597), and ASWMRS (administrative and support, waste management and remediation services) ($669).

[9] Management and Companies and Enterprises is excluded.

In the United States the industry variation was even greater with software investment in information and cultural industries at $21,392 per worker, more than five times the business sector average.

The gap between software investment in both countries was greatest in information and cultural industries.[10] The U.S. software investment per worker was $21,392 in information and cultural industries and in Canada, software per worker for the same industry was $3,398 in Canada, 15.8 per cent of the U.S. level. The gap was also large in a number of other industries including: professional, scientific, and technical services; wholesale trade; finance and insurance; and ASWMRS.[11]

However, for a number of industries, software investment per worker in 2012 was noticeably higher in Canada than in the United States. In real estate rental and leasing, U.S. software investment per worker was $415 and $2,587 in Canada – more than six times the level in the United States. This is in marked contrast to estimates for this sector from OECD data that will be discussed below. Similarly for utilities, U.S. software investment per worker was $3,557 while in the Canadian value was $7,086. Software investment per worker in 2012 was also higher in Canada for a number of other industries including: transportation and warehousing, educational services, and accommodation and food services.

Decomposition by industry is conducted to determine the contributions of the various industries to the gap. First, Table 4 presents the decomposition of the industry differences in 2012 to determine their contribution to the gap. Figure 13 plots the contributions by industry from most important to least important. Employment shares for the United States are used as weights for the relative contribution of each industry. This table supports earlier finding that various industries do not contribute equally to the gap in the business sector software investment per worker between Canada and the United States. The industry group with the highest contribution to the gap was information and cultural services. This industry is responsible for 28.6 per cent of the gap despite only accounting for 2.2 per cent of employment. Similarly, management of companies and enterprises accounted for 19.7 per cent of the gap and 0.1 per cent of employment while professional, scientific and technical services accounted for 13.6 per cent of the gap and 7.3 of employment. In total, these three industries accounted for 61.9 per cent of the gap.[12]

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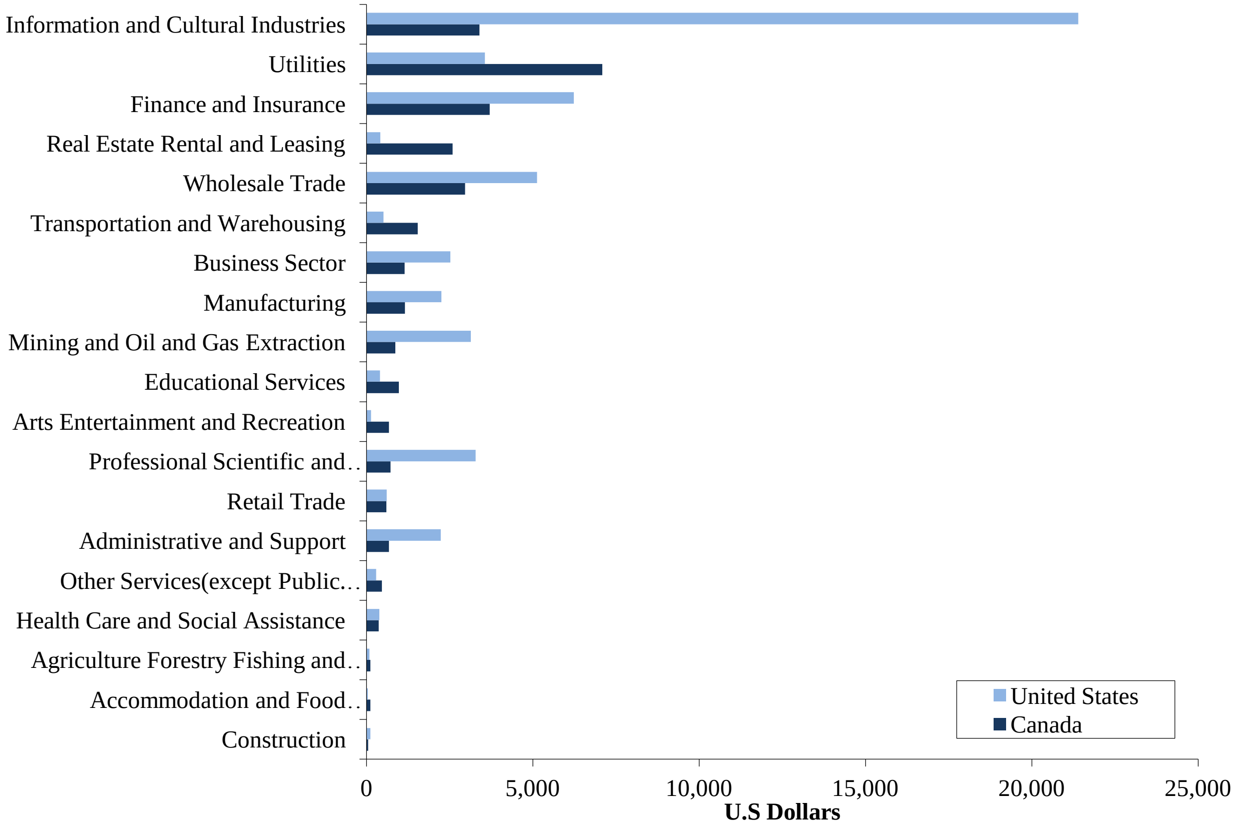
[10] Information and cultural industries include: publishing industries (except Internet), motion picture and sound recording industries, broadcasting (except Internet), telecommunication, data processing, hosting and related services, and other information services.

[11] ASWMRS- Administrative and support, waste management and remediation services.

[12] In 2000, the industry that contributed the to the 36.4 per cent gap is manufacturing, accounting for 19.9 per cent of the gap and 15.0 per cent of the employment. The other two industries with relatively higher contributions were professional, scientific, technical services and information and cultural industries, both industries are consistent with the 2012 results. These three industries accounted for 55.8 per cent of the gap in software in investment

Figure 12: Software ICT Investment Per Worker by Industry in Canada and the United States, current U.S. dollars, 2012



Source: CSLS ICT Database Tables ICT-U.S. 2012 29b-v and ICT-Canada 2012 12b-v

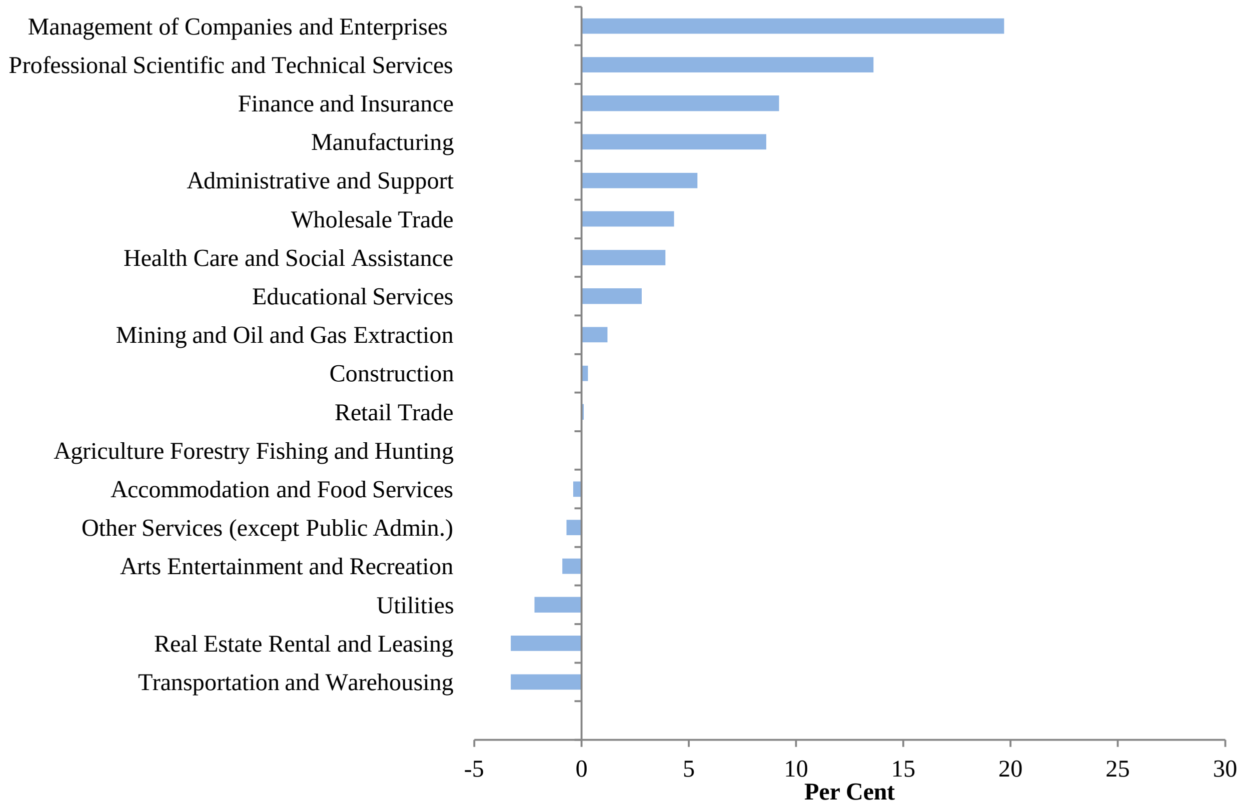
Table 4: Decomposition of Software Investment per Worker by Business Sector Industry, 2012

	Software investment per worker				Industry employment shares for the United States (per cent)	Weighted contribution to the software investment per worker gap (%)
	Canada (current U.S. dollars)	United States (current U.S. Dollars)	Canada relative to the U.S. (per cent)	Difference		
	A	B	C= A/B	D=A-B	E	F= E*D/-1377
Agriculture Forestry Fishing and Hunting	118	84	141.1	34	1.61	0.0
Mining and Oil and Gas Extraction	869	3,130	27.8	-2,261	0.70	1.2
Utilities	7,086	3,557	199.2	3,529	0.88	-2.2
Construction	45	112	40.0	-67	6.60	0.3
Manufacturing	1,157	2,252	51.4	-1,095	10.82	8.6
Wholesale trade	2,964	5,122	57.9	-2,158	2.72	4.3
Retail trade	597	605	98.6	-8	11.92	0.1
Transportation and Warehousing	1,535	506	303.4	1,029	4.48	-3.3
Information and Cultural Industries	3,398	21,392	15.9	-17,994	2.19	28.6
Finance and Insurance	3,706	6,232	59.5	-2,526	5.00	9.2
Real Estate Rental and Leasing	2,587	415	623.7	2,172	2.07	-3.3
Professional Scientific and Technical Services	717	3,282	21.9	-2,565	7.30	13.6
Management of Companies and Enterprises	11,198	208,439	5.4	-197,241	0.14	19.7
Administrative and Support	669	2,234	30.0	-1,565	4.74	5.4
Educational services	0	402	0.0	-402	9.54	2.8
Health Care and Social Assistance	0	380	0.0	-380	14.29	3.9
Arts Entertainment and Recreation	674	137	491.0	537	2.23	-0.9
Accommodation and Food Services	112	42	266.4	70	7.49	-0.4
Other Services (except Public. Admin.)	464	285	163.1	180	5.28	-0.7
Business sector	1,141	2,517	45.3	-1,377	100.00	100.0

Source: CSLS ICT Database Tables ICT-U.S. 2012 29b-v; ICT-Canada 2012 12b-v

Notes: Weighted relative contribution is the difference in each industry relative to the business sector difference in total ICT investment per worker, weighted by the employment shares of that industry in the United States. Industries for which data are not available for both countries are omitted. Education and health care in Canada are treated as zero for the decomposition. Finally, the relative weighted contribution will not sum to 100 per cent exactly, as we only use the U.S. employment weights to calculate the contribution, but the total gaps depend on a blend of U.S. and Canadian employment and ICT component shares. U.S. employment is simply the most important of these weights.

Figure 13: Sectoral Contributions to the Canada-U.S. Software Investment per Worker Gap (per cent of total gap)



Source: CSLS ICT Database Tables ICT-U.S. 2012 29b-v; ICT-Canada 2012 12b-v

Notes: Weighted relative contribution is the difference in each industry relative to the business sector difference in total ICT investment per worker, weighted by the employment shares of that industry in the United States. Industries for which data are not available for both countries are omitted. Education and health care in Canada are treated as zero for the decomposition. Finally, the relative weighted contribution will not sum to 100 per cent exactly, as we only use the U.S. employment weights to calculate the contribution, but the total gaps depend on a blend of U.S. and Canadian employment and ICT component shares. U.S. employment is simply the most important of these weights.

In summary, a review of the nature of the software investment in Canada and the United States reveals much pertinent information.

- There is noticeable variation in software investment per worker at the two-digit industry level in both Canada and the United States. In Canada the industry with the lowest level of software investment per worker was construction ($45) while the industry with the highest level was utilities ($7,086) (note management of companies and enterprises is excluded). The contribution by industry to the software gap appears to remain relatively unchanged from 2000.

- The high level of software investment per worker in management of companies and enterprises (MCE) in both countries is an allocation issue and potentially misleading.

MCE investment represents investments made by head offices. However, U.S. statistical agencies appear to use the head office category for management of companies and enterprises more than their Canadian counterparts, which increases software investment for this industry in the U.S. relative to Canada. This produces an extremely large (and implausible) gap between MCE ICT investment between the two countries. Ultimately, however, these differences in software investment estimates by sector are inconsequential to aggregate estimates of total software investment.

- For two-digit NAICS industries, there is a large variation in the Canada-U.S. relative levels of software investment per worker, ranging from 15.9 per cent (information and cultural industries) to 623.7 per cent (real estate rental and leasing). In four industries, Canada's software investment per worker levels was more than double of the U.S. levels suggesting that Canada-U.S. software investment gap is partly driven by industry-level differences in software investment.

- Six Canadian industries had levels of software investment per worker, relative to those in the United States, lower than the business sector average of 41 per cent. The two most important industries in this category were: information and cultural industries (15.9 percent) and professional, scientific and technical services (21.9 percent). The relative levels of these industries were also lower than the business sector average in 2000 (in addition to manufacturing).

ii. International perspective on software investment intensity by sector

The available data on software investment per worker was disaggregated by industry sectors to determine the relative contribution of the various industries to the average performance and ranking for each country. This analysis was only conducted for 2007 and the software investment data for Canada was from the Statistics Canada while the software investment data for the remaining countries was from the EU KLEMS database. Employment data by industry for: Canada was from the Statistics Canada Labour Force Survey; the United States was from the U.S. Bureau of Labor Statistics; and the remaining countries is from the OECD Employment and Labour Force Market Statistics. While the various employment data sources are based on different statistical industry classifications[13], there is sufficient concordance across sources to produce the presented industry classifications.

From

[13] The KLEMS database is based on the Nomenclature statistique des activités économiques dans la Communauté européenne (NACE), employment data for the United States and Canada are based on the North American Industry Classification System (NAICS) and employment data for the remaining countries is based on the International Standard Industrial Classification (ISIC rev. 3).

Table 5, it can be seen that the average software investment per worker and ranking masks noticeable variation across (and within) countries. Across countries, there was considerable difference in the amount each country invested in software for each worker in similar industries. For example, in the agriculture, hunting forestry and hunting sector, the country with the highest software investment per worker was Denmark ($1,039) while the country with the lowest software investment per worker was Spain ($5). Similarly, in mining and quarrying, the United States had the highest software investment per worker ($6,685) while Spain spent the least per worker on software ($99).

Specifically for Canada, out of thirteen OECD countries, Canada's software investment per worker ranked relatively high (third) in the real estate, renting and business activities sector but ranked quite poorly (thirteenth) in the construction and transportation sectors. In six of the industry groups Canada's ranked sixth to eighth, close to its average ranking of seventh.

Table 4 shows that Canada's software investment per worker was significantly lower than the United States in a number of industries, in particular construction and mining and quarrying, where Canada's software investment per worker represented just nine per cent of the level for the United States.

Table 5: Software Investment per Worker by Industry for Selected OECD Countries, 2007 (USD per worker)

	AUS	AUT	CAN	DNK	FIN	DEU	ITA	JPN*	NLD	ESP	SWE	GBR	USA
Agriculture	215	108	133	1,039	170	126	23	109	277	5	54	248	224
Relative Rank	5	10	7	1	6	8	12	9	2	13	11	3	4
Construction	251	299	56	421	220	178	116	319	372	83	663	327	628
Relative Rank	8	7	13	3	9	10	11	6	4	12	1	5	2
Education	758	107	696	824	866	448	88	193	381	155	1,252	986	1,270
Relative Rank	6	12	7	5	4	8	13	10	9	11	2	3	1
Utilities	5,376	2,598	5,880	2,549	6,929	3,396	2,354	6,033	3,963	2,476	10,299	1,961	6,625
Relative Rank	6	9	5	10	2	8	12	4	7	11	1	13	3
Finance	5,053	5,665	4,674	18,357	15,914	1,412	2,471	4,196	9,864	8,054	19,519	5,683	3,636
Relative Rank	8	7	9	2	3	13	12	10	4	5	1	6	11
Health	399	87	340	111	635	420	249	374	276	329	436	306	803
Relative Rank	5	13	7	12	2	4	11	6	10	8	3	9	1
Manufacturing	729	663	1,003	1,646	1,864	924	679	1,235	2,040	245	3,643	1,858	3,105
Relative Rank	10	12	8	6	4	9	11	7	3	13	1	5	2
Mining	3,072	503	624	3,398	821	427	401	585	19,653	99	1,024	733	6,685
Relative Rank	4	10	8	3	6	11	12	9	1	13	5	7	2
Other	888	295	430	1,517	1,204	518	302	822	349	1,240	1,307	657	427
Relative Rank	5	13	9	1	4	8	12	6	11	3	2	7	10
Real Estate	1,386	2,836	3,380	7,026	1,564	1,627	1,412	951	1,751	757	3,063	3,134	21,887
Relative Rank	11	6	3	2	9	8	10	12	7	13	5	4	1
Transport	2,177	1,290	1,264	5,432	2,033	1,426	1,674	1,423	2,786	4,467	3,074	2,003	3,491
Relative Rank	6	12	13	1	7	10	9	11	5	2	4	8	3
Trade	667	316	966	1,476	1,320	580	434	968	791	497	2,418	1,538	912
Relative Rank	9	13	6	3	4	10	12	5	8	11	1	2	7
Total	1,046	807	1,146	2,378	1,553	779	635	957	1,366	805	2,417	1,509	1,863
Relative Rank	8	10	7	2	4	12	13	9	6	11	1	5	3

Source: Software investment --Canada- ICT CSLS Database (12a -v) and other countries - EU KLEMS Database; Employment-- OECD and Statistics Canada; Exchange rates—OECD

Notes: AUS = Australia, AUT= Austria, CAN= Canada, DNK= Denmark, FIN= Finland, DEU= Germany, ITA= Italy, JPN= Japan, NLD= Netherlands, ESP = Spain, SWE= Sweden, GBR= United Kingdom, USA= United States

*Figures for Japan are for 2006

F. Literature Review

There is an increasing amount of research done on the role of ICT investment and productivity gains. This section provides a brief summary of some of the literature exploring this relationship. Unfortunately, most of the literature has focused on the role of ICT as a whole, with little research dedicated to examining ICT's individual components.

