November 2016

151 Slater Street, Suite 710
Ottawa, Ontario
K1P 5H3

613-233-8891
csls@csls.ca

CENTRE FOR THE STUDY OF LIVING STANDARDS

NEW EVIDENCE ON THE CANADA-U.S. ICT INVESTMENT GAP, 1976-2014

Jasmin Thomas

CSLS Research Report 2016-17

November 2016

Prepared for Innovation, Science and Economic Development Canada

New Evidence on the Canada-U.S. ICT Investment Gap, 1976-2014

Abstract

Productivity growth results in part from investment in information and communications technologies (ICT). To better understand Canada's poor productivity growth relative to the United States since 2000, this report provides a detailed examination of ICT investment trends in the two countries. The report finds that real ICT investment in the total economy in Canada has yet to recover from the 2008-2009 recession, while it has not suffered the same fate south of the border. Between 2008 and 2014 real ICT investment in Canada fell 1.0 per cent per year, compared to a 2.9 per cent per year increase in the United States. The gap was even greater for real ICT investment per job, down 1.8 per cent per year in Canada versus a 2.8 per cent annual increase in the United States. The weaker ICT investment growth in Canada resulted in a large increase in the Canada-US ICT investment gap from 31.6 percentage points to 43.7 points, as nominal ICT investment per job fell from 68.4 per cent of the US level in 2008, the highest value ever achieved, to 56.3 per cent in 2014.

New Evidence on the Canada-U.S. ICT Investment Gap, 1976-2014

Table of Contents

New Evidence on the Canada-U.S. ICT Investment Gap, 1976-2014

Executive Summary

Information and communications technology (ICT) investment is an important contributor to productivity growth. In recent years, Canadian productivity growth has lagged behind that of the United States. To shed light on the role of ICT investment in this situation, this report provides a detailed examination of trends in ICT investment in both Canada and the United States, as well as developments in the Canada-U.S. ICT investment gap.

The most striking results relate to the post-2008 period. By 2014, total economy real ICT investment in Canada has yet to regain its pre-recession 2008 level, shrinking 1.0 per cent per year. In contrast, in the United States it had far surpassed its pre-recession level, growing 2.9 per cent per year. This failure of ICT investment to recover in Canada reflected falls in real investment in both computer hardware and telecommunications equipment.

Canada experienced total economy employment growth of 0.8 per cent per year in the 2008-2014 period, in contrast to only 0.1 per cent in the United States. This stronger employment growth resulted in ICT investment intensity, that is ICT investment per worker, falling nearly 5 percentage points per year in Canada, relative to the United States: -1.8 per cent versus 2.8 per cent. This much weaker ICT investment growth per worker in Canada resulted in a large increase in the Canada-US ICT investment gap from 31.6 percentage points to 43.7 points, as nominal ICT investment per job fell from 68.4 per cent of the US level in 2008, the highest value ever achieved, to 56.3 per cent in 2014.

One important finding, consistent with other CSLS research reports on ICT investment, is the large contribution of computer software and databases to the overall gap in nominal ICT investment per job in Canada relative to the United States. In 2014, this component accounted for 75.8 per cent of the total gap in nominal Canada-U.S. ICT investment per job. More importantly, computer software and databases has consistently, and increasingly, been the largest contributor to the gap in ICT investment in Canada relative to the United States since 1998, the first year of data availability.