Guerrieri et al. (2003) attempts to establish the determinants of ICT investment, finding that financial conditions, income growth and comparative advantage affect ICT investment, but that hardware and software investments' determinants vary considerably. It is found that software investment does not relate positively to R&D spending or to comparative advantage. This is possibly because software investments are preferred in sectors with low R&D intensity (such as service sectors); as for comparative advantage, the authors suggest that the geographic proximity of producers and consumers that can grant a comparative advantage may favour hardware investment over software investment. Finally, the authors note that in Europe, while ICT investment has considerably increased, the acceleration in productivity growth has not been commensurate with the experience of the United States.

Indeed, the lack of productivity acceleration in Europe is the object of the work of Eicher and Strobel (2008a), who seek to explain why Germany's productivity declined while the U.S. experienced surges in productivity post-1995 and post-2000. They attribute the surge in the U.S. to strong ICT investment, especially in ICT-intensive industries. The authors find that there were significant post-1995 gains in German productivity in ICT-producing industries, yet these were not great enough to offset the declining productivity growth in non-ICT-intensive industries. For the post-2000 period, not even ICT-intensive industries are found to experience higher productivity growth.

Eicher and Strobel (2008b) then examine software investment as a potential driver of productivity growth, finding that the drastic drop in the price of prepackaged software since the 1960s has lead to capital substitution toward software investments, and reductions in the total cost of ICT hardware investments. In fact, the authors assert that software is the crucial interface that ultimately determines the productivity improvement of all ICT investments. Software-intensive industries, specifically, are found to have been the crucial determinant of German productivity growth since 1995, both contributing strongly to productivity growth as well as offsetting the declining investment and productivity levels of other industries. For example, after 1995 per-worker software investment fell in most German industries, while capital investment grew within software-intensive industries, accounting for over half of German productivity growth by 2000-2004, a contribution that cannot be overstated. What's more, software-intensive industries are found to have contributed 35 per cent of German labour productivity growth for since 1991, while falling total factor productivity in other industries actually dragged down German labour productivity by 15 per cent.

This research reveals a clear divide between software-intensive industries and non-software-intensive ones, as the former experienced growth acceleration in capital deepening and total factor productivity, while the latter experienced declines. Pre-packaged software is the most significant software component, responsible for two-thirds of labour productivity growth in software-intensive industries. The authors recommend further research into the complementarities of combining two types of ICT investment (for instance, software and computers). Likewise, the determinants of a given industry's software intensity (what makes an industry become software-intensive) are as of yet unclear.

Kleis et al. (2012) explores the specific interaction of ICT in creating productivity gains, seeking to establish the link between ICT investment, knowledge creation, and the output resulting from innovation. They find that a 10 per cent increase in ICT input is associated with a 1.7 per cent increase in innovation output for a given level of innovation-related spending, with this relationship being particularly strong for the late 1990s. The advantage of ICT is its effectiveness in information sharing and partner monitoring, as well as the reduction of transaction costs on projects with multiple partners; these are all processes in which software plays a key role. The authors emphasize that ICT capital does not contribute directly to creating breakthrough innovations; rather, factors such as strategic orientation, organizational practices, and the management of R&D may be more important to innovation, especially when it comes to "breakthrough or radical innovations". Nevertheless, ICT does contribute positively to the innovation creation process.

II. Synthesis of Key Informant Findings

To complement the statistical analysis of the Canada-U.S. software investment intensity gap given in the following section of the report, and to gain additional insight on possible reasons for the gap, the CSLS in November-December 2013 conducted a number of key informant interviews with persons possessing many years of experience in the IT sector.

This section of the report provides a synthesis of key findings of the interviews. The key informants confirmed that the estimates produced by Statistics Canada showing a large software investment per worker gap between Canada and the United States were consistent with their experience. But there was no consensus among the key informants on the reasons for this gap. Factors found important by some informants were dismissed by others as not important.

i. Organizational and Cultural Factors

Some interviewees feel that company culture is not a factor in the software investment gap because software investment decisions by both Canadians and Americans are driven by the same business needs, despite Canadians being somewhat slower at making such decisions. Other interviewees feel that cultural and organizational factors are important considerations in the software investment gap. According to some interviewees, one fundamental difference between the two countries is that American executives view software not merely as an enabling function but as the very fabric by which business is performed. Greater investment in technology in the United States, some interviewees say, is a by-product of more risk-taking by U.S. firms, which in turn is a necessary prerequisite for the attainment of exponential growth (a key goal in many American businesses).

In addition to cultural differences, a number of behavioural differences by Canadian firms possibly play a role in lowering software investment in Canada relative to the United States. These differences relate to Canadian executives:

- Not seeing the same strategic value in software as their American counterparts;
- Developing weaker ICT strategies and having less of a focus on software and innovation in general;
- Not striving to be early adopters of technology;
- Exhibiting more fear and caution when it comes to software adoption and potentially unsuccessful deployment, in part due to a lack of operational skills (internally) at their companies;

- Fostering fewer business-academia partnerships that can drive innovation in technology at their firms;
- Competing less aggressively than their U.S. counterparts;
- Focusing more on achieving comfortable growth in Canada than on achieving greater innovation and productivity levels and becoming global competitors; and
- Having a greater willingness to continue using existing technology or freeware, hire additional people, and add work shifts as an alternative to making costly investments in operating systems and middleware utilities.

The last difference, which relates to economic considerations, is important to consider when examining why many Canadian SMEs continue to rely on Excel and QuickBooks in their business. Indeed, when some SMEs do decide to take technology risks, they often try to save money by building their own software – even if they lack the necessary capacity to do so. These issues, coupled with the fact that prices for software in Canada are said to be higher than in the United States, possibly discourage software investment in Canada. Generally speaking, however, some interviewees find it plausible that the overall business model at some Canadian companies may not lend itself to new technology.

With regard to competition in Canada, the interviewees find that the degree of competitive intensity varies across the country, with SMEs in big cities such as Toronto being more willing to invest in software than comparable firms in smaller centres. Considering that Canada is deemed generally competitive in many respects according to international metrics, proving that less competition exists in Canada relative to the United States would entail further research into several issues, including where competition is taking place in Canada, and to whom Canadian companies are selling their products or services (i.e. local, regional or global entities).

Large Firms

Some interviewees believe that large Canadian firms with a strong presence in the United States do invest heavily in new software technologies and are just as competitive as their American counterparts. In the banking industry, for example, these interviewees do not observe a significant difference in software investment between banks in Canada and their counterparts in the United States. Other interviewees, however, do find that software purchases by major players in the U.S. banking industry remain significantly higher than those by large Canadian banks. In addition to such differences, these interviewees find variations in the pervasiveness of technology across large businesses in both countries. Such variations are reflected by: (1) a higher usage of devices by employees at work in the United States relative to Canada (the latter reflecting a greater level of comfort with technology in the United States), and (2) the observation that managers at large Canadian companies do not foster as dynamic a flow of information across their supply chains and lines of work as their American counterparts. That is why some interviewees feel that the pervasiveness of technology in the United States remains unique. There have been initiatives to enhance technology's pervasiveness at some large Canadian companies in recent years, but they have been slow.

One final note on company size concerns whether the average size of companies in Canada may be another reason why Canadian investment per worker in software is significantly below American investment per worker. That is, if Canadian companies tend to be smaller than American companies, they may invest less in software.

ii. Estimation and Reporting Considerations

General Measurement Issues

According to the interviewees, several issues arise when it comes to estimating software investment figures in Canada and the United States, which may in turn affect the software investment gap. In particular, issue arise in the following cases:

- When providing software services to Canadian companies, firms like IBM often purchase software from other firms as intermediate inputs. Interviewees questioned whether such purchases of software were accounted for by statistical agencies, assuming they were in fact reported by the companies.

- When software that is developed in one division at a given company is utilized in another, it may not be considered an investment but, rather, own-account software used internally.

- When software is developed and used internally as well as sold as part of global operations as in the case of IBM), is this process considered an investment or merely the production of a product?

- When an investment in software made in a company's home country, but used in another country where the firm has operations, is not reported as an investment in that country, software investment in that country may be underestimated.

- Statistical agencies' measurement and survey methodologies for software investment are potentially yielding inconsistent estimates from Canadian companies. Some interviewees report that there is often little clarity about the categories that statistical agencies refer to in their surveys of software investment, which results in firms sometimes lumping electronic components and the like in categories like “other”, instead of clearly identifying them as investments. These firms may also be underreporting their software investment by labeling certain fees as “business services fees”.

- Software piracy is more prevalent in Canada than the United States, and the pirated software may not be captured in software investment statistics.

- There may be problems with the use of the exchange rate when comparing software spending between Canada and the United States.

Outsourcing and Cloud Services

The validity of the methodologies used to estimate software expenditures in Canada and the United States is an issue that was raised by several interviewees, in particular as it relates to outsourcing and cloud services. If outsourcing is not adequately measured and reported, the Canada-U.S. software investment gap may be affected. For example, some companies in Canada that outsource or utilize cloud services from the United States may be lumping hardware, software and networking services under the umbrella term of “services expenditures” rather than “software investment”[14], which may be distorting software investment figures for Canada. Considering that much IT work in the Canadian private sector is outsourced to U.S. firms – proportionally more than U.S. firms outsource –, it is important to determine whether an underestimation of outsourcing is occurring in Canada.

Open Source Software and Freeware

With software updates becoming more unpopular nowadays, more companies are resorting to freeware like Linux, which was initially developed as a free operating system. The use of open source software may be more common in Canada (especially in Quebec) than in the United States, and such software is often not accounted for in software expenditure figures.

Industrial Structure

Several interviewees suggest controlling for industry composition or mix when comparing software investment in Canada and the United States, since Canada tends to be more weighted toward processing industries, which in turn are less penetrated by computer technology. Other interviewees also find value in eliminating Silicon Valley from the industry mix in the United States and seeing how that might affect software investment figures. Others

[14] Services bills often have software as their main component, and the latter is not always broken down into its different components.

believe that Silicon Valley is as much an innovation and risk culture as it is an investment hub, but that its absence in Canada does not impact businesses' decisions to invest in software. The reason is because a software purchase is an outcome of solving an immediate problem in a given business.

iii. Skills

Supply Side

Some interviewees believe that a lack of qualified people in the technology market in Canada represents one of the biggest – if not the biggest – challenges to investment in software by SMEs and large companies alike. They feel that a shortage of general IT skills, technical IT skills, and functional IT skills exists in the talent pool, and that this lack of skills supply – coupled with internal deficiencies in IT operation skills at some companies in Canada – may be affecting Canadian companies' decisions to invest in software. The lack of skills may be due to:

- Many of the big brand names in the software industry not having a significant presence in Canada. Large as well as small service providers probably pay less attention to the Canadian market because it offers fewer opportunities given its size and the dispersion of its population.

- The task of maintaining an implemented software system at an SME may not appeal to highly skilled and reliable IT practitioners who have numerous work opportunities to choose from.

- The lack of technical support from IT firms for Canadian SMEs may be due to several factors, including a lack of software investment by Canadian firms and reduced spending on software, add-ons and software customization in Canada; some Canadian managers' reluctance to fix or update existing technologies when they are not malfunctioning (especially in times of recession); and the presence of a greater variety of clients in the United States that companies can choose to service.

However, not all interviewees agree that a lack of software use and management skills is a contributing factor to the Canada-U.S. software investment gap. Some say that it typically takes two months to find an appropriate hire for entry-level positions in software use and management, and 5 months to find an appropriate hire for management-level positions; and while Americans usually make faster decision about when to hire, there is probably a similar lag between the "want and get" (demand and supply) for skills in Canada and the United States.

One interesting observation with regard to the lack of internal software skills at some Canadian SMEs is that such companies' financial performance and ability to compete is impressive given their lack of technological "sophistication". One interviewee gave the example of several Canadian businesses he has encountered over the years whose sales were in the $20-30 million without their using email or developing a web presence.

Demand Side

The interviewees mentioned a number of specific issues that may affect companies' demand for persons with software skills in Canada:

- Canadian companies often prefer to buy equipment or undertake activities with a more immediate and direct effect on their work as opposed to paying technology experts for new software implementation and maintenance. This, in turn, may translate into fewer employment opportunities for technology experts in Canada.

- For some software implementation, neither IT knowledge nor skills are needed by Canadian companies since software service providers often offer both in-person and distance-based "train the trainer" programs to facilitate technology adoption.

- The Canadian IT market is not doing enough to attract much-needed IT expertise due to reduced investments in IT in general. Since the implementation of certain software programs has the potential to trigger greater demand for software, reduced investments in software decrease such demand potential.

- Canadian companies tend to rely on who they know in order to resolve some technological problems, as opposed to conducting needs-specific due diligence on the best sources of expert assistance. Complicated software that is implemented by some Canadian firms, however, sometimes does pose usage challenges and entail the use of expertise from the United States.

Education and Training Policies

Some interviewees believe that, while the presence of adequate education and training policies may have affected software investment in the past, this effect is now offset by the fact that younger generations are using software extensively. Others believe that it does not hurt to have sound education or training policies in place in Canada that help to ensure that the incoming labour force has the sufficient skill level and software experience needed by companies. However, they add that the presence of more managers with MBAs in Canada would not necessarily affect the likelihood of a given Canadian company investment in software.

Where training may be needed in Canada is when it comes to proper technology adoption and induced organizational behaviour changes. When investing in or installing software, some Canadian companies and software suppliers reportedly do not foster an effective "change in behaviour" in tandem with new technology use. This can result in some companies using new technologies in old ways, which may in turn undermine productivity since "It is the adoption of technology that creates the productivity, not the deployment of technology."[15]

Software Variety and Awareness

Several interviewees agree that there exists a software awareness gap on the business side in Canada (notably for SMEs, which are the main problem), but not on the individual or consumer side. Larger Canadian companies that operate on a global scale reportedly fare just as well as their American counterparts when it comes to software awareness.

Some interviewees feel that lower software awareness at Canadian SMEs[16] is not a result of varying skills or abilities between the two countries, but a result of previously discussed differences in corporate culture, level of technology investment, and competition in the IT industry. To overcome this gap in software awareness, some interviewees suggest: (1) having a more in-depth introduction to software varieties in the education sector to change corporate views toward software over the long term (five years or so); and (2) ensuring (in tandem) that greater efforts at enhancing technology and innovation are undertaken by Canadian SMEs.

iv. Specific Factors

The Military's Role

Several interviewees agree that the military's role, which is much larger in the United States than in Canada, results in technology and software spillovers into the corporate world. They cite the GPS as an example of the U.S. military's biggest contributions to technology and software. Other interviewees believe that this spillover of technology and software is driven more by company size than by the military's larger role per se.

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[15] According to Gartner Research VP Mike Gotta, technology adoption is "about literacy, understanding technology in the context of work and becoming fluent in its use so that the technology becomes part of a user's work style (and potentially their lifestyle as well)". The deployment of information technology refers to "the architecture, applications, integration, networking, infrastructure, security, and operations". Source: http://mikeg.typepad.com/perceptions/2007/01/technology_depl.html.

[16] Canadian SMEs are deemed significantly behind their counterparts in both Europe and the United States when it comes to software awareness.

Other Factors

The interviewees mentioned several other factors that may potentially affect the Canada-U.S. software investment gap:

- Software upgrades have become unpopular with many people in Canada over the years, and because most software vendors continually upgrade their software, the software does not really become "outdated" over time.

- There is often a lack of reliable cloud computing service providers in Canada.

- There may be a greater embedding of software in the hardware component, and when the cost of software is included in the price of the hardware, it may be more challenging to account for.

III. Explanations of Canada-U.S. Software Investment Intensity Gap

This section of the report discusses factors that may explain the much lower levels of software investment per worker in Canada relative to the United States.[17] The role of lower productivity and income levels in Canada relative to the United States in accounting for lower ICT investment levels, including software is first discussed. The contribution of software measurement issues to the gap is then addressed. The third part examines the issue of cloud computing, while the fourth part looks at software prices. The fifth part then analyses the role of industry structure. The sixth part looks at the issue of software piracy, followed by a seventh part on open source software, an eighth part on cultural differences, and a ninth part on other factors, including taxes, competition, and the size of the small business sector.

A. Labour Productivity

Labour productivity is an important determinant of income per capita, which in turn affects ICT investment per worker, including software investment. In this sense, differences in labour productivity explain part of the Canada-U.S. ICT investment and software per worker gap. Holding constant ICT investment as a share of GDP, a country with higher labour productivity (defined here as PPP-adjusted nominal GDP per worker) will have a higher level of ICT investment per worker compared to a country with a lower labour productivity level. Sharpe and Rai (2013: 66-73) develops a detailed stylized example to clarify this point.

Sharpe and Rai (2013) found that in 2011, the Canada-U.S. ICT investment per worker gap would have been 12.6 percentage points lower *if* the two countries had the same labour productivity level. This finding applies to the software per worker gap as well. This represents slightly less than one-fifth of the ICT gap of 60 percentage points in 2011. The higher share of software investment in GDP in the United States accounted for the remaining fourth-fifths of the Canada-U.S. software gap. Despite some significant fluctuations over the period (especially in the early 1990s), the contribution of labour productivity differentials to the Canada-U.S. ICT software gap in absolute terms has remained fairly stable over time.

It is important to highlight that the decomposition of the Canada-U.S. software investment per worker gap into these two factors offers only a *proximate* explanation of the gap. After all, it does not answer the question as to what exactly is causing labour productivity differences between the two countries or why Canada invests less in software (as a share of GDP) than the United States. It is also true that the difference in labour productivity is not entirely an exogenous phenomenon. It may well be the case that Canada's lower software

[17] For literature on the drivers of software investment, see Eicher and Strober (2008) and Guerrieri et al. (2003). One issue in this literature is how these drivers differ, if at all, from those determining non-software investment.

investment per worker partially explains its lower labour productivity when compared to the United States, rather than the reverse.

B. Differences in Software Investment Measurement Methodology

Software investment was responsible for 85 per cent of the Canada-U.S. ICT investment gap in 2012, and has been responsible for a similar share of the gap for much of the last decade. Software is furthermore the most difficult component of ICT investment to accurately measure. Business accounting practices are generally inadequate for investment surveys to accurately capture software investment, and so software investment in Canada and the United States is estimated using indirect methods. In this section, which draws on the comprehensive analysis found in Sharpe and Rai (2013), we compare the indirect methods used by Statistics Canada and the Bureau of Economic Analysis to estimate investment in the three types of software.

i. Measurement of Pre-Packaged Software

Investment per worker in pre-packaged software in Canada, which was just 26.4 per cent of the U.S. level, was responsible for 31.2 per cent of the total gap in business sector ICT investment per worker on its own in 2009, the most recent year for which detailed data are available. The discussion of measurement methodology in this section should provide a better understanding of the accuracy of these estimates. We review the methodology used by Statistics Canada and the Bureau of Economic Analysis to estimate investment in pre-packaged software, and discuss any differences thereof.

a) Commodity-flow methodology for pre-packaged software investment

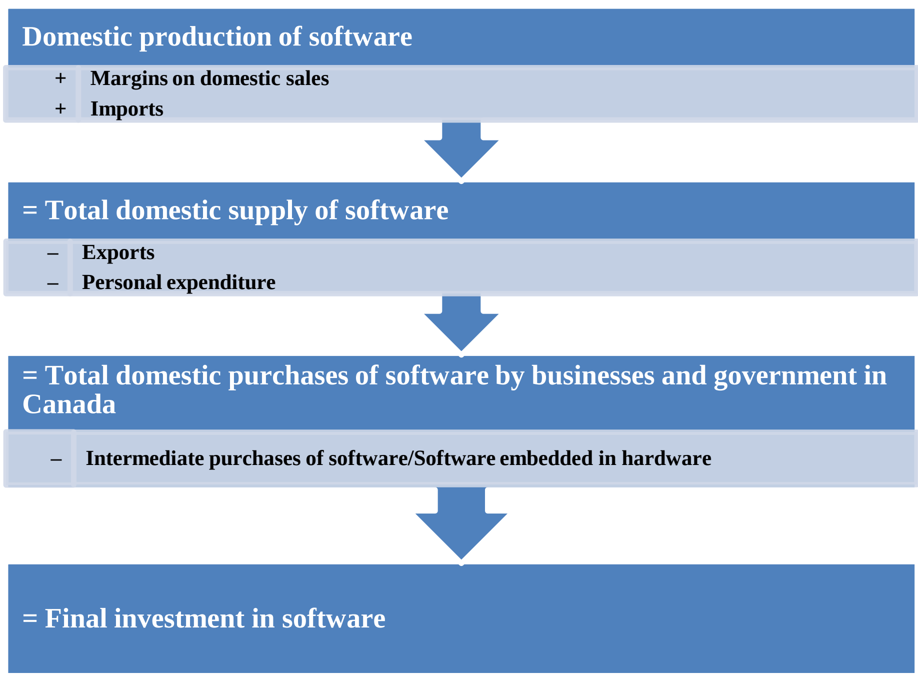
In Canada and the United States, estimates of software investment do not rely exclusively on the survey data due to challenges in business accounting which make it difficult for businesses to report data in sufficient quality or detail. Instead, an indirect method of estimating pre-packaged software investment is used. In Canada, these estimates are constructed by Statistics Canada's Canadian System of National Accounts (CSNA) and then used by FCFS (Fixed Capital Flows and Stocks) to produce estimates of final investment in software. In the United States, the three divisions within the Bureau of Economic Analysis (BEA) are involved in this estimation.

The CSNA uses a commodity-flow method to estimate pre-packaged software investment, shown in Figure 14. First, the CSNA determines total domestic production of pre-packaged software, based on the value of total sales of the producers of software. In Canada, pre-packaged software is produced almost entirely in the software publishing industry (NAICS

511210), sales data for which are taken from Statistics Canada's annual surveys of Computer Services, and International Transactions in Commercial Services.

To this amount, CSNA adds the margins on domestic sales,[18] based on IO benchmarks, and the value of imports, using balance of payments (BOP) and merchandise trade data. This new figure is equal to the total domestic supply of software. From total domestic supply, the CSNA subtracts the value of exports, again from trade data, and the value of personal expenditure by households on software, from Statistics Canada's Annual Survey of Household Spending. This new figure is total domestic expenditure on software – the only remaining adjustment before arriving at final investment in software is to remove intermediate spending, which is largely software purchased to be embedded in hardware. To estimate intermediate spending on pre-packaged software, the CSNA deducts the input expense of the software publishing industries based on IO estimates.

Figure 14: Commodity-Flow Method for the Estimation of Pre-packaged Software Investment in the CSNA



Source: CSLS based on Jackson (2002)

The methodology used by the BEA in the United States is essentially the same. The BEA begins with total domestic production, based on data from the Census Bureau's quinquennial Census of Services Industries and Census of Manufacturers in its benchmark year; in non-benchmark years, the BEA uses receipts of industries involved in producing software from survey data. From this total, they deduct intermediate purchases and changes in inventory. Data

[18] Margins reflect the value of purchaser prices, which will include distribution costs, taxes, and other costs not reflected in the producer or "at-the-gate" factory price.

on intermediate purchases are based on input-output estimates from the computer manufacturing industry based on the census of manufacturers; in non-benchmark years, the shares are assumed to be the same as the most recent benchmark year. Inventory changes are based on IO estimates in benchmark years only; the value of inventory changes in non-benchmark years is assumed to be zero due to a lack of data. This adjustment is equal to the total domestic supply of software for final use; the BEA deducts exports from and adds imports to domestic supply, to produce an estimate of total final investment in software. Table 6 summarizes the methodology and data sources for the commodity-flow estimation of software investment in Canada and the United States.

Table 6: Commodity-Flow Method and Data Sources for Software Investment Estimates in Canada and the United States

Component	Data Source in Canada	Data Source in United States	
		Benchmark Years	Non-Benchmark Years
Total domestic production (Canada) or shipments (United States)	Survey of Computer Services and Survey of International Transactions in Commercial Services (production)	Census Bureau's quinquennial Census of Service Industries and Manufacturers (shipments)	Receipts of programming industries from annual survey data (shipments)
(+)			
Imports	BOP and merchandise trade data		
Margins on Sales	Estimates based on IO margins for producers	n.a.	
(--)			
Exports	BOP trade data		
Inventory changes	n.a.	IO estimates	Assumed to be zero
Personal consumption	Survey of Household Consumption	Census Bureau retail sales	Census Bureau retail trade surveys
Intermediate purchases	Input expense of software publishes	IO estimates for the computer manufacturing industry.	Benchmark year share of intermediate purchases in total purchases.
= Total final investment in software			

Note: n.a. indicates that a step is not performed in that country.

b) Differences in the estimation of pre-packaged software investment

Table 6 shows two differences in the commodity-flow methods in Canada and the United States. The first difference involves how Statistics Canada and the BEA arrive at their initial value of total domestic software production. Statistics Canada begins with producer prices prior to shipment, and adds margins on sales based on estimates from IO data, while the U.S. methodology is based on receipts and is at purchaser prices. In principle, margins on sales should be equal to the difference in producer and purchaser prices, so these methodologies are equivalent.

The second difference is that the BEA explicitly adjusts for changes in inventory in benchmark years, while the CSNA at Statistics Canada makes no adjustment for inventory changes in any year. Data from U.S. benchmark years indicates that inventory changes have traditionally been very small, below 0.2 per cent of the value of purchased software in benchmark years, and so the magnitude of this discrepancy is likely to be extremely small. This is unsurprising, considering that when designing their methodology, the BEA believed it was valid to omit this step for every non-benchmark year.[19] This is because most changes in inventory will already be accounted for through production and sales data.

The most important adjustment, the deduction for intermediate purchases of pre-packaged software, is estimated using essentially the same methodology in Canada and the United States.

There is an additional complication with regard to the estimation of business sector software investment. In Canada and the United States, business sector software investment is calculated as a residual by deducting government purchases of software, which are known from administrative data. The business sector data therefore cannot uniquely identify and exclude software investment by non-profit organizations and charities. This is not an issue for comparing the data, since we are comparing software investment by the same establishments in both countries. However, if the software investment per worker and relative size of the non-profit sectors in Canada and the United States are not comparable, then estimates of the gap based on these data will differ from the true business sector gap. This bias cannot be quantified without uniquely identifying software investment, which is the very same reason it exists. Nevertheless, the non-profit sector is likely small enough in both countries that the contribution to the total gap of software investment by those establishments is relatively small.

Having reviewed these factors, it appears very unlikely that measurement differences account for any significant portion of the extremely large gap in pre-packaged software investment per worker. This means that Canada’s very low level of investment per worker in pre-packaged software, which was just a quarter of the United States in 2009, is largely unexplained.

ii. Measurement of Custom Designed Software

The measurement methodology of custom design software in Canada and the United States is exactly the same as for pre-packaged software. The description of the commodity-flow method in Figure 14 and the sources in Table 6 apply to custom software as well, and there are no major differences in the overall methodology. There is, however, one key difference in the calculation of intermediate purchases. Statistics Canada is able to identify all intermediate

[19] Benchmark years are based on the quinqennial censuses, and so they occur every five years.

purchases of software, but is not able to uniquely identify pre-packaged and custom software; all intermediate software purchases are therefore assigned to pre-packaged software. The BEA, in contrast, only identifies intermediate purchases of pre-packaged software, and reduces custom software by the same amount. In general, these intermediate purchases are difficult to measure, and so a fair amount of judgment was required to develop these methodologies. The estimates of intermediate purchases are always continually revised based on benchmark shares and software investment estimates.

The difference in the methods used to account for intermediate purchases cannot affect the overall gap or the gap in software investment, but it will affect the gap by software type and the share of software investment in each type of software. This is because Statistics Canada, by explicitly assigning all intermediate purchases of software to pre-packaged software, reduces the share of software investment in pre-packaged software, and increases the share of investment in custom software. This explains some of the greater share of custom software investment in Canada relative to the United States, shown in Table 7.

Table 7: Shares of Software Investment by Type of Software, Canada and the United, 2009

	Pre-packaged	Custom	Own Account
Canada	19.4	46.6	34.0
United States	29.7	31.8	38.5

Source: CANSIM Table 381-0023 and BEA Fixed Asset Account detailed table 2.5

Note: All figures refer to business sector investment in current dollars.

However, total intermediate purchases of purchased – meaning both pre-packaged and custom design – software comprised only 4.6 per cent of software investment in 2009, according to IO input estimates from Statistics Canada. Even reducing the share of custom software and increasing the share of pre-packaged software by this amount only makes a modest difference to the distribution software investment in Canada. This explains only a small percentage of Canada's large gap in pre-packaged software investment per worker.

More to the point, however, this difference in the treatment of intermediate purchases does not affect total software investment. Based on our analysis in this section, we conclude that measurement differences in custom designed software cannot account for a significant portion of the Canada-U.S. software investment per worker gap. The methodology used by Statistics Canada and the Bureau of Economic Analysis for both categories of purchased software is in fact essentially the same.

iii. Non-Capitalized Purchases of Software

Investment data in Canada and the United States only include capitalized purchases of software. For the two categories of software investment considered, this refers to two types of purchases: (1) leases or licensed software, which are considered investment made by the lessee in both countries, and (2) purchases of either pre-packaged or custom software. In recent years, cloud computing has emerged as a new technology, but its use is generally governed by Software-as-a-Service (SaaS) agreements, which are not included in either of the preceding categories. SaaS agreements are considered services, not assets, and so will not be classified as fixed capital formation. From the perspective of capital use, however, SaaS agreements are an example of extracting capital services from existing capital stock.

The potential measurement issue is that cloud computing agreements may be more appropriately considered investment, as they do increase the amount of software available to a worker. SaaS agreements therefore have the potential to affect the allocation of software investment estimates in two ways. First, domestic production of cloud computing software will be considered investment by the owner of the software, while the expenditure of the establishment using the software as part of a SaaS agreement is engaging in trade in services. This means that the allocation of investment on an ownership basis, rather than a use basis, may be misrepresenting ICT investment per worker by industry. Second, the same allocation problem exists with respect to trade; SaaS agreements with non-residents will not affect estimates of software investment, even though they may increase or decrease the software available for domestic use. A third issue, arising from the second, is that if the capital services extracted from cloud computing software held by non-residents are better considered investment, then it is possible that software investment is currently under- or overestimated.

Detailed domestic data and international trade data on the trade in computer and information services trade, however, are not capable of uniquely identifying SaaS agreements to allow us to quantify to what degree this may affect estimates of software investment. As the vast majority of ICT-related imports in both countries tend to be for data processing services, it is unlikely that a large number of SaaS agreements are crowding out capitalized purchases of software in Canada or the United States.

In 2011, for example, the share of computer and information services imports in computer and data processing services in the United States was 92 per cent, according to U.S. Trade in Services data. The same detailed data are not available on CANSIM, but the data on trade in services (available in CANSIM 376-0033) indicate that Canada has a trade surplus in computer and information services. A trade surplus means Canada is a net exporter of computer services, which is not consistent with the hypothesis that a significant volume of SaaS imports are leading to software investment in Canada being underestimated. We find that it is very unlikely that this complication has a significant impact on the gap, but as cloud computing grows, more detailed data measuring purchases of these services is warranted.

iv. Measurement of Own-account Software

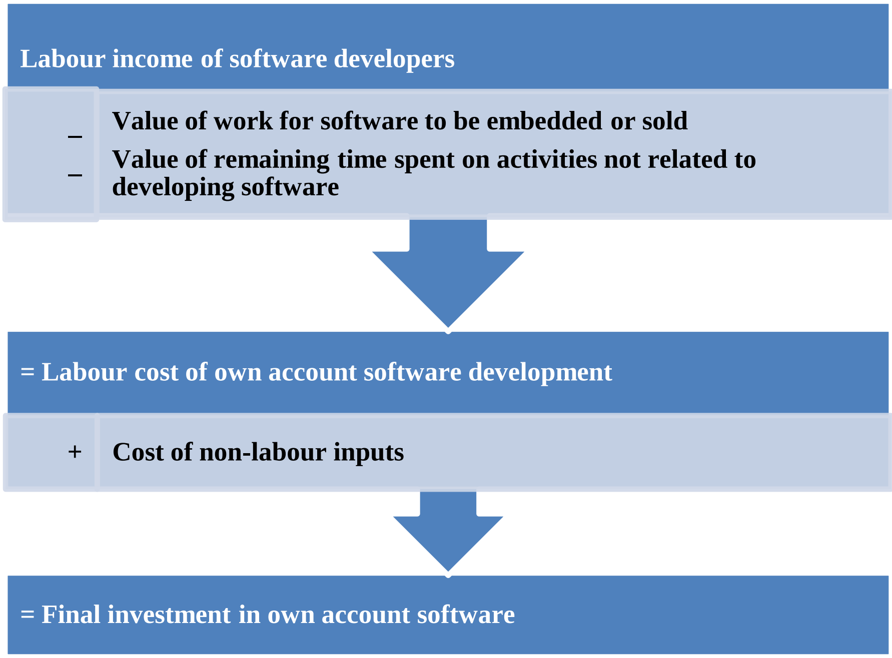
We focus now on own-account software investment, motivated by the fact that it was responsible for 35.1 per cent of the Canada-U.S. ICT investment per worker gap in 2009, and that it tends to account for approximately one-third of software investment in both Canada and the United States. Business accounting practices are even more inadequate for investment survey data to accurately measure own-account software, compared to pre-packaged and custom software. Indeed, in interviews with Statistics Canada, the staff administering the CES indicated that while the response rate for the survey overall was more than satisfactory, the response rate for the section for own-account software was extremely low. This challenge has led to the development of indirect methods for estimating own-account software in Canada and the United States, which we describe in this section. We have previously identified that own-account software investment was responsible for 35.1 per cent of the total Canada-U.S. ICT investment per worker gap in 2009; this extraordinary contribution to the gap motivates our investigation into how estimates of own-account software investment are produced.

At the outset, we note that the methodology to measure own-account software used by the CSNA in Canada was largely based on the methodology used by the BEA in the United States. Any sources of measurement error are therefore likely to be symmetrical – they will introduce the same bias into the estimates of both countries, which will not have a clear effect on the gap. It is also therefore unlikely that differences in measurement methodology will account for a significant portion of the Canada-U.S. gap in software investment per worker. Nevertheless, we provide an explanation of the methodology and note where they differ in this section.

a) Cost-based methodology for own-account software investment

Own-account software is not bought or sold on a market, and as a result, it has no market value comparable to the purchaser price values we use for determining final investment in purchased software. Consequently, the CSNA and BEA use a cost-based approach to measuring investment in own-account software. The cost-based methodology used by Statistics Canada is shown in Figure 15.

Figure 15: Methodology for own-account software investment at the Canadian System of National Accounts



The CSNA methodology uses labour and non-labour costs of own-account software development to estimate the value of own-account software. The process begins with the total labour income of software developers, deducting the labour costs of other activities software developers are engaged in, and adding the non-labour cost of own-account software development. Non-labour costs include the depreciation of machinery and equipment, utilities, travel, property and other taxes, and overhead, including personnel, accounting, and procurement.

From Figure 15, there are four values which must be computed for the methodology used in Canada: (1) the labour cost of software developers; (2) the proportion of their labour cost that produces software for sale or embedding in hardware; (3) the proportion of their labour cost not spent on developing own-account software; and (4) the cost of other inputs. The methodology and data required in the United States are essentially the same.[20]

[20] The BEA methodology for current-year quarterly estimates is different from what is described here, but our focus is on the annual estimates, which follow this methodology.