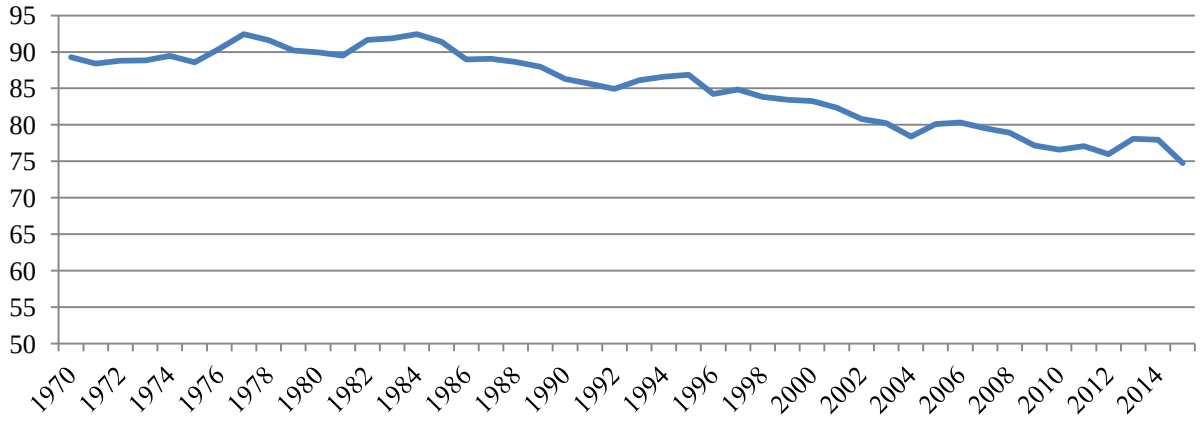
Given the importance of computer software and databases, future ICT investment research should focus on this component. Are we mismeasuring computer software and databases? Are we capturing ICT services, such as cloud computing, properly and accurately? Are we appropriately measuring ICT prices, especially for new products and services? What are the challenges of the digital economy for the national accounts? Is there a way to measure ICT, especially computer software and databases, more appropriately with digitalization?

New Evidence on the Canada-U.S. ICT Investment Gap, 1976-2014[1]

I. Introduction

Growth in labour productivity determines growth in wages (and therefore living standards) in the long-run. Canada's total economy labour productivity relative to United States' total economy labour productivity, starting at about 90 per cent in 1970, was fairly steady until the mid-1980s, after which the situation began to slowly deteriorate (Chart 1). By 2015, productivity levels in the total economy in Canada fell to represent only about 75 per cent of that of the United States.[2]

Chart 1: Relative Labour Productivity (Nominal GDP Per Hour), Total Economy, Canada as a Proportion of the United States, Per Cent, 1970-2015



Source: CSLS (2016).

Since growth in information and communications technology (ICT) investment contributes to labour productivity growth, tracking ICT investment in Canada and the United States can shed light on an important driver of relative productivity levels and productivity growth.

For this reason, this report examines trends in information and communications technology (ICT) investment in Canada and the United States between 1970 and 2014 and

[1] This report was prepared by Jasmin Thomas under the supervision of Andrew Sharpe for Innovation, Science and Economic Development (ISED) Canada. Email: jasmin.thomas@csls.ca. The author would like to thank ISED officials for comments and James Uguccioni for assistance with the database.

[2] The decline in relative Canada-U.S. labour productivity from 77.9 per cent in 2014 to 74.7 per cent in 2015 was caused by a fall of US$0.88 in GDP per hour in Canada and a rise of US$1.63 in GDP per hour in the United States. These changes were caused by a 0.5 per cent increase in nominal GDP in Canada, a 3.3 per cent increase in nominal GDP in the United States, a 0.8 per cent increase in the number of hours worked in Canada, a 1.2 per cent decline in the number of hours worked in the United States, and a 0.6 per cent increase in the USD/CAD GDP PPP.

developments in the Canada-U.S. ICT investment gap.[3] It is based on an updated version of the Centre for the Study of Living Standards (CSLS) ICT database.[4]

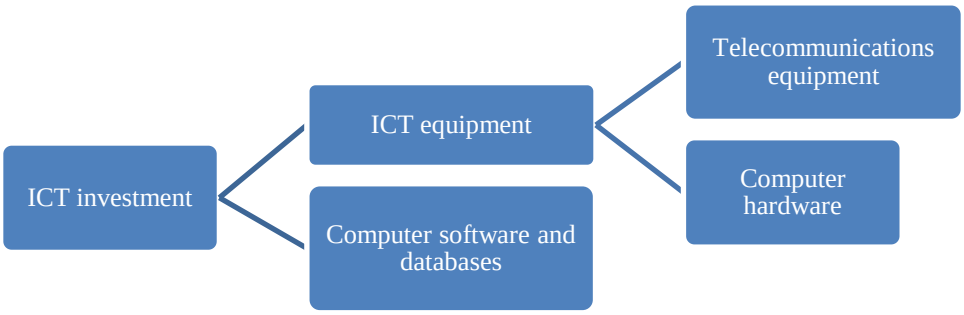
The report is structured as follows. Section II reviews the data and the methodology. Section III and Section IV provide an overview of ICT investment in Canada and the United States respectively. Section V compares total economy ICT investment in Canada by examining relative nominal Canada-U.S. ICT investment per job, relative Canada-U.S. nominal ICT investment as a share of nominal GDP, and relative real ICT investment growth rates in Canada and the United States. Section VI discusses issues related to the future of tracking developments in ICT investment. Section VII concludes.

II. Data and Methodology

The data in this report are drawn from the ICT database that is developed and maintained by the Centre for the Study of Living Standards (CSLS). This database is created by using estimates of ICT investment (total and components) compiled by the Organisation for Economic Cooperation and Development (OECD) based on national data sources. The CSLS database provides estimates of ICT investment and its three components in Canada and the United States for the total economy and for 19 industries.

The database provides estimates of total ICT investment, ICT investment per job, ICT investment as a share of gross fixed capital formation, and ICT investment as a share of GDP. The estimates of total ICT investment and ICT investment per job are expressed in both nominal terms (current dollars) and real terms (constant 2007 dollars for Canada and chained 2009 dollars for the United States), while the estimates of ICT investment as a share of gross fixed capital formation and ICT investment as a share of GDP are only available in nominal terms (current dollars).

Figure 1: Breakdown of ICT Investment into Components



Source: CSLS

[3] For previous reports from the CSLS on ICT investment in Canada and the United States, see Sharpe, 2005, 2006 and 2010; CSLS, 2008; Sharpe and Arsenault, 2008; Sharpe and De Avillez, 2010; Sharpe and Moeller, 2011; Sharpe and Andrews, 2012; Capeluck, 2012 and 2013; and Thomas, 2015 and 2016.
[4] The CSLS database is available online at no charge: http://www.csls.ca/data/ict.asp.

ICT investment in this report is broken down into two components: (1) ICT equipment (as defined in the SNA 2008 (UN, 2008)) and (2) computer software and databases. The former component, ICT equipment, can be broken down into two additional subcomponents: (1) telecommunications equipment and (2) computer hardware (Figure 1).

Table 1: Data Availability, Total Economy, Canada and the United States, 1970-2014

	Canada	United States
Nominal ICT investment	1976-2014	1970-2014
Computer hardware	1970-2014	1970-2014
Telecommunications equipment	1970-2014	1970-2014
Computer software and databases	1976-2014	1970-2014
Real ICT investment	1976-2014	1970-2014
Computer hardware		1970-2014
Telecommunications equipment	1970-2014*	1970-2014
Computer software and databases	1976-2014	1970-2014
Jobs	1997-2014	1998-2014
Nominal gross fixed capital formation	1970-2014	1970-2014
Nominal GDP	1970-2014	1970-2014
M&E PPP	1990-2014	
Exchange rate	1970-2014	

* An aggregate of these two components, ICT equipment (SNA 2008) is available for Canada for 1970-2014.
Source: CSLS.

Given the availability of data for the 1970-2014 period (Table 1), comparisons between the total economies in Canada and the United States vary depending on the relative measure that is being examined. In particular:

- Estimates for Canada-U.S. ICT investment per job (adjusted using the machinery and equipment purchasing power parity (M&E PPP) or the market exchange rate) are available for the 1998-2014 period because data on US jobs are only available from 1998;

- Canada-U.S. ICT investment as a share of GDP is available for 1970-2014;

- Canada-U.S. ICT investment as a share of gross fixed capital formation is available between 1970 and 2014; and

- Comparisons of real ICT investment growth rates and growth accounting for Canada and the United States are available for the 1976-2014 period.[5]