Table 8: Data Sources for Own Account Software Estimates in Canada and the United States

	Data source in Canada	Data source in the United States
Labour cost of programmers	Census of population	BLS occupational employment survey
(–)		
Deduction for embedded software and software for sale	Cap of 1 per cent of the labour income of employees in software producing industries	Cap of 1 per cent of the employment of computer programmers
Time spent not developing software	50 per cent reduction of remaining income assumed	50 per cent reduction of remaining income assumed
(+)		
Non-labour inputs	Estimate non-labour inputs from labour inputs, based on cost structure of custom software production from Survey of Computer Services	Estimate non-labour inputs from labour inputs, based on cost structure of custom software production from Census of Service Industries
(=)		
Final investment in own account software		

Note: the labour cost in both countries is adjusted to include benefits, employment insurance, public and private pensions, performance pay, etc., to provide a comprehensive reflection of the cost to employers.

Each step in this process is based on data from either the census or surveys, except for the two deductions. The first deduction, for embedded software and software for final sale, is slightly different in the two countries; we leave this issue for the next section. The second deduction subtracts 50 per cent of the remaining labour income of software developers, on the basis that software developers only work on developing own-account software for about half of their time. This is based on a study in the United States from 1981 of how software developers use their time, which found that software developers use 62 per cent of their time to develop software.[21] The BEA and Statistics Canada arbitrarily reduced the share to 50 per cent, on the basis that this is an approximate exercise. They were also motivated by a belief, when this methodology was developed following the 1981 study this share is taken from (Boehm, 1981), that own-account software was becoming less important.

b) Differences in the estimation of own account software investment

Table 8 reveals one difference in the methodologies used to estimate own-account software investment in Canada and the United States. This is the deduction for embedded software and software for final sale: in Canada, this deduction is based on an estimate that software developers account for roughly 1 per cent of all wages, salaries and supplementary income in industries not engaged in producing software for sales or embedding it in hardware. The CSNA uses this percentage to cap the labour cost of software developers in software producing and developing industries, on the basis that any labour cost above this amount must be for the purpose of producing software to be embedded or sold. The BEA performs the same adjustment, but it is based on 1 per cent of the employment of software developers, not 1 per cent of their income. Given different average wages, this will result in a different share of

[21] The study in question is: Boehm, B (1981).

income being excluded. However, both Canada and the United States have verified and adjusted these shares using survey data, so any inconsistency resulting from this difference in methodology will reflect a real difference in the production of own-account software in Canada and the United States.

As this is the only apparent difference in the methodologies used by Statistics Canada and the BEA to estimate the production of own-account software, we conclude that there are no significant differences in the methodology used to measure own-account software in Canada and the United States.

v. Impact of Wages on Own Account Software Investment Estimates

The previous section discussed the cost-based methodology for estimating own-account software in Canada and the United States, which relies heavily on the labour income of software developers, and determined that the methodologies are largely the same.

However, the fact that U.S. salaries are greater for software developers is a conceptual challenge to this cost-based approach to valuing own-account software. In theory, a software developer with the same skill level could earn more, and contribute to a greater level of own-account software investment, simply by virtue of being employed in the United States. This could occur even if a software developer in each country produced precisely the same software for their employer to use. In this case, the greater level of investment in the United States does not reflect differences in software investment, but instead only reflects the fact that software developers in the United States earn a salary premium relative to their counterparts in Canada. This section explores this conceptual challenge, examining how own-account software investment in Canada changes if software developers in Canada earned U.S. wages.

Our methodology in this section to produce an estimate of how this wage gap has affected the Canada-U.S. ICT investment per worker gap will be as follows. We use employment and wage data from 2005 to establish a wage gap; 2005 is chosen because it was a census year in Canada, so we have the greatest level of detail for employment and average earnings in this year. Second, we use the wage gap and the data we have for own-account software investment for 1998-2009 to see what impact the difference in wages between Canada and the United States for software developers had based on that data. This will allow us to provide an estimate of the difference in wages of software developers on the Canada-U.S. ICT investment per worker gap.

a) Differences in labour cost of software developers

Statistics Canada and the BEA use a cost-based methodology described in the previous section to estimate own-account software. The labour cost of software developers is the primary input – some of this cost is deducted for time spent on other work, and the remaining cost is increased using the ratio of operating expenses to labour costs. All of these relationships are proportional, so an increase in labour costs would, in this methodology, also result in an increase in the estimated non-labour inputs.

Our estimate of the wage is shown in Table 9. The software developers in Statistics Canada's cost-based methodology consist of NOC 2006 C071-75, so we include these occupational codes.

Table 9: Average Salary of Software Developers in Canada, 2005

NOC Code(s)	Occupation	Employment	Share of Employment	Average Salary	Relative to All Occupations
NOC 0	All Occupations	17,146,135	100.00	37,855	100.00
C071	Information systems analysts and consultants	142,400	0.83	61,448	162.33
C072	Database analysts and data administrators	13,630	0.08	54,474	143.90
C073	Software engineers and designers	30,740	0.18	71,486	188.84
C074	Computer programmers and interactive media developers	100,365	0.59	52,375	138.36
C075	Web designers and developers	20,550	0.12	31,618	83.53
	Total Software Developers	307,685	1.79	57,190	151.08

Source: 2006 Census, see Appendix Table 16a for detailed calculations.

Note: Average salary for all software developers is weighted average of NOC codes C071-5.

The same data for the United States is provided in 2006, for the Standard Occupation Classification (SOC) codes that the BEA informed us they use in their cost-based methodology. The BLS Occupation Employment Statistics, which we have taken these estimates from, is also the source of data used by the BEA to estimate own account software. The SOC code numbers have changed since 2006, but they are substantially the same otherwise.

Table 10: Average Salary of Software Developers in the United States, 2006

SOC Code (2006)	Occupation	Employment	Average Salary	Share of Employment	Salary Relative to All Occupations	Relative to Canada
00-0000	All Occupations	130,307,840	37,870	100.00	100.00	116.33
15-1021	Computer Programmers	389,090	67,400	0.30	177.98	..
15-1031	Computer Software Engineers, Applications	455,980	79,540	0.35	210.03	..
15-1032	Computer Software Engineers, Systems Software	320,720	84,310	0.25	222.63	..
15-1051	Computer Systems Analysts	492,120	70,430	0.38	185.98	..
	Total Software Developers	1,657,910	74,910	1.27	197.81	152.31

Source: BLS Occupational Employment Statistics.
Note: Relative to Canada is estimated using GDI PPP of 0.86 in 2005.

Based on these data and GDI PPP of 0.86 in 2005, software developers earned 52.31 per cent more in the United States: $74,910 compared to $57,190 earned in Canada. We use GDI PPP to convert instead of exchange rates because PPP reflects differences in prices and provides a more accurate comparison of the labour cost of employing software developers in Canada and the United States.

Before applying this estimate of the wage gap to our data on own account software investment, we note three important differences between Table 10 and Table 11. First, software developers earn much more relative to the national average in the United States than Canada. Software developers in the United States earn nearly twice as much as the average salary for all occupations, compared to around 50 per cent more in Canada. Second, Statistics Canada includes web developers in their definitions of software developers, while the BEA does not. Web developers make up a relatively small share of employment, but we still note that the two countries have different definitions of software developers for the purpose of estimating own-account software. Third, software developers make up a significantly smaller share of total employment in the United States than Canada. Their employment share of 1.79 per cent is 40.9 per cent higher than the U.S. share of 1.27 per cent.[22]

It is surprising that own-account software investment per worker is so much lower in Canada than the United States given that there are relatively more software developers in Canada. This difference could be explained in part by a larger share of software developers in Canada working in industries which only sell or embed software in hardware. The wage difference, of course, also explains part of this discrepancy, but not all of it. Further research is required to determine precisely why own-account software investment per worker is so much lower in Canada than the United States despite greater employment of software developers.

[22] Software developers in Canada represented 1.78 per cent of the working-age population in 2005, compared to 0.73 per cent in the United States, based on LFS and CPS data.

We also note that the U.S. salary premium estimate of 52.31 per cent in Table 11 depends on the value of PPP for GDI, which we used to convert CAD to USD. Given similar growth rates of nominal salaries in Canada and the United States, the U.S. salary premium will change over time depending on the relative value of the CAD and USD as measured by PPP. To allow our estimate of the U.S. salary premium to change over time, we assume that the growth rates of nominal salaries in Canada and the United States are close enough that changes in the U.S. salary premium will depend only on changes in PPP. This estimation is shown in Table 12.

Table 11: Salary Premium of U.S. Software Developers Relative to Canada, 1998-2009

	U.S. Salary Premium in 2005 in domestic currency(per cent)	GDI for PPP (USD per CAD)	U.S. Salary Premium Adjusted for PPP(per cent)
	A	B	C = A/B
1998	130.98	0.83	157.81
1999	130.98	0.83	157.81
2000	130.98	0.83	157.81
2001	130.98	0.84	155.93
2002	130.98	0.83	157.81
2003	130.98	0.84	155.93
2004	130.98	0.84	155.93
2005	130.98	0.86	152.31
2006	130.98	0.88	148.84
2007	130.98	0.91	143.94
2008	130.98	0.94	139.34
2009	130.98	0.92	142.37

Source: Appendix Table 16a

b) Contribution of salary differences to the gap

Using the data we have for own-account software investment from the Input-Output tables, we can use the U.S. salary premium for software developers shown in Table 12 to estimate own-account software investment in Canada adjusting for the Canada-U.S. wage differential for software developers. This will allow us to produce an estimate of the contribution of wages to the Canadian-U.S. ICT investment per worker gap for the 1998-2009 period, based on data for own-account software investment in Canada. This depends on our previous assumption that nominal growth of salaries of software developers in Canada and the United States is similar.

We can see from Table 13**Error! Reference source not found.** that, using the adjusted values of own-account software, the total Canada-U.S. ICT investment per worker gap shrinks by approximately four percentage points in each year, representing about seven per cent of the total Canada-U.S. ICT investment per worker gap.

Table 12: Simulated Canada-U.S. Investment per Worker Gap Based on U.S. Salaries for Canadian Own Account Software Investment, 1998-2009

	U.S. Salary Premium (per cent)	Actual Investment per Worker in Canada (U.S. dollars)			Simulated Investment per Worker in Canada (U.S. Dollars)		
		Own Account	Software	Total ICT	Own Account	Software	Total ICT
	A	B	C	D	E = A x B	F = C – B + E	G = D – B + E
1998	157.8	163	608	1,554	257	702	1,649
1999	157.8	178	636	1,691	280	739	1,793
2000	157.8	183	669	1,859	289	774	1,965
2001	155.9	233	725	1,834	363	855	1,964
2002	157.8	211	692	1,746	333	814	1,868
2003	155.9	181	715	1,766	283	816	1,868
2004	155.9	205	808	1,949	320	923	2,064
2005	152.3	286	930	2,131	436	1,080	2,280
2006	148.8	305	944	2,251	454	1,093	2,400
2007	143.9	334	1,095	2,296	480	1,241	2,443
2008	139.3	331	1,089	2,306	461	1,219	2,436
2009	142.4	322	875	1,993	458	1,012	2,129

Source: Appendix Tables 16a and 16b

Table 13: Canada-U.S. ICT Investment per Worker Gap at U.S. Salaries for Software Developers, 1998-2009

	Actual Canada Relative to the United States (per cent)			Simulated Canada Relative to the United States (per cent)			Difference (percentage points)		
	Own Account	Software	Total ICT	Own Account	Software	Total ICT	Own Account	Software	Total ICT
	A	B	C	D	E	F	G = D - A	H = E - B	I = F - C
1998	47.8	53.7	57.6	75.5	62.0	61.1	27.7	8.33	3.50
1999	37.2	45.8	54.3	58.7	53.1	57.6	21.5	7.39	3.30
2000	32.0	41.7	52.2	50.5	48.3	55.2	18.5	6.60	2.97
2001	39.5	44.3	54.9	61.6	52.3	58.8	22.1	7.96	3.90
2002	35.5	42.2	56.6	56.0	49.6	60.6	20.5	7.43	3.95
2003	28.2	41.6	56.5	43.9	47.5	59.7	15.8	5.90	3.24
2004	29.1	44.3	59.9	45.3	50.6	63.4	16.3	6.29	3.53
2005	39.8	49.0	64.7	60.6	56.9	69.3	20.8	7.88	4.54
2006	40.9	48.0	65.2	60.9	55.6	69.6	20.0	7.58	4.32
2007	42.7	52.6	63.1	61.4	59.7	67.1	18.7	7.05	4.03
2008	39.5	49.1	62.5	55.0	55.0	66.0	15.5	5.87	3.53
2009	35.6	37.3	54.0	50.7	43.1	57.7	15.1	5.81	3.69

Source: Appendix Tables 16a and 16b

C. Cloud Computing

Cloud computing has gained a large amount of momentum and attention in the short time since it was introduced to the market. It has already changed the way businesses function and invest and will continue to do so in the future. Cloud services are offered by a service provider who, from an off-site location, can offer three services: Platform as a Service (PaaS), Infrastructure as a Service (IaaS), and Software as a Service (SaaS). These services can be purchased through a subscription or on a pay-per-use basis from a service provider. The provider, in turn, manages the physical hardware necessary while the client receives the benefits of having access to certain services. An important example of this would be data storage, which can be done completely online through the cloud rather than on-site through physical hardware storage. Adoption of the cloud, however, has been slower in Canada than in the United States for several reasons.

i. Caution

Although many Canadian companies are starting to adopt the cloud or have plans to do so in the future, they are limited by a number of concerns surrounding the emerging technology. Studies conducted recently by Telus and IT World Canada have shed some light on what these concerns are and why they are worrying Canadian firms.[23] The largest concern that deters companies from adopting the cloud is, by far, the issue concerning security and negligence. As most of the large cloud computing service providers are American firms, these firms would not only have complete access to company data, but they would also shoulder the task of maintaining this data. In other words, instead of a member of the on-site IT staff, the data would be managed by a remote individual with no connection to the company. This gives rise to concerns about negligence and human error on the part of cloud employees or service providers. According to the study conducted by IT World Canada, a company's track record is the most highly ranked major factor in play when deciding to start or continue using cloud services (Schick, 2011).

There are also concerns regarding the security in terms of the *Patriot Act* in the United States, which gives the government the right to intercept, access, and disclose information it sees as necessary to the protection or defense of the country against terrorism and other threats against domestic security (Senf, 2012). However, this fear is generally considered to be perceived as more of a threat than it is in reality. The types of data to which the U.S. government would have access are limited by cloud service agreements and cloud providers have the option of providing only the minimal information required by law. Not only is the risk of the law being invoked low, but in the case that it *is* invoked, the data being provided would most likely be of a

[23] Telus: Senf, D. (2012); World Canada: Schick, S. (2011).

general nature.[24] Moreover, firms should keep in mind that Canada and the United States have signed a bilateral MLAT (Mutual Legal Assistance Treaty) which includes the Treaty on Mutual Legal Assistance in Criminal Matters. According to this agreement, both countries will provide each other information when this information is necessary to a criminal or security-based investigation. Therefore, if the Canadian government has access to a document, the United States may ask for access to this document and will only be denied in certain circumstances.[25] Moreover, if a firm has any U.S. presence (i.e. a U.S. branch or headquarters), then it is within the reach of the *Patriot Act* regardless (Lakatos, 2012). As explained above, many of the concerns regarding the security of data stored in the United States are perceived to be of greater importance than they are in reality. Nevertheless, these concerns still act as a deterrent for cloud use for any data based function.

A cautious business sector, deterred by security and negligence concerns, will invest less in cloud computing, which widens the software investment per worker while simultaneously slowing down future technological growth in the country.

ii. Economic Structure of Market

The size of the American market is vastly larger than the Canadian market. The public cloud services market value in Canada is $3.4 billion U.S. dollars for a population of 34 million. In the United States, the public services market value is $50.5 billion U.S. dollars for a population of 313 million.[26] In other words, for a population just over eight times greater than the Canadian population, the United States has a public cloud services market valued at an amount almost fourteen times greater than its Canadian counterpart. Because the size of the market is so much greater in the United States, the market is seen as being a more mature market than the Canadian market. This means that cloud service providers are investing in the American market first, because they have more confidence in a more mature market.[27]

Aside from the maturity and size of the market, competition also plays a role in the cloud service market. As we have discussed, the larger size and greater maturity of the United States' market causes more cloud service providers to establish a cloud service provider initiative than in Canada (Maimona, 2013). This means that there are a greater number of American firms which offer SaaS than Canadian firms, which pushes the cost of using the cloud down in the United States. Therefore, competition ensures that prices stay low in the United States. Canadian firms and organizations interested in proving cloud services have to be able to compete with these large firms in the United States which are pushing prices down but they do not have the same competitive structure (i.e. there is less competition in Canada) and therefore must innovate

[24] Lakatos, A. C. (2012).
[25] Department of Foreign Affairs and International Trade Canada (1995).
[26] Business Software Alliance (2013).
[27] Maimona, M. (2013).

to be competitive in a market where the competitors have the price advantage. Furthermore, Canadian firms which use SaaS generally purchase these services from firms in the United States such as Microsoft and IBM (Senf, 2012). On the other hand, services specific to Canada are not seen as "worth it" to companies such as Google because there is not enough demand to support a targeted Canadian market (Maimona, 2013).

The maturity and size of the American market attracts both foreign and domestic service providers to the United States rather than to Canada. This, coupled with the fact that Canadian businesses are cautious of using cloud services being provided from the United States, means that not only are Canadians not investing in cloud services from the United States, but the domestic cloud market is also hindered in terms of growth and opportunity. As a result, Canadian firms do not find it competitive to use domestic cloud service providers, of which there are only a few, and thus the software investment per worker gap is once again widened.

iii. Policy

Although we focus on the business sector in this report, policy decisions can make a large impact on the way the business sector invests by encouraging or discouraging software investment. The United States have implemented a national set of policies to encourage broadband use under the Connect America Fund. This set of policies is applicable to both urban and rural areas and aims to have 100 million people have access to download speeds of 100 Mbps (megabytes per second) and upload speeds of 50 Mbps by 2020. In addition, it wants to offer access to at least 1 Gbps (gigabytes per second) to all "anchor institutions" such as schools, hospitals, and government buildings. Canada did not previously have a nationally funded broadband plan, though the 2014 Federal Budget has announced $305 million over five years to extend and enhance access to high-speed broadband networks for up to 280 thousand households in rural and Northern Canada (Finance Canada, 2014). Furthermore, the Canadian Radio-television and Telecommunications Commission (CRTC) has publicly announced objectives aiming for upload and download speeds of 5 Mbps and 1 Mbps respectively for *all* Canadians by 2015 (Business Software Alliance, 2013).

Although the timelines and objectives for these plans are similar, we can see several major differences. Upload and download speeds here are important. SaaS applications typically do not require continuous use of the Internet, but for many firms – especially large firms who would use the cloud for continuous email, storage, and applications – slow Internet speeds or low reliability could potentially become an obstacle for the implementation and use of cloud services. In this case, Canada has a plan which aims toward a wider coverage geographically but does not offer the same speeds as the United States. Speed would likely be an important factor in cloud computing services, which would be provided by servers off-site and would be accessible largely through the Internet. This is especially true for applications that cannot be used offline, such as data storage and retrieval along with email. However, this also means Internet speed would only affect those firms who used cloud computing for the abovementioned activities. Many applications are used offline on a subscription basis; these functions would not be affected at all by Internet speed.

More information is needed regarding how firms are using the cloud (i.e. which services are being used most intensively) in order to determine how this affects the software investment per worker gap. For instance, if offline services are most often used then Internet speed is inconsequential and we can conclude that geographical coverage is more important than speed in terms of cloud adoption. This would mean that policy in Canada is better suited to encouraging cloud use than policy in the United States. On the other hand, if online services such as data storage and retrieval and email were used most often, then we would conclude that Internet speed is an important factor in cloud adoption. In this case, policy in the United States would be better suited to encourage cloud adoption and the software investment per worker gap would increase.

iv. Measurement Issues

Software as a Service blurs the lines between investment and operating costs. Because no physical capital is being purchased, it may not be accounted for as an investment. At the same time, SaaS provides a service which is replacing a cost historically accounted for as an investment. On the other hand, because this can be seen as subscribing to or paying per use for a service rendered, companies may be accounting for cloud computing as a cost rather than as an investment. As a result, investment may be over- or underestimated in one or both countries depending on the way in which it is accounted for in national accounts. More research is needed to understand the accounting practices of firms in both countries as well as the differences in definitions of “software investment” from Statistics Canada and the BEA. As a new technology, it is possible that it is being accounted for in different ways both between countries and within the same country. If cloud computing is being counted as a cost in both countries, then cloud computing would not have any effect on investment in software in either countries. If it is being accounted for as an investment in both countries, then the factors discussed above would favour the United States in terms of software investment and the gap would increase because of this.

The most interesting case would be if Canada and the United States were accounting for cloud services in different ways. For instance, if Canada accounted for it as a cost while the United States accounted for it as an investment, this would inflate the investment figures in the United States while underestimating the figures in Canada, which would mean the gap is overestimated. However, if the United States accounted for cloud expenditures as an operating expense while Canada accounted for it as an investment, this would mean the software investment per worker gap is underestimated, albeit by a smaller margin since we have determined that cloud computing is not as widespread or popular in the Canadian business sector for the reasons listed above.

For the purposes of this report, the component of cloud computing that should be discussed is SaaS. A company that uses SaaS pays the supplier of this service on a subscription or pay-per-use basis. The supplier or vendor, on the other hand, is responsible for the acquisition and maintenance of the actual software and server through which the software is used by various subscribers by means of the Internet.

Most companies that offer SaaS are American. This means that although Canadians may be using software applications, they are not investing the initial fixed cost for the software. Instead, Canadian firms pay a fee per use or per given time period in order to use a service performed by software. Because the actual fixed costs of investment along with server maintenance costs are being undertaken by firms in the United States, the investment figure for those American firms offering these services rises, even though the firm paying to use the services provided is in Canada. On the other hand, the software investment figures in Canada would undervalue the cost of software actually in use by Canadian firms.

D. Software Prices Issues

i. Software prices indices

One factor affecting the rate of adoption of software is the price of this software. If software prices are higher in Canada, or at least falling at a slower rate than in the United States, purchases of software may be less. Unfortunately, there are no official series comparing the absolute level of software in the two countries. Anecdotal evidence suggests that software prices are higher in Canada, which suggests that firms have less incentive to buy software.

While data are not available on the absolute level of software prices in the two countries, trends in the relative movement of software prices can be gauged from the respective software deflators. Between 1981 and 2000, the implicit software deflator (nominal software spending divided by real software spending) followed an almost identical path in the two countries, down 28.1 per cent in Canada versus 28.5 per cent in the United States. But since 2000 this pattern has changed considerably. Software prices have fallen 10.9 per cent in Canada, versus 5.7 per cent in the United States. Yet since 2000 the Canada-U.S. software gap has increased, up from an average of 40 per cent in the 1987-2000 period to 55 per cent from 2001 to 2012. It does not appear that the lower prices, linked to the appreciation of the value of the Canadian dollar from $0.67 U.S. in 2000 to $1.00 U.S. in 2012, can explain any of the greater software gap.

Another perspective on software prices is provided by the Commercial Software Price Index (CSPI) in Canada and the Pre-packaged Software Index (PSI) in the United States

(Appendix Table 9). According to the CSPI, price levels for software have decreased 36.4 per cent from 2000 to 2011 in Canada, similar to the 33.5 per cent fall in the United States. This suggests that that commercial software was not becoming relatively cheaper in Canada, in contrast to the trend in the software deflator.

It should be noted that the CSPI takes into account a fixed bundle, which is not ideal for the case of software, as a representative bundle of software may change greatly as new software is introduced to a market. The implicit deflator takes into account the rapidly changing landscape in the software market by using a chained index which represents a fluid basket. Furthermore, the CSPI reflects prices for commercial (i.e. pre-packaged) software only, which ignores the prices of own-account and custom software, which is where 80.5 per cent of Canadian expenditures on software are allocated. In addition, the CSPI includes software used by both government and businesses, so the price levels for a bundle used only by the private sector cannot be separated from the overall index. Therefore, the CSPI cannot reasonably be compared to the implicit deflator for software.

The closest comparison to make in American accounts is with the Average Year Price Indexes for Pre-Packaged Software, which also takes into account a fixed bundle of pre-packaged software although it separates the private sector from the public. By using these indices, the decreases in price from 2000 to 2011 are comparable at 36.4 per cent in Canada versus 33.5 per cent in the United States. Although Canadian prices still decreased 2.9 percentage points more than those in the United States, this difference is not highly significant, especially given the year-to-year fluctuations in the index.

ii. PPP measurement

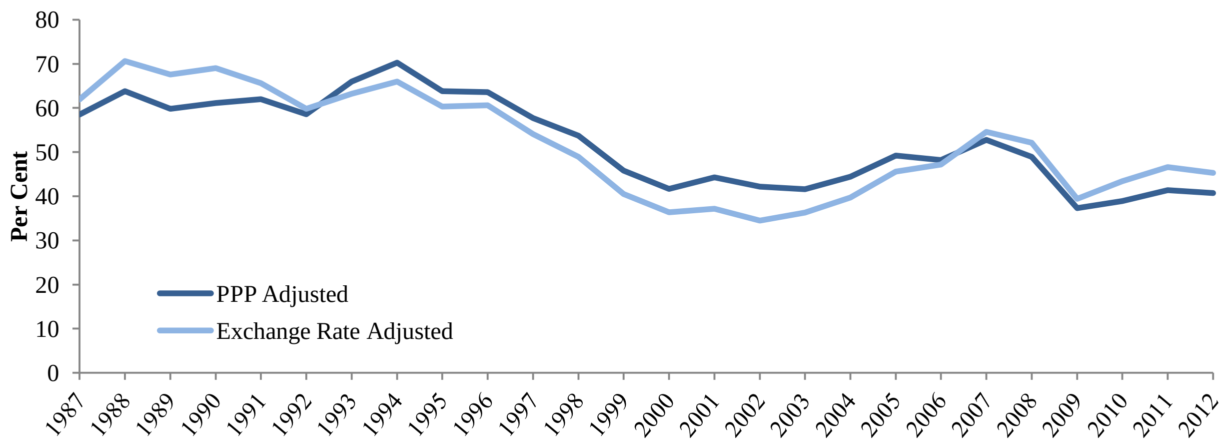
The Purchasing Power Parity (PPP) between Canada and the United States plays another role in the estimation of the software investment gap between the two countries since software investment must be expressed in a common currency, namely the U.S. dollar. In theory, the PPP is an implicit exchange rate which adjusts currency in a way which gives each currency the same purchasing power (i.e. a given amount of money would buy the same amount of goods and services in both countries). The PPP is often said to provide a long-run anchor for the market exchange rate, although because of capital flows and other factors, there can be considerable long run divergence between the market exchange rate and the PPP. However, in the short-term, the exchange rate does not accurately represent the purchasing power of each currency as a multitude of other factors, such as events in the news, also affect the exchange rate. The software investment per worker gap, therefore, should be adjusted according to the PPP.

Statistics Canada produces PPP estimates for expenditure categories, including machinery and equipment. In 2012, the System of National Accounts reclassified software as an

Intellectual Property Product but historically, software has been only one of the many components which constitute machinery and equipment. Therefore, the PPP for machinery and equipment may not be representative of the actual PPP for software. In 2012, the PPP for machinery and equipment, including software is estimated to be was 0.90, which means that 90 cents spent on machinery and equipment in the United States could purchase the same amount of goods and services as one dollar spent on machinery and equipment in Canada.

However, because software is now a component of Intellectual Property Products we cannot accurately measure the PPP-adjusted gap. In addition, the gap which has been historically adjusted using the PPP for machinery equipment may not be a good indicator of the actual adjusted gap as the PPP for intellectual property products (including software) may move in a completely different direction than the PPP for machinery and equipment. As such, given the limitations of the CSPI and PPP for machinery and equipment, an alternative estimate of the software gap can be obtained by using the market exchange rate to convert software investment expressed in Canadian dollars into U.S. dollars. Figure 16 shows that this metric does not produce significantly difference estimates for the relative Canada-U.S. software investment per worker.

Figure 16: Software Investment per Worker in Canada as Share of Software Investment per Worker in U.S., PPP-Adjusted and Exchange Rate-Adjusted Current Dollars, 1987-2012



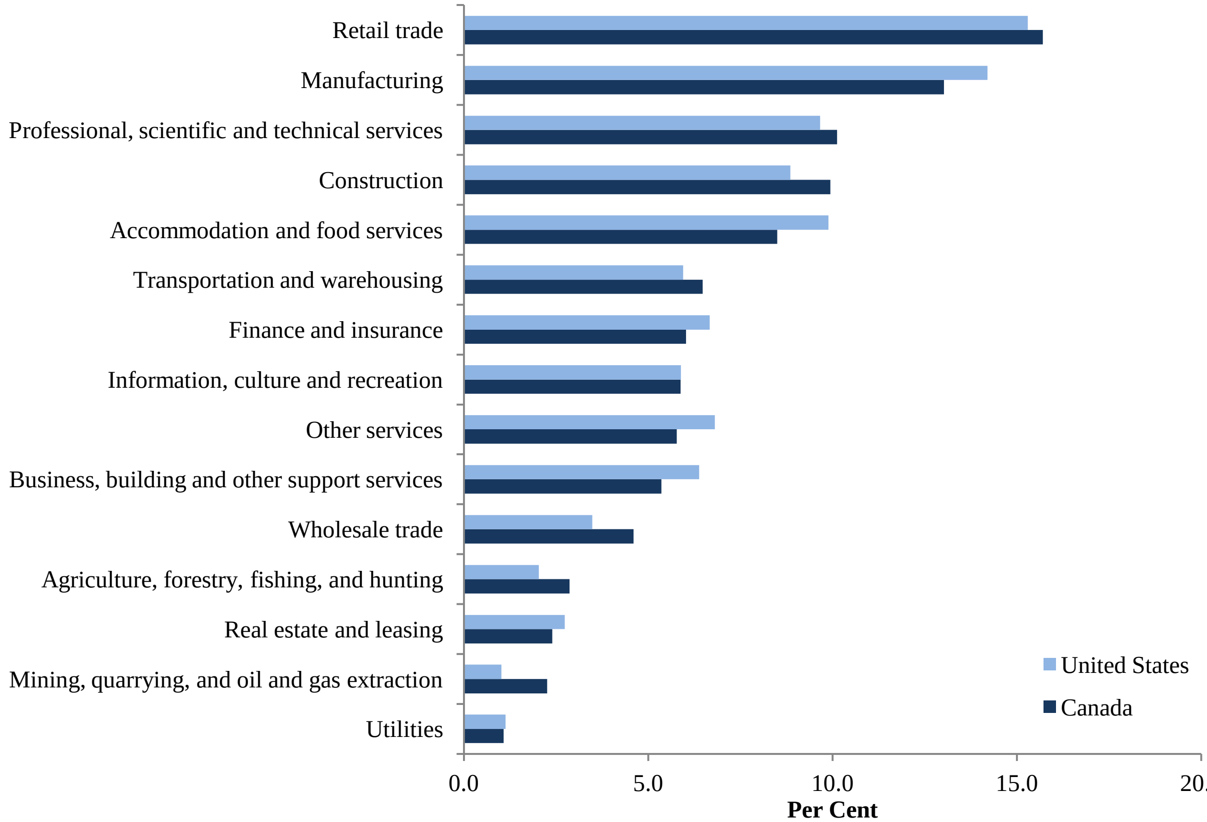
E. Differences in Industry Structure

It is often suggested that the differences in industry structure can account for differences in ICT investment between Canada and the United States. It is said that Canada has a greater share of employment in less ICT-intensive sectors and if the country had the same industry structure as the United States, much of the ICT investment intensity gap would disappear. Sharpe and Rai (2013) showed that this was not true for total ICT investment as they find that only 10 per cent of the gap can be explained by industry structure. This section does a similar analysis for software investment.

At the business sector level, software investment per worker is the weighted average of software investment per worker at the *industry level*, where the weights are employment shares. If compared to Canada, the U.S. economy favours software-intensive industries, i.e. industries with above-average levels of software investment per worker, then this will increase the gap compared to a baseline scenario where both countries have the same industrial structure. To estimate the effect of industrial structure on the software investment gap between both countries, the CSLS calculated how much Canada's business sector software investment per worker would be if Canada's employment shares were equal to those of the United States.

Before presenting the results, it is important to highlight that the employment shares across the various industries are broadly similar in both countries (Figure 17). The industry group with the largest employment share in 2013 was retail trade as it accounted for about 15 to 16 per cent of employment in both countries. The industry group with the second largest share in both countries was manufacturing, with 13.0 per cent and 14.2 per cent in Canada and United States respectively. Followed by professional, scientific, and technical services (10.1 per cent in Canada and 9.7 in the United States); construction (9.9 per cent in Canada and 8.9 per cent in the United States); and accommodation and food services (8.5 per cent in Canada and 9.9 per cent in the United States). These five industry groups accounted for approximately 57 to 58 per cent of total employment shares in both countries.

Figure 17: Employment Shares by Industry in the Business Sector, Canada and the United States, 2013



Sources: Statistics Canada, Labour Force Survey (CANSIM TABLE 282-0008); U.S. Bureau of Labor Statistics, Current Population Survey (CPS Table 18).

Notes: 1) ASWMRS-Administrative and support, waste management and remediation services; MCE- Management of companies and enterprises; 2) Business Sector is defined here as total economy minus public administration; health care and social assistance; and education.

Table 14 presents the simulated level of software level of ICT investment per worker in Canada using U.S. employment shares as weights, and compares it to the actual level in 2012. Using U.S. weights, business sector software per worker in Canada was $1,155, 1.2 per cent higher than the actual level of $1,141. It can be seen that if Canada had the U.S. employment shares, its business sector software investment per worker level would have been 45.9 per cent of the U.S. level – a difference between the simulated and actual values of 0.6 percentage points.

This analysis suggests that industrial structure plays a minor role in explaining the Canada-U.S. software investment per worker gap. This finding is somewhat expected given the similarity in the Canada and the United States employment shares across industries. However, it is worth noting though that there are some differences in the manner in which labour is allocated between both countries. For example, in 2013, mining and oil and gas extraction in Canada represents 2.3 per cent of the business sector employment in Canada compared to 1.0 per cent in the United States, a difference of 1.3 percentage points. On the other hand, the employment share of the accommodation and food services industry is higher in the United States than in Canada (9.9 per cent compared to 8.5 per cent, respectively).

Table 14: Canada- U.S. ICT Investment per Worker Relative (exchange rate adjusted U.S. dollars), Actual vs. Simulated (U.S. employment share weights), 2012

		Variable	Unit	Value
Canada	A	Software Investment per worker, actual	(CDN dollars)	1,140
	B	Software Investment per worker, simulated	(CDN dollars)	1,154
	C= B-A	Difference between Simulated and Actual	(CDN dollars)	14
	D= (C/A)*100		(per cent)	1.2
	E	Exchange rate	(ex. rate)	1.0006
	F = A* E	Software Investment per Worker, actual	(ex. rate -adjusted U.S. dollars)	1,141
	G= B*E	Software Investment per Worker, simulated	(ex. rate -adjusted U.S. dollars)	1,155
United States	H	Software Investment per Worker	(U.S. dollars)	2,517
Canada as a share of the United States	I=(F/H)*100	Software Investment per Worker, actual	(per cent)	45.3
	J=(G/H)*100	Software Investment per Worker, simulated	(per cent)	45.9
	M= K-L	Difference between Simulated and Actual	(percentage points)	0.60

Source: CSLS calculations based on data from the CSLS ICT Database

Table 15 reveals how each industry contributed to the overall effect of industrial structure on the Canada-U.S. software investment per worker gap in 2012. As noted earlier, the simulated software investment per worker level (using U.S. weights) in 2012 was greater than the actual level by $14 (see Table 12). The three industries with the highest contribution to the gap were: finance and insurance ($22); management of companies and enterprises ($18); and real estate rental and leasing ($9).[28] Software investment per worker in each of these three industries was also higher than the business sector average, playing a role in their contribution to the overall effect. On the other hand, the three industries that contributed the most to closing the gap between simulated and actual levels were: wholesale trade (-$32); mining, oil and gas extraction (-$12); and transportation and warehousing (-$9). In total, eleven of the seventeen industries contributed to *increasing* the difference between the actual and simulated levels of software investment per worker.