In this report, we focus on levels of M&E PPP-adjusted ICT investment per job in the two countries as this measure of ICT investment intensity is a key productivity driver. In a perfect world, we would use an ICT PPP, but there are no estimates for this available from Statistics Canada. The closest approximation is the PPP for machinery and equipment. This introduces two potential measurement issues. First, software is not included in M&E; it is included in intellectual property products (IPP). This means that we are not accounting for relative Canada-U.S. software prices when converting ICT investment into U.S. dollars using the M&E PPP. Second, the M&E PPP includes more than computer hardware and telecommunications equipment prices. If computer hardware and telecommunications prices behave differently than the prices of non-ICT components of machinery and equipment included in the M&E PPP, ICT investment in Canada in U.S. dollars will not be exactly accurate.[6]

The most recent version of the CSLS ICT database has undergone some important changes. Earlier versions of the database were based on data taken from Statistics Canada for Canada and the U.S. Bureau of Economic Analysis and the U.S. Bureau of Labor Statistics for the United States. The data are now taken from the OECD for two reasons.

First, using OECD data minimizes the number of potential errors that could be introduced from using Fisher relatives, a complex procedure with many steps that the CSLS implemented in previous databases to obtain ICT estimates for the United States. In particular, in the past, the CSLS calculated estimates of real ICT investment from extremely detailed investment data obtained from the U.S. Bureau of Economic Analysis.[7] To aggregate these data into ICT investment by industry, we implemented a complex Fisher relative methodology (Thomas, 2015:56-58). The many steps in this procedure meant that there were more places for potential calculation errors. By using OECD data, we significantly reduce the number of instances where we must use Fisher relatives to obtain estimates, and thereby, we significantly limit the number of potential errors.

Second, Statistics Canada made significant changes to the availability of data in early 2016. In particular, Statistics Canada's Stock and Consumption of Fixed Non-Residential Capital Program reclassified the commodities within ICT investment so that there are only two components to ICT investment instead of three. In particular, ICT investment used to be an aggregate of 'computers,' 'telecommunications equipment,' and 'software,' but estimates of computers and telecommunications equipment are no longer published separately. Instead, Statistics Canada publishes a component called 'computers and electronic products,' which is an aggregate of the previous 'computers' and 'telecommunications equipment' categories, plus a new commodity called 'measuring and control devices: electrical, medical and scientific.'

[5] The availability of industry-level ICT data is much more difficult to summarize. For details, refer to the online database.

[6] Official Statistics Canada M&E PPP estimates between 1991 and 1993 raise some red flags: in 1991, the M&E PPP was 0.86, but by 1993, it had fallen to 0.72. This is a massive decline for a two-year period and is inconsistent with trends in the M&E deflators in the two countries.

[7] The data are available from: http://www.bea.gov/national/FA2004/Details/Index.htm.

Statistics Canada continues to publish 'software' separately of 'computer and electronic products.'[8] Data from the OECD, on the other hand, has estimates for all three components, which they call 'computer hardware,' 'telecommunications equipment,' and 'computer software and databases.' This allows us to provide an analysis that is similar to previous CSLS reports.

One disadvantage of the OECD data is that it does not provide capital stock estimates. In order to avoid mixing a number of different data sources, and creating potential comparability issues, we have chosen to no longer include ICT capital stock estimates in the CSLS ICT database. This decision is also supported by the fact that deflators for ICT investment suffer from potential cross-country comparability issues (Thomas, 2016:162) and that ICT investment adds to and eventually determines overall capital stock.

In addition to the change in the source of primary data from national sources to the OECD, a second important change in the CSLS ICT data relates to the definition of the aggregate economy.[9] Earlier versions of the database used the business sector because the U.S. Bureau of Economic Analysis did not make public ICT investment estimates for public administration, an integral part of the total economy. Furthermore, since Statistics Canada does not publish business sector estimates of ICT investment using the traditional business sector definition,[10] the CSLS was forced to use the definition of the business sector from Statistics Canada's Stock and Consumption of Fixed Non-Residential Capital Program.[11] By switching to OECD data, we can now avoid the issues in defining the business sector since the OECD publishes data on ICT investment for the total economy, including public administration in the United States.