Two key points of the simulation exercise are worth reiterating. First, differences in industrial structure play a minor role in explaining the Canada- U.S. software investment per

[28] Again, the contribution of MCE is likely an allocation issue (see explanation on page 22).

worker gap. According to the results, the Canada-U.S. software investment per worker gap was only 0.6 percentage points higher than it would have been if Canada had the same industrial structure as the United States. In other words, difference in industrial sector explains only 1.3 percentage point of the 45.3 per cent Canada-U.S. software investment gap or around 3 per cent. Second, there are noticeable differences in the contribution of various industries to the Canada-U.S. software investment gap.

Table 15: Industry Contributions to the Difference between Actual and Simulated Software Investment per Worker Level in Canada, 2012

	Employment Shares			Software Investment per Worker		Industry Contributions to Difference Between Simulated and Actual	
	Canada	United States	U.S-Canada	Level, Actual	Compared to Business Sector		
	(percent)			(dollars)		(dollars)	(percent)
	A	B	C= B-A	D	E	F= (C/100)*D	G= (F_{ind}/F_{tot})*100
Business Sector	100.0	100.0	0.0	1,140	=	14	100.0
Agriculture	2.9	2.1	-0.8	118	<	-1	-6.6
Mining and Oil	2.3	0.9	-1.3	868	<	-12	-84.7
Utilities	1.1	1.2	0.1	7,082	>	6	40.8
Construction	9.6	8.7	-1.0	45	<	0	-3.2
Manufacturing	13.6	14.2	0.6	1,156	>	7	51.0
Wholesale Trade	4.7	3.6	-1.1	2,962	>	-32	-232.4
Retail Trade	15.5	15.6	0.2	597	<	1	7.8
Transportation	6.5	5.9	-0.6	1,534	>	-9	-64.8
Information Industries	3.0	2.9	-0.2	3,396	>	-5	-37.9
Finance and Insurance	6.0	6.6	0.6	3,704	>	22	160.7
Real Estate	2.4	2.7	0.4	2,585	>	9	65.9
Professional Services	9.9	9.6	-0.3	717	<	-2	-15.8
MCE	0.0	0.2	0.2	11,190	>	18	133.3
ASWMRS	5.2	6.2	1.0	669	<	7	47.7
Arts	3.0	2.9	-0.1	674	<	0	-3.3
Accommodation	8.4	9.8	1.4	112	<	2	11.7
Other Services	6.1	6.9	0.9	464	<	4	29.4

Source: CSLS calculations based on the CSLS ICT database.

Notes: 1) ASWMRS- Administrative and support, waste management and remediation services; MCE- Management of companies and enterprises; 2) Business Sector is defined here as total economy minus public administration; health care and social assistance; and education.

F. Issues surrounding piracy of software

The Business Software Alliance defines software piracy as being the illegal copying or distribution of any software.[29] As pirated software is distributed at little to no cost, it is not accounted for in a firm's software investment accounts or in accounts of the distributor. A relatively high piracy rate would indicate that out of all units of software in use, a relatively high proportion was acquired through illegal copying or distribution and vice versa. It is important to note that because this software is acquired through illegal means and often at no cost, it is not attributed to the total software investment of the country, so a relatively higher rate of piracy indicates that, holding all other factors constant, more investment is not being included in national accounts.

The piracy rate in the United States was estimated to be 19 per cent in 2011. The commercial value lost due to pirated software was estimated to be approximately $9,773 million including both individuals and businesses.[30] Although this represents a relatively high level of value lost, the United Stated had the lowest rate globally. This may be due to the strict consequences facing corporations who breach American copyright law "wilfully and for purposes of commercial advantage or private financial gain", which range from fines of a maximum of $500,000 for first-time offenders to a maximum of $1,000,000 for repeat offenders. American copyright law also dictates that first-time offenders may by imprisoned for a maximum of five years in addition to or in lieu of the imposed fine. Similarly, repeat offenders could be subject to imprisonment of up to ten years in addition to or in lieu of the imposed fine.[31]

In contrast, Canada had an estimated piracy rate of 27 per cent in 2011 and the commercial value lost was estimated to be $1,141 million including both individuals and businesses (BSA, 2011). Although this represents a lower absolute value than the United States, the rate of piracy is relatively much higher. The maximum penalties in Canada for corporate copyright infringement are largely less severe. Those who breach the law for commercial purposes are subject to fines ranging from $500 to $20,000 for *each* infringement with no threat of imprisonment.[32] When compared to the United States, a lesser proportion of Canadians list "fear of getting caught" or "pirating software is illegal" as good reasons to not acquire unlicensed software (BSA, 2011).

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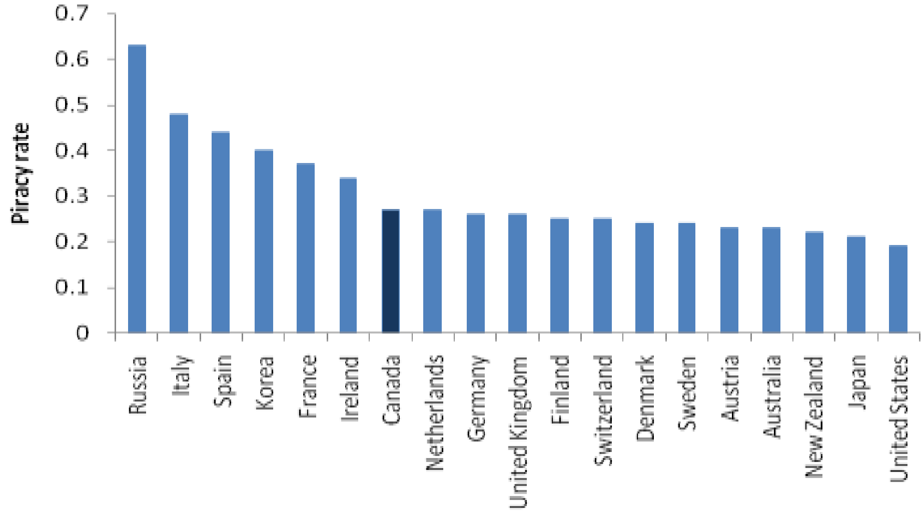
[29] Source: Business Software Alliance.
[30] Source: Business Software Alliance, 2011 Global Software Piracy Study.
[31] Source: US Copyright Law, Chapter 12: Protection and Management Systems, accessed from http://www.copyright.gov/title17/92chap12.html#1204.
[32] Source: Canadian Copyright Act, accessed from http://laws-lois.justice.gc.ca/eng/acts/C-42/page-40.html#docCont.

Figure 18: 2011 Piracy Rate, Select Countries



Source: Ninth annual Business Software Alliance Global Software Piracy Study, 2011

Given that pirated software is not accounted for in investment figures as there is generally little to no cost associated with it, this may be a contributing factor in the large software investment gap between Canada and the United States. Although these rates are based on the responses of all PC users and not uniquely those in the business sector, the Business Software Alliance reported that in North America (which, for the purposes of their study, includes Canada, the United States, and Puerto Rico), business-decision makers[33] are more likely to self-report as having used pirated software than all respondents on the whole (BSA, 2011). Considering this likelihood, the piracy rates in both Canada and the United States may in fact be slightly underestimated with regard to the business-sector. However, there is no reason to believe that business decision-makers in the United States are more or less likely to pirate software than their Canadian counterparts, so we can assume that this does not skew the data in favour of any one country.

Unadjusted for piracy, the pre-packaged software investment gap between Canada and the United States in 2009 was 66.1 per cent. If Canada were to decrease its piracy rate from 27 per cent to 19 per cent to match the United States, this represents a total pirated commercial value of 42.0 million dollars. In this case, legal investment in pre-packaged software would rise by 42.0 million and the adjusted gap would decrease to 58.7 per cent.

[33] The Business Software Alliance study defines "Business Decision Maker... as someone who has significant business decision-making authority for their company, multiple departments, or their own department".

Table 16: Piracy Rate, Investments and Number of Workers, United States, 2003 to 2011

	United States				
	Piracy Rate	Legal Investment, Millions of Current Dollars	Number of Workers, Millions	Pirated Investment in Pre-Packaged Software	Legal Pre-Packaged Software Investment Per Worker
	A	**B**	**C**	**D = (A*B)/(1-A)**	**E = (B/C)**
2003	22	64185	131.5	18103.5	488.1
2004	21	68903	132.9	18316.0	518.5
2005	21	72213	135.2	19195.9	534.1
2006	21	73172	139.1	19450.8	526.1
2007	20	75621	139.3	18905.3	542.9
2008	20	76575	138.6	19143.8	552.5
2009	20	76227	133.0	19056.8	573.1
2010	20	n.a.	132.1	n.a.	n.a.
2011	19	n.a.	133.0	n.a.	n.a.

Source: Ninth annual Business Software Alliance Global Software Piracy Study, 2011 and U.S. Bureau of Labour Statistics.

Table 17: Piracy Rate, Investments and Number of Workers, Canada, 2003 to 2011

	Canada					
	Piracy Rate	Legal Investment, Millions of Current Dollars	Number of Workers, Millions	Pirated Investment in Pre-Packaged Software	Legal Pre-Packaged Software Investment Per Worker	Pirated Pre-Packaged Software Investment Per Worker
	A	**B**	**C**	**D = [(A*B)/(1-A)**	**E = (B/C)]**	**(F = D/C)**
2003	35	2n 437	15.7	1312.2	155.6	83.8
2004	36	2528	15.9	1422.0	158.8	89.3
2005	33	2684	16.1	1322.0	166.5	82.0
2006	34	2588	16.4	1333.2	157.7	81.2
2007	33	2796	16.8	1377.1	166.4	81.9
2008	32	2553	17.1	1201.4	149.4	70.3
2009	29	2823	16.8	1153.1	167.9	68.6
2010	28	n.a.	17.0	n.a.	n.a.	n.a.
2011	27	n.a.	17.3	n.a.	n.a.	n.a.

Source: Ninth annual Business Software Alliance Global Software Piracy Study, 2011 and Statistics Canada Labour Force Survey.

Table 18: Comparison of Piracy Rates, Canada and United States, 2003 to 2011

	Piracy Rate	Legal Investment, Millions of Current Dollars	Number of Workers, Millions	Pirated Investment in Pre-Packaged Software	Legal Pre-Packaged Software Investment Per Worker	Pirated Pre-Packaged Software Investment Per Worker	Adjusted Pre-Packaged Software Per Worker
	A	B	C	D = (A*B)/(1-A)	E = (B/C)	F = (D/B)	G = (F+E)
2003	22	2437	15.7	687.4	195.5	43.9	239.4
2004	21	2528	15.9	672.0	205.9	42.2	248.1
2005	21	2684	16.1	713.5	204.2	44.2	248.4
2006	21	2588	16.4	687.9	197.0	41.9	238.9
2007	20	2796	16.8	699.0	206.7	41.6	248.3
2008	20	2553	17.1	638.3	182.4	37.4	219.7
2009	20	2823	16.8	705.8	194.5	42.0	236.5
2010	20	n.a.	17.0	n.a.	n.a.	n.a.	n.a.
2011	19	n.a.	17.3	n.a.	n.a.	n.a.	n.a.

Source: CSLS Calculations.

Table 19: Adjusted Canada-U.S. Pre-Packaged Software Investment Gap, 2003 to 2011

	Unadjusted Pre-Packaged Software Investment Per Worker Gap	Piracy-Adjusted Pre-Packaged Software Investment Per Worker Gap
2003	60.0	51.0
2004	60.3	52.2
2005	61.8	53.5
2006	62.5	54.6
2007	61.9	54.3
2008	67.0	60.2
2009	66.1	58.7
2010	n.a.	n.a.
2011	n.a.	n.a.

Source: CSLS calculations.

G. Use of open source software and freeware

Open source software is any software for which the source code is available, with a software license which may propose certain restrictions, for the licensee to modify and add to the existing code as well as redistribute it. Freeware, on the other hand, is software with an open source code which is also freely available. Although all freeware qualifies as open source software, not all open source software is available at no cost. In addition, although the initial software may come at no cost, open source software publishers often charge money for the maintenance of the software by providing services such as technical assistance and upgrades which are subject to fees.

Therefore, the effects of open-source or free software could work in opposing directions. On one hand, the widespread use of open-source or free software could decrease the value of software investment as the initial fixed costs would be either low or nonexistent. On the other hand, it could increase the value of software investment if the practice was widespread and the cost of maintenance, technical support, and customization were accounted for. Also, if the low cost of using open-source software were to incentivize more companies to invest in software, then we would reach a breakeven point at which the difference in cost between commercial and open-source software were completely compensated for by the amount of additional investment being done in software. Unfortunately, without relevant data on open-source and free software use in Canada and the United States, there is no way to ascertain whether these technologies have a significant effect of software investment and, if so, to what degree and in what direction this change is taking place.

H. Differences in Business Culture

Many key informants argued that the lower level of software investment reflected the strategic orientation of Canadian firms, in particular their unwillingness to use ICT to drive the business. It was said that the lower competitive intensity in Canada relative to the United States provides little incentive to innovate and adopt best practices. Canadian firms are too comfortable.

A problem with this view is that it is hard to evaluate and what evidence there exists is mixed. There is some evidence that the level of competition in certain sectors in lower in Canada. On the other hand, surveys of business leaders in Canada and the United States have shown that they exhibit surprisingly similar attitudes and values, even toward risk.

I. Other Factors

Many other factors have been suggested as explanations of the Canada-U.S. software gap (see Sharpe and Rai (2013) for a comprehensive review). For example, it has been suggested that higher taxes in Canada may discourage software investment. But corporate taxes in Canada are now lower than in the United States, yet the software gap has grown.

The greater relative size of the small has also been put forward as small businesses, with fewer resources, generally spend less than large firms on ICT, including software. But comparisons of employment by firm size are difficult and the evidence to support this hypothesis is mixed although it may play some role.

The high level of foreign ownership in the Canadian economy has been cited as a possible reason for the software gap. If foreign forms purchase software in their home country and then share it with their subsidiaries without a transaction or paper trail, or at least a transaction at fair market value, software spending in the subsidiary's country may be underestimated. Information on this practice is very difficult to obtain.

J. Summary

Table 20 synthesises the arguments discussed in the second and third sections of this report as they pertain to explaining the Canada-U.S. software investment gap.

Table 20: Summary of Arguments Proposed to Explain the Software Investment Gap

Labour productivity	• Holding constant ICT investment as a share of GDP, a country with higher labour productivity will have a higher level of ICT investment per worker compared to a country with a lower labour productivity level. • In 2011, the Canada-U.S. ICT investment per worker gap would have been 13 percentage points lower if the two countries had the same labour productivity level. This represents slightly less than one-fifth of the 2011 ICT gap of 60 percentage points.

Measurement issues	• There are myriad business practices and measurement limitations that may bias estimates of software investment.
	  ○ It is challenging to account for the costs of software where software is included in the hardware investment component.
	  ○ Interviewees report a significant degree of confusion in surveys and accounting practices that can lead to investment being mislabelled.
	  ○ Sharing software between divisions of a single firm, or the use of software within a firm that is, itself, a product that the firm sells (for example, software used within IBM) can be difficult to account for consistently.
	• Given that U.S. software workers earn greater salaries, a software developer with the same skill level could earn more and contribute to a greater level of own-account software investment simply by virtue of being employed in the United States, even if the same software was being developed.
	• The total software investment per worker gap falls by about four percentage points once we adjust for this wage gap.

Industrial structure	• Some interviewees suggest that Canada is weighted toward processing industries, which are less penetrated by computer technology. If the U.S. economy favours software-intensive industries over that of Canada, the gap will increase. • However, employment shares by industry are broadly similar in both countries, and this report finds that if Canada had the U.S. employment shares per industry, the business sector software investment per worker level would only be one percentage point lower than that of the United States.
Firm size	• Some interviewees proposed that Canadian SMEs do not invest as heavily in software as larger firms; for example, there is not a significant difference in software awareness and adoption within Canada's banking sector, which is predominantly composed of large firms.
Cloud computing	• Canadian cloud computing firms are reportedly less reliable than U.S. firms, which encourages outsourcing. If businesses lump cloud services under "service expenditures" rather than software investment, software investment will be underestimated.
Educational and training policies	• Lack of qualified technology people in Canada is one of the biggest challenges to investment in software by SMEs and large companies alike. A shortage of fundamental IT skills exists in the talent pool, which may affect decisions to invest. • Some interviewees argued that training in the proper adoption of technology, as well as the (crucial) implementation of organisational changes in accordance with new software,

	would improve productivity and encourage further software investment.

Business culture	• Business culture is a frequently-cited (albeit difficult to quantify) factor of the software investment intensity gap.
	  ○ Many informants argued that Canadian firms are more complacent than their U.S. counterparts, and are thus less likely to invest. On the other hand, surveys of business leaders in both countries have found similar attitudes to risk.
	  ○ Some interviewees felt that Canadian firms are more cautious, have a greater lag in making investment decisions, and do not feel the compulsion to be early adopters of technology.
	  ○ U.S. firms are perceived to be more risk-taking, whereas Canadian firms are content to use existing or free technology or hire new people rather than invest in costly technology.
	  ○ Canadian firms may be more focused on comfortable growth than on greater innovation and global competitiveness.
	  ○ Canadian companies provide fewer employment opportunities for technology experts in Canada through their reluctance to pay technology experts for new software implementation.
	• While some interviewees perceived Canadian firms to be less driven by competition and growth, it is difficult to prove that Canadian firms are actually less competitive.

Software awareness	• It was suggested that SMEs, more so than large firms or consumers, lack software awareness, owing perhaps to differences between Canada and the U.S. in corporate culture and in ICT industry competitiveness.
Open-source software	• This software may be more common in Canada (especially in Quebec); however, there are no relevant data on open-source or freeware use in Canada and the U.S., so the role of these technologies is impossible to ascertain.
Software piracy	• The rate of software piracy is said to be much greater in Canada than in the United States; were Canada to have the same rate of piracy as the U.S., legal investment in pre-packaged software would rise, and the adjusted gap would decrease.
The role of the military	• The greater role of the military in the U.S. was cited by some as creating technology and software spillovers into the corporate world.
Tax rates	• Some interviewees suggested that tax rates contributed to the investment gap, though the gap has continued to grow even though corporate taxes are now lower in Canada.
Price of software	• The price of software can influence the investment; if prices are higher in Canada, purchases of software will be less. Unfortunately, there exists no price series comparing Canada and the U.S., though anecdotal evidence suggests that prices are higher in Canada.
Foreign firm ownership	• If a foreign firm purchases software in its home country and distributes it to subsidiaries without a transaction, software spending may be underestimated.

IV. Summary, Policy Implications, and Conclusion

A. Key Findings

This report has provided a comprehensive analysis of the Canada-U.S. software investment per worker gap through a detailed analysis of the estimates, key informant interviews with persons in the IT sector, and an assessment of possible explanations. In many ways, this report is an extension of the earlier report by Sharpe and Rai (2013) on the factors behind the Canada-U.S. ICT investment gap as it was that report which identified software as the most important of the three ICT components in accounting for the overall ICT investment gap.

Not surprisingly, a number of the results for the overall ICT gap identified in that report apply to the software gap. First, the lower productivity level in Canada means that income levels are lower in this country. Firms consequently have fewer resources in absolute terms to invest in software. The difference between Canada's software investment to GDP ratio and software investment per worker relative to those of the United States is explained by this factor. The software investment to GDP ratio is the more appropriate metric for assessing the adequacy of investment, with about one-fifth of the software gap being due to Canada's lower productivity and income level.

This report also collaborated the results of the 2013 report that the lower salaries of workers developing own account software in Canada explain about 6 percentage points, or 10 per cent of the software gap, given that investment is based on production costs, largely determined by wages. The report also found that industry structure differences only account for a small proportion of the software gap, around 3 per cent.

Additional factors that have been identified in this report as contributing to the software gap include a greater software piracy rate in Canada compared to the United States, contributing about 8 percentage points or 13 per cent to the gap, greater use of freeware in Canada, which likely makes only a marginal contribution to the gap, and the outsourcing of cloud services by Canadian firms to the United States, with the required software investment for these services consequently taking place in that country than in Canada. Unfortunately, the quantitative importance of these latter two factors could not be estimated and should be the object of future research.

The report shows that in 2012 software investment per worker was actually greater in Canada than in the United States in seven out of seventeen industries. This is an extremely important finding. It suggests that the Canada-U.S. ICT investment per worker gap is not the result of a broad, macroeconomic phenomenon, but instead is primarily the result of industry-specific factors, including possible measurement error. More detailed analysis of software investment at the industry level is needed to ascertain if Canadian industries truly do lead their U.S. counterparts in the use of software in nearly one half of all two-digit industries.

Another important finding is that Canada is not an outlier among OECD countries in having considerable lower software investment per worker than the United States. Indeed, OECD data show Canada ranked seventh out of thirteen countries in terms of software investment per worker in 2007, well below the United States and the Nordic counties, but ahead of Germany. The software gap issue is not just a Canadian problem, but a phenomenon that affects many OECD countries, and some much more severely than Canada.

Despite the above findings, the Canada-U.S. software gap issue should be a serious concern for the private sector and policy makers in Canada for at least two reasons. First, the gap appears greater for the business sector than for the total economy which includes the public sector. Second, the software gap has been increasing since 2007 when software investment per worker peaked in Canada while continuing to enjoy robust growth in the United States. This is a disconcerting development. It is well known that ICT is a key driver of productivity growth. Canada has experienced much weaker labour productivity growth than the United States since 2000, 0.8 per cent versus 2.0 per cent per year. The shortfall in software investment may have contributed to this situation.

The report notes that, in contrast to software investment, computer per worker investment has advanced rapidly in Canada and by 2012 was 110 per cent that of the United States. While a positive trend, this development has been insufficient to offset the software shortfall and overall ICT investment per worker has not increased. More importantly, the weakness of computer investment, and the strength of software investment in the United States, the world leader in the IT revolution, in recent years may signal a structure shift in the nature of ICT. Software may be assuming a much more important role than hardware. From this perspective, the continued strength of computer investment and weakness of software investment in Canada may indicate that firms in this country, unlike in the United States, have not recognized this transformation. More work is needed on the changing nature of ICT investment.

B. Policy Implications

The policy implications of this report are important. First, it is well known among policy makers and private sector decision makers that Canada has a significant ICT investment shortfall with the United States. But the fact that software accounts for 85 per cent of this shortfall is little known. This piece of information should be widely publicized, and the industries with the largest shortfalls highlighted. Once cognizant of their much lower levels of software investment compared to their U.S. counterparts, firms may seek and identify opportunities to use software to boost productivity.

A number of the explanations of the software gap advanced by key informants have limited policy implications. For example, some argued that Canadian firms generally are less strategic in their approach to innovation than U.S. firms, and hence make less use of software. There are likely deep-rooted reasons for this behaviour and it is unlikely that government policy can change it at least in the short to medium term.

No public policy or program was identified as reducing software investment and thereby contributing to the software gap. But a number of key informants pointed out that many Canadian firms, particularly SMEs, have not adopted the latest and most productive digital technologies. A national digital technology adoption strategy that assisted SMEs to identify what technologies are most appropriate for them could boost software investment and productivity. The Business Development Bank of Canada (BDC) offers support to SMEs looking to adopt and exploit digital technologies through the Smart Tech service; businesses may also apply for an available $200 million in loans for investment in hardware, software and consulting services.

C. Conclusion

At first glance, the figure that Canadian firms spend only 40 per cent as much as their U.S. counterparts per worker on software appears shocking. Do firms not realize the importance of software for productivity advance? Why do they not just ramp up software spending? The analysis in this report suggests a more nuanced approach to the issue is needed. Yes, software spending is a problem for the Canadian business sector, but it is important to understand the nature of this problem. First, a significant part of the software gap can be explained by productivity differences and measurement issues. Second, many OECD countries invest less in software than the United States. While Canada does worse than the Nordic countries, it is in the middle of the pack, not an outlier, and outperforms such industrial powerhouses as Germany. Third, despite the very large Canada-U.S. aggregate software intensity shortfall, seven of seventeen Canadian industries actually invest more per worker in software than their U.S. counterparts. The Canada-U.S. software gap is largely concentrated in one sector: information and cultural industries. This suggests that the software gap issue may be to a considerable extent an industry-specific issue and not as pervasive a reality as sometimes painted. This more positive view seems consistent with the fact that computer investment per worker by Canadian firms now exceeds that in the United States and that Canadian consumers are generally as savvy in digital technologies as their U.S. counterparts.

Despite the above caveats, there is no doubt that software investment in Canada is less than in the United States and that the reduction of this gap could contribute to improved productivity growth. Software appears to be assuming a greater role in the continuing IT transformation of the economy and society. Canadian firms must keep up. SMEs appear to have the largest software gap, given their limited resources. This observation was confirmed by the key informants interviewed for this report, but not by data given the lack of statistics on ICT investment by firm size. This suggests that public policies and programs that foster digital technology adoption by SMEs are needed.

Much of the Canada -U.S. software gap remains unexplained. Further research is needed on explanations of the gap that are discussed in this report, but for which definitive conclusions have not been drawn, largely because of lack of data. This areas for future research include the impact of cloud computing, the use of freeware, and software piracy. A key data lacuna in the analysis of ICT investment gap between Canada and the United States is the lack of information on ICT investment by firm size. It is well known that small firms invest less in ICT than large firms and that Canada has relatively more small firms than the United States. However, because we do not know the differences in ICT investment by firm size, an estimate of the effect of this factor on the overall ICT investment gap cannot be made.

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Appendix Tables

Appendix Table 1: Software ICT Investment per Worker in the Business Sector in Canada and the United States, current dollars, 1987-2012

	Canada					U.S.	Canada vs. U.S.	
	Software Investment per Worker in Canadian current dollars	**PPP for Machinery and Equipment, U.S. dollar per Canadian dollar**	**Software Investment per Worker in current U.S. dollars, PPP Adjusted**	**Exchange Rate, U.S dollar per Canadian dollar**	**Software Investment per Worker in current U.S. dollars, Exchange Rate Adjusted**	**Software Investment per Worker in current U.S. dollars**	**Software Investment per Worker in Canada relative to Software Investment per Worker in U.S**	
							PPP Adjusted	**Exchange Rate Adjusted**
	A	**B**	**C=A*B**	**D**	**E=A*D**	**F**	**G=C/F*100**	**H=E/F*100**
1987	258	0.71	184	0.75	195	314	58.5	61.9
1988	313	0.73	229	0.81	254	360	63.8	70.6
1989	345	0.75	258	0.84	291	431	59.8	67.6
1990	392	0.76	297	0.86	336	487	61.1	69.0
1991	419	0.82	346	0.87	366	558	62.0	65.6
1992	437	0.81	354	0.83	362	605	58.6	59.8
1993	536	0.81	434	0.78	416	658	66.0	63.2
1994	609	0.78	475	0.73	446	676	70.3	66.0
1995	595	0.77	458	0.73	433	718	63.8	60.3
1996	665	0.77	512	0.73	488	805	63.6	60.6
1997	738	0.77	569	0.72	533	986	57.7	54.1
1998	821	0.74	608	0.67	554	1,132	53.7	48.9
1999	837	0.76	636	0.67	564	1,391	45.8	40.5
2000	868	0.77	669	0.67	585	1,604	41.7	36.4
2001	941	0.77	725	0.65	608	1,636	44.3	37.2
2002	888	0.78	692	0.64	565	1,640	42.2	34.5
2003	872	0.82	715	0.71	622	1,716	41.6	36.3
2004	939	0.86	808	0.77	722	1,819	44.4	39.7
2005	1,045	0.89	930	0.83	863	1,892	49.2	45.6
2006	1,049	0.90	944	0.88	925	1,958	48.2	47.2
2007	1,216	0.90	1,095	0.93	1,132	2,074	52.8	54.6
2008	1,238	0.88	1,089	0.94	1,160	2,228	48.9	52.1
2009	1,055	0.83	875	0.88	924	2,347	37.3	39.4
2010	1,043	0.87	907	0.97	1,012	2,330	38.9	43.4
2011	1,123	0.90	1,011	1.01	1,135	2,439	41.4	46.6
2012	1,140	0.90	1,025	1.00	1,141	2,517	40.7	45.3
					Average Annual Growth Rate			
1987-1995	11.00	0.96	12.08	-0.43	10.53	10.88	1.08	-0.32
1987-2012	6.12	0.93	7.11	1.14	7.33	8.68	-1.44	-1.24
1987-2000	9.79	0.59	10.44	-0.87	8.83	13.36	-2.58	-4.00
2000-2012	2.29	1.30	3.63	3.36	5.73	3.83	-0.19	1.83

Source: PPP from Statistics Canada, Purchasing Power Parities and Real Expenditures, United States and Canada, Item Catalogue no. 13-604-MIB no.53, 2007; Exchange rate from Statistics Canada, CANSIM II Table 16-0049 V37694. Computers Investment for the U.S. business sector is from BEA. National Economic Accounts: Table 2.7. Software Investment for the Canadian business sector from Statistics Canada unpublished data. The number of workers for the Canadian business sector from the Productivity Program, Statistics Canada. CANSIM series v15857247 for 1997-2005, extended back to 1987 using growth rates of estimated employment for the total economy from Statistics Canada unpublished LFS data Feb 2006. The number of workers for the U.S. business sector from an unpublished series of the U.S. Bureau of Labor Statistics, corresponding to BLS series PRS84006013.

Appendix Table 2: Employment and Software ICT Investment Figures for Canada and the U.S., 1987-2012

	Canada				USA		
Year	**Workers (thousands)**	**Software ICT Investment, millions of current dollars**	**PPP for Machinery and Equipment, U.S. dollar per Canadian dollar**	**Software Investment per Worker (PPP adjusted), current Canadian dollars**	**Workers (thousands)**	**Software ICT Investment, millions of current dollars**	**Software Investment per Worker, current U.S. dollars**
1987	9,639	2,486	0.71	184	92,301	29,000	314
1988	9,922	3,102	0.73	229	95,119	34,200	360
1989	10,133	3,495	0.75	258	97,171	41,900	431
1990	10,118	3,964	0.76	297	97,810	47,600	487
1991	9,836	4,125	0.82	346	96,287	53,700	558
1992	9,653	4,220	0.81	354	95,743	57,900	605
1993	9,677	5,190	0.81	434	97,760	64,300	658
1994	9,933	6,049	0.78	475	101,060	68,300	676
1995	10,160	6,042	0.77	458	103,902	74,600	718
1996	10,308	6,852	0.77	512	106,191	85,500	805
1997	10,614	7,838	0.77	569	109,043	107,500	986
1998	10,910	8,961	0.74	608	111,286	126,000	1,132
1999	11,217	9,392	0.76	636	113,088	157,300	1,391
2000	11,499	9,984	0.77	669	115,016	184,500	1,604
2001	11,635	10,952	0.77	725	114,085	186,600	1,636
2002	11,886	10,552	0.78	692	111,554	183,000	1,640
2003	12,135	10,577	0.82	715	111,300	191,000	1,716
2004	12,343	11,593	0.86	808	112,743	205,100	1,819
2005	12,474	13,036	0.89	930	114,780	217,200	1,892
2006	12,643	13,263	0.90	944	116,907	228,900	1,958
2007	12,925	15,719	0.90	1095	117,763	244,200	2,074
2008	13,082	16,191	0.88	1089	116,033	258,500	2,228
2009	12,745	13,441	0.83	875	109,395	256,800	2,347
2010	12,836	13,385	0.87	907	108,142	252,000	2,330
2011	13,024	14,630	0.90	1011	109,711	267,600	2,439
2012	13,136	14,974	0.90	1025	111,861	281,600	2,517

Source: PPP from Statistics Canada, Purchasing Power Parities and Real Expenditures, United States and Canada, Item Catalogue no. 13-604-MIB no.53, 2007.

Computers Investment for the U.S. business sector is from BEA. National Economic Accounts: Table 2.7.

Software Investment for the Canadian business sector from Statistics Canada unpublished data.

The number of workers for the Canadian business sector from the Productivity Program, Statistics Canada. CANSIM series v15857247 for 1997-2005, extended back to 1987 using growth rates of estimated employment for the total economy from Statistics Canada unpublished LFS data Feb 2006.

The number of workers for the U.S. business sector from an unpublished series of the U.S. Bureau of Labor Statistics, corresponding to BLS series PRS84006013.

Appendix Table 3: Software Investment by Type from Input-Output Tables for Canada, Business Sector, 1998-2012

	Investment (millions of current dollars)				Shares of total software (percent)		
	Total Software	**Pre-packaged**	**Custom Design**	**Own Account**	**Pre-packaged**	**Custom Design**	**Own Account**
1998	8,961	2,518	3,942	2,405	28.4	44.5	27.1
1999	9,392	2,033	4,651	2,623	21.8	50.0	28.2
2000	9,984	1,984	4,697	2,733	21.1	49.9	29.0
2001	10,952	1,990	5,377	3,518	18.3	49.4	32.3
2002	10,552	1,969	5,044	3,213	19.3	49.3	31.4
2003	10,577	2,437	5,686	2,683	22.6	52.6	24.8
2004	11,593	2,528	6,515	2,946	21.1	54.3	24.6
2005	13,036	2,684	6,862	4,008	19.8	50.6	29.6
2006	13,263	2,588	7,170	4,283	18.4	51.1	30.5
2007	15,719	2,796	8,149	4,794	17.8	51.8	30.5
2008	16,191	2,553	8,722	4,919	15.8	53.9	30.4
2009	13,441	2,823	6,758	4,945	19.4	46.5	34.0
2010	13,385						
2011	14,630						
2012	14,974						

Source: Total software from CSLS Database Canadian Table 4v (based on Statistics Canada, CANSIM Table 031-0003); Software component figures obtained from Table 16 in Sharpe and Rai (2013)

Notes: 1) the Canadian software component data is based on unpublished Input-Output estimates for 1998 to 2009, provided by Statistics Canada upon request. 2) Data by software type treats margins and taxes slightly differently and classifies investment as business sector using different criteria from the estimates in the FCFS tables, as such, the sum of investment by software type is not equal to total software. Shares are calculated as shares of the sum of software investment by type, not the share of total software.