One challenge of cross-country analysis is determining the comparability of the data. Fortunately, in general, the ICT investment data obtained for Canada and the United States from the OECD is comparable. First of all, it appears that there are not significant differences in the measurement of computer software and databases in the two countries; the minor differences that

[8] Statistics Canada also made a change to data availability by industry. It now produces estimates for fewer industries than in the past. In particular, real estate and rental and leasing and finance and insurance are now considered one aggregate industry, whereas in the previous Stock and Consumption of Fixed Non-Residential Capital Program, they were considered as two separate industries. This means that instead of 20 two-digit NAICS industries, there are now only 19 two-digit NAICS industries.

[9] The OECD data source is accessed at https://stats.oecd.org/Index.aspx?DataSetCode=NAAG# One then goes to National Accounts/Annual National Accounts/Detailed Tables and Simplified Accounts/8A. Capital Formation by Activity, ISIC, Rev4.

[10] The traditional or official business sector definition is based on whether production at the firm level is marketable or non-marketable. In particular, Statistics Canada defines the business sector as all transactors producing goods and services for sale at a price intended to cover costs of production, namely corporations, government business enterprises, unincorporated businesses, and independent professional practices. It also includes owners occupying their own dwelling, treated as businesses themselves, and associations of individuals, treated as businesses with respect to their capital outlays and their intermediation activities. The U.S. Bureau of Economic Analysis defines the business sector as all corporate and non-corporate private entities organized for profit and certain other entities that are treated as businesses in the national income and product accounts (NIPAs), including mutual financial institutions, private non-insured pension funds, cooperatives, non-profit organizations that primarily serve businesses, Federal Reserve banks, federally sponsored credit agencies, and government enterprises.

[11] This program defines the business sector as the total economy, excluding three two-digit NAICS industries: health care and social assistance, educational services, and public administration.

do exist likely cannot explain the Canada-U.S. ICT investment gap (Thomas, 2016; Sharpe, 2014). Moreover, the assets that are included in computer hardware and telecommunications equipment investment are broadly similar in both Canada and the United States. The small differences that we identified cannot account for the Canada-U.S. gap in ICT investment.

For example, watches, clocks and parts of watches and clocks are included in Canada but not in the United States. Given that investment in these assets is likely to be extremely small in Canada for the non-residential economy, it is unlikely that the inclusion of these assets will create large measurement errors. There are other types of assets that are included in Canada and not in the United States, but these also represent a very small share of overall total ICT investment, and hence, will not likely impact the Canada-U.S. ICT investment gap to a large extent.[12] It is important to note, however, that the inclusion of these assets only boosts Canada's relative ICT investment estimates above the true prevailing situation, causing the estimated Canada-U.S. ICT investment gap to be smaller than in reality.

III. An Overview of ICT Investment in Canada

This section aims to provide an overview of developments in ICT investment in Canada since 2000. Estimates are provided for the 2000-2008 and 2008-2014 sub-periods as well as the two most recent years, 2013 and 2014.

A. ICT Investment

In 2014, nominal ICT investment in Canada rose to $42.2 billion from $40.5 billion in 2013, or 4.1 per cent (Table 2). Since ICT prices rose 3.8 per cent in 2014, real ICT investment barely grew at all, increasing only 0.3 per cent from $40.7 billion (2007 dollars) in 2013 to $40.8 billion (2007 dollars) in 2014.

From a longer-term perspective, growth in real ICT investment was 3.8 per cent per year between 2000 and 2014, driven by falling ICT prices (2.2 per cent per year) and increased nominal ICT investment (1.5 per cent per year).[13]

[12] See Appendix Table 1 and Appendix Table 2 for full lists of the assets included in computer and telecommunications equipment investment in Canada and the United States. With these lists, it is possible to determine where discrepancies exist between the definitions of ICT equipment investment in Canada and the United States.

[13] By definition, growth in real ICT investment per job can be broken down into growth in nominal ICT investment, growth in ICT prices, and growth in employment. Mathematically, this can be expressed as:

$$\Delta\%R \approx \Delta\%X - \Delta\%Y - \Delta\%Z$$

where R is real ICT investment, X is nominal ICT investment, Y is ICT prices, and Z is employment. Note that ICT prices are calculated as implicit price deflators