Appendix Table 4: Software Investment by Type from Input-Output Tables for the United States, Business Sector, 1998-2012

	Investment (millions of current dollars)				Shares of total software (percent)		
	Total Software	**Pre-packaged**	**Custom Design**	**Own Account**	**Pre-packaged**	**Custom Design**	**Own Account**
1998	125,991	42,861	45,184	37,946	34.0	35.9	30.1
1999	157,330	49,661	53,614	54,055	31.6	34.1	34.4
2000	184,456	54,683	63,927	65,846	29.6	34.7	35.7
2001	186,592	55,883	63,435	67,274	29.9	34.0	36.1
2002	183,039	60,260	56,490	66,289	32.9	30.9	36.2
2003	191,008	63,283	56,068	71,657	33.1	29.4	37.5
2004	205,074	66,972	58,517	79,585	32.7	28.5	38.8
2005	217,171	69,176	65,456	82,539	31.9	30.1	38.0
2006	228,908	69,073	72,773	87,062	30.2	31.8	38.0
2007	244,180	70,325	81,705	92,150	28.8	33.5	37.7
2008	258,543	72,848	88,489	97,206	28.2	34.2	37.6
2009	256,775	71,286	86,489	99,000	27.8	33.7	38.6
2010	251,969	62,003	93,681	96,285	24.6	37.2	38.2
2011	267,562	66,899	100,110	100,553	25.0	37.4	37.6
2012	281,634	72,079	105,850	103,705	25.6	37.6	36.8

Source: BEA Detailed Fixed Asset Table 2.5

Appendix Table 5: Software Investment per Worker by Component, Canada and United States in current U.S. dollars, business sector, 1998-2012

	Canada				United States			
	Total Software	Pre-packaged	Custom Design	Own Account	Total Software	Pre-packaged	Custom Design	Own Account
1998	554	156	244	149	1,132	385	406	341
1999	564	122	279	157	1,391	439	474	478
2000	585	116	275	160	1,604	475	556	572
2001	608	110	298	195	1,636	490	556	590
2002	565	105	270	172	1,641	540	506	594
2003	622	143	334	158	1,716	569	504	644
2004	722	157	406	183	1,819	594	519	706
2005	863	178	454	265	1,892	603	570	719
2006	925	180	500	299	1,958	591	622	745
2007	1,132	201	587	345	2,073	597	694	783
2008	1,160	183	625	352	2,228	628	763	838
2009	924	194	465	340	2,347	652	791	905
2010	1,012				2,330	573	866	890
2011	1,135				2,439	610	912	917
2012	1,141				2,518	644	946	927

Canada Relative to the United States (per cent)				
	Total Software	Pre-packaged	Custom Design	Own Account
1998	48.9	40.4	60.0	43.6
1999	40.5	27.8	58.9	32.9
2000	36.4	24.4	49.5	28.0
2001	37.2	22.5	53.7	33.1
2002	34.5	19.5	53.4	29.0
2003	36.2	25.2	66.4	24.5
2004	39.7	26.5	78.2	26.0
2005	45.6	29.5	79.6	36.9
2006	47.2	30.5	80.3	40.1
2007	54.6	33.7	84.6	44.1
2008	52.1	29.1	81.9	42.1
2009	39.4	29.8	58.8	37.6
2010	43.4			
2011	46.6			
2012	45.3			

Source: Calculations based on CSLS ICT Database Canadian Tables 12v; CANSIM Table 176-0064; and BEA Detailed Fixed Asset Table 2.5

Appendix Table 6: Decomposition of Software Investment per Worker by Business Sector Industry, 2000

	Software investment per worker				Industry employment shares for the United States (per cent)	Weighted contribution to the software investment per worker gap (per cent)
	Canada (current U.S. Dollars)	United States (current U.S. Dollars)	Canada relative to the U.S. (per cent)	Difference		
	A	B	C= A/B	D=A-B	E	F= E*D/-1020
Business Sector	585	1,604	36.4	-1,020	100.00	100.0
Agriculture	57	51	111.8	6	1.88	0.0
Mining and Oil	389	3,084	12.6	-2,695	0.36	1.0
Utilities	3,753	3,206	117.1	547	0.98	-0.5
Construction	46	196	23.6	-150	7.59	1.1
Manufacturing	401	1,754	22.8	-1,353	15.02	19.9
Wholesale Trade	1,230	2,167	56.7	-937	3.22	3.0
Retail Trade	253	347	72.9	-94	12.05	1.1
Transportation	685	971	70.5	-287	4.66	1.3
Information Industries	3,300	9,151	36.1	-5,851	3.10	17.8
Finance and Insurance	2,037	4,098	49.7	-2,061	5.08	10.3
Real Estate	1,627	425	382.9	1,202	2.09	-2.5
Professional Services	346	3,265	10.6	-2,918	6.32	18.1
MCE	14,160	383,452	3.7	-369,292	0.02	8.6
ASWMRS	161	1,541	10.4	-1,380	4.09	5.5
Educational Services	0	224	0.0	-224	8.61	1.9
Health Care	0	265	0.0	-265	11.42	3.0
Arts and Recreation	149	129	115.1	19	1.94	0.0
Accommodation	54	51	106.6	3	6.61	0.0
Other Services	236	299	78.9	-63	4.93	0.3

Source: CSLS ICT Database Tables ICT-U.S. 2012 29b-v; ICT-Canada 2012 12b-v

Notes: Weighted relative contribution is the difference in each industry relative to the business sector difference in total ICT investment per worker, weighted by the employment shares of that industry in the United States. Industries for which data is not available for both countries are omitted. Education and health care in Canada are treated as zero for the decomposition. Finally, the relative weighted contribution will not sum to 100 per cent exactly, as we only use the U.S. employment weights to calculate the contribution, but the total gaps depends on a blend of U.S. and Canadian employment and ICT component shares. U.S. employment is simply the most important of these weights.

Appendix Table 7: Piracy Rates by Country, 2011

Country	Piracy Rate	Country	Piracy Rate	Country	Piracy Rate
United States	0.19	Italy	0.48	Panama	0.72
Luxembourg	0.20	Qatar	0.50	Honduras	0.73
Japan	0.21	Saudi Arabia	0.51	Tunisia	0.74
New Zealand	0.22	Croatia	0.53	Albania	0.75
Australia	0.23	Poland	0.53	Kazakhstan	0.76
Austria	0.23	Brazil	0.53	Dominican Republic	0.76
Belgium	0.24	Colombia	0.53	China	0.77
Denmark	0.24	Latvia	0.54	Kenya	0.78
Sweden	0.24	Lithuania	0.54	Senegal	0.78
Finland	0.25	Bahrain	0.54	Montenegro	0.79
Switzerland	0.25	Malaysia	0.55	Bolivia	0.79
Germany	0.26	Mexico	0.57	Guatemala	0.79
United Kingdom	0.26	Mauritius	0.57	Nicaragua	0.79
Canada	0.27	Costa Rica	0.58	El Salvador	0.80
Netherlands	0.27	Jordan	0.58	Botswana	0.80
Norway	0.27	Kuwait	0.59	Vietnam	0.81
Israel	0.31	Chile	0.61	Ivory Coast	0.81
Singapore	0.33	Egypt	0.61	Nigeria	0.82
Ireland	0.34	Oman	0.61	Zambia	0.82
Czech Republic	0.35	Greece	0.61	Paraguay	0.83
South Africa	0.35	Turkey	0.62	Cameroon	0.83
Taiwan	0.37	India	0.63	Sri Lanka	0.84
UAE	0.37	Romania	0.63	Ukraine	0.84
France	0.37	Russia	0.63	Algeria	0.84
South Korea	0.40	Bulgaria	0.64	Indonesia	0.86
Slovakia	0.40	Bosnia	0.66	Pakistan	0.86
Reunion	0.40	FYROM	0.66	Iraq	0.86
Portugal	0.40	Morocco	0.66	Azerbaijan	0.87
Hungary	0.41	Brunei	0.67	Belarus	0.87
Puerto Rico	0.42	Peru	0.67	Armenia	0.88
Hong Kong	0.43	Ecuador	0.68	Venezuela	0.88
Malta	0.43	Uruguay	0.68	Yemen	0.89
Spain	0.44	Argentina	0.69	Bangladesh	0.90
Slovenia	0.46	Philippines	0.70	Moldova	0.90
Estonia	0.48	Lebanon	0.71	Libya	0.90
Cyprus	0.48	Thailand	0.72	Georgia	0.91
Iceland	0.48	Serbia	0.72	Zimbabwe	0.92

Source: Ninth annual Business Software Alliance Global Software Piracy Study, 2011

Appendix Table 8: Software Deflators in Canada and the United States

	Canada			United States		
	Software Investment, Current Prices (Millions)	Software Investment, Chained 2007 Dollars (Millions)	Deflator (2007 Base)	Software Investment, Current Prices (Millions)	Software Investment, Chained 2007 Dollars (Millions)	Deflator (2007 Base)
1981	1,072.0	648.5	165.3	11,800.0	8,045.4	146.7
...						
2000	12,228.0	10,292.5	118.8	184,500.0	175,869.2	104.9
2001	13,495.0	11,219.5	120.3	186,600.0	177,132.6	105.3
2002	12,881.0	10,915.2	118.0	183,000.0	176,891.2	103.5
2003	13,922.1	12,554.0	110.9	191,000.0	188,965.8	101.1
2004	15,212.0	14,179.3	107.3	205,100.0	207,930.2	98.6
2005	17,524.9	16,819.0	104.2	217,200.0	221,203.9	98.2
2006	18,257.0	18,130.2	100.7	228,900.0	230,356.1	99.4
2007	20,688.0	20,688.0	100.0	244,200.0	244,200.0	100.0
2008	21,040.0	20,508.9	102.6	258,500.0	256,243.7	100.9
2009	19,851.0	18,672.7	106.3	256,800.0	256,795.8	100.0
2010	20,446.0	19,519.1	104.7	252,000.0	254,191.9	99.1
2011	21,142.0	20,241.6	104.4	267,600.0	269,627.9	99.2
2012	21,861.80	20,655.10	105.8	281600.0	284619.7	98.9
			Per Cent			
1981-2000			-28.1			-28.5
2000-2012			-10.9			-5.7
1981-2012			-36.0			-32.5

Source: Statistics Canada. CANSIM Table 031-0003, Flows and stocks of fixed non-residential capital, by sector of North American Industry Classification System (NAICS) and asset, Canada, annual (dollars x 1,000,000) --Bureau of Economic Analysis. Fixed Assets Accounts Tables 2.7 (Investment in Private Fixed Assets, Equipment and Software, and Structures by Type) and 2.8 (Chain-Type Quantity Indexes for Investment in Private Fixed Assets, Equipment and Software, and Structures by Type).

Appendix Table 9: Commercial Software Price and Average Year Price Indices

	Commercial Software Price Index (Canada, 2007 Base)	Price Index for Pre-Packaged Software (United States, 2005 Base)
2000	153.7	130.3
2001	152.6	127.3
2002	146.9	122.0
2003	130.0	112.4
2004	120.6	104.3
2005	116.0	100.0
2006	104.4	99.0
2007	100.0	96.7
2008	101.5	95.0
2009	105.6	92.0
2010	100.8	89.0
2011	97.8	86.7
	Per Cent	
2000-2011	-36.4	-33.5

Source: Statistics Canada. CANSIM. Table 331-0006, Commercial software price index, monthly (index, 2007=100). --Bureau of Economic Analysis. Chain-Type Quantity Indexes for Investment in Private Non-residential Fixed Assets.

Appendix Table 10: Software Investment by Type from Input-Output Tables for Canada, Business Sector, 1998-2012

	Investment (millions of current dollars)				Shares of total software (per cent)		
	Total Software	**Pre-packaged**	**Custom Design**	**Own Account**	**Pre-packaged**	**Custom Design**	**Own Account**
1998	8,961	2,518	3,942	2,405	28.4	44.5	27.1
1999	9,392	2,033	4,651	2,623	21.8	50.0	28.2
2000	9,984	1,984	4,697	2,733	21.1	49.9	29.0
2001	10,952	1,990	5,377	3,518	18.3	49.4	32.3
2002	10,552	1,969	5,044	3,213	19.3	49.3	31.4
2003	10,577	2,437	5,686	2,683	22.6	52.6	24.8
2004	11,593	2,528	6,515	2,946	21.1	54.3	24.6
2005	13,036	2,684	6,862	4,008	19.8	50.6	29.6
2006	13,263	2,588	7,170	4,283	18.4	51.1	30.5
2007	15,719	2,796	8,149	4,794	17.8	51.8	30.5
2008	16,191	2,553	8,722	4,919	15.8	53.9	30.4
2009	13,441	2,823	6,758	4,945	19.4	46.5	34.0
2010	13,385						
2011	14,630						
2012	14,974						

Source: Total software from CSLS Database Canadian Table 4v (based on Statistics Canada, CANSIM Table 031-0003); Software component figures obtained from Table 16 in Sharpe and Rai (2013)

Notes: 1) the Canadian software component data is based on unpublished Input-Output estimates for 1998 to 2009, provided by Statistics Canada upon request. 2) Data by software type treats margins and taxes slightly differently and classifies investment as business sector using different criteria from the estimates in the FCFS tables, as such, the sum of investment by software type is not equal to total software. Shares are calculated as shares of the sum of software investment by type, not the share of total software.

Appendix Table 11: Software Investment by Type from Input-Output Tables for the United States, Business Sector, 1998-2012

	Investment (millions of current dollars)				Shares of total software (per cent)		
	Total Software	Pre-packaged	Custom Design	Own Account	Pre-packaged	Custom Design	Own Account
1998	125,991	42,861	45,184	37,946	34.0	35.9	30.1
1999	157,330	49,661	53,614	54,055	31.6	34.1	34.4
2000	184,456	54,683	63,927	65,846	29.6	34.7	35.7
2001	186,592	55,883	63,435	67,274	29.9	34.0	36.1
2002	183,039	60,260	56,490	66,289	32.9	30.9	36.2
2003	191,008	63,283	56,068	71,657	33.1	29.4	37.5
2004	205,074	66,972	58,517	79,585	32.7	28.5	38.8
2005	217,171	69,176	65,456	82,539	31.9	30.1	38.0
2006	228,908	69,073	72,773	87,062	30.2	31.8	38.0
2007	244,180	70,325	81,705	92,150	28.8	33.5	37.7
2008	258,543	72,848	88,489	97,206	28.2	34.2	37.6
2009	256,775	71,286	86,489	99,000	27.8	33.7	38.6
2010	251,969	62,003	93,681	96,285	24.6	37.2	38.2
2011	267,562	66,899	100,110	100,553	25.0	37.4	37.6
2012	281,634	72,079	105,850	103,705	25.6	37.6	36.8

Source: BEA Detailed Fixed Asset Table 2.5

Appendix Table 12: ICT investment in Canada by Component in the Business Sector (millions of current dollars), 1987 and 2000-2011

	Current Canadian dollars				Current U.S. dollars (PPP-adjusted)			
	Total ICT	**Computers**	**Communic-ations**	**Software**	**Total ICT**	**Computers**	**Communic -ations**	**Software**
1987	8,864	3,224	3,154	2,486	6,825	2,482	2,429	1,914
…								
2000	27,763	9,101	8,679	9,984	21,378	7,008	6,683	7,688
2001	27,710	7,691	9,068	10,952	21,337	5,922	6,982	8,433
2002	26,610	7,889	8,169	10,552	20,756	6,153	6,372	8,231
2003	26,138	8,206	7,355	10,577	21,433	6,729	6,031	8,673
2004	27,970	9,280	7,097	11,593	24,054	7,981	6,103	9,970
2005	29,862	9,869	6,957	13,036	26,577	8,783	6,192	11,602
2006	31,622	11,151	7,208	13,263	28,460	10,036	6,487	11,937
2007	32,980	10,731	6,530	15,719	29,682	9,658	5,877	14,147
2008	34,280	10,953	7,137	16,191	30,166	9,639	6,281	14,248
2009	30,602	10,165	6,996	13,441	25,400	8,437	5,807	11,156
2010	30,937	10,557	6,996	13,385	26,915	9,185	6,087	11,645
2011	32,890	10,879	7,382	14,630	29,601	9,791	6,644	13,167
			Annual Average Growth Rates					
1987-2011	5.62	5.20	3.61	7.66	6.56	6.14	4.54	8.63
1987-2000	9.18	8.31	8.10	11.29	9.67	8.80	8.59	11.79
2000-2011	1.55	1.64	-1.46	3.53	3.00	3.09	-0.05	5.01

Source: CSLS ICT Database Tables 5v, 9v, and S1

Appendix Table 13: ICT investment in Canada by Component in the Business Sector (millions of current dollars), 1987 and 2000-2011

	Total ICT	**Computers**	**Communications**	**Software**
1987	104,000	35,800	39,200	29,000
…				
2000	409,500	101,700	123,300	184,500
2001	381,400	85,700	109,100	186,600
2002	344,200	77,500	83,700	183,000
2003	348,100	75,400	81,400	191,300
2004	367,000	77,900	83,400	205,700
2005	377,800	76,600	83,200	218,000
2006	403,400	82,400	91,200	229,800
2007	428,900	84,500	99,400	245,000
2008	428,400	82,400	88,800	257,200
2009	404,000	71,200	75,900	256,900
2010	414,500	70,500	83,100	260,900
2011	431,300	75,800	76,800	278,700
		Annual Average Growth Rates		
1987-2011	6.11	3.17	2.84	9.89
1987-2000	9.73	9.20	7.59	14.22
2000-2011	0.47	-2.64	-4.21	3.82

Appendix Table 14: PPP for Machinery and Equipment in USD per CAD and Business Sector Employment for Canada and the United States (thousands of workers), 2001-2011

	Purchasing Power Parity for Machinery and Equipment	U.S. Business Sector Employment	Canada Business Sector Employment
1987	0.73	92,301	9,639
…			
2000	0.77	115,016	11,499
2001	0.77	114,085	11,635
2002	0.78	111,554	11,886
2003	0.82	111,300	12,135
2004	0.86	112,743	12,343
2005	0.89	114,780	12,474
2006	0.90	116,907	12,643
2007	0.90	117,763	12,925
2008	0.88	116,033	13,082
2009	0.83	109,395	12,745
2010	0.87	108,142	12,836
2011	0.90	109,711	13,024
	Annual Average growth (per cent)		
1987-2011	0.90	0.72	1.26
1987-2000	0.45	1.71	1.37
2000-2011	1.43	-0.43	1.14

Source: CANSIM Table 380-0057 for PPP; Bureau of Labour Statistics Major Sector Productivity dataset for U.S. Business Sector employment, Statistics Canada Productivity Program for Canadian Business sector employment

Appendix Table 15: Software Investment per Worker by Industry Ranking Relative to the United States, USA = 100, 2007

	AUS	AUT	CAN	DNK	FIN	DEU	ITA	JPN*	NLD	ESP	SWE	GBR
Agriculture	96	48	59	464	76	56	10	49	124	2	24	111
Construction	40	48	9	67	35	28	18	51	59	13	106	52
Education	60	8	55	65	68	35	7	15	30	12	99	78
Utilities	81	39	89	38	105	51	36	91	60	37	155	30
Finance	139	156	129	505	438	39	68	115	271	222	537	156
Health	50	11	42	14	79	52	31	47	34	41	54	38
Manufacturing	23	21	32	53	60	30	22	40	66	8	117	60
Mining	46	8	9	51	12	6	6	9	294	1	15	11
Other	208	69	101	355	282	121	71	192	82	290	306	154
Real Estate	6	13	15	32	7	7	6	4	8	3	14	14
Transport	62	37	36	156	58	41	48	41	80	128	88	57
Trade	73	35	106	162	145	64	48	106	87	55	265	169
Total	56	43	62	128	83	42	34	51	73	43	130	81

Notes: AUS = Australia, AUT= Austria, CAN= Canada, DNK= Denmark, FIN= Finland, DEU= Germany, ITA= Italy, JPN= Japan, NLD= Netherlands, ESP = Spain, SWE= Sweden, GBR= United Kingdom, USA= United States

*Data for Japan are for 2006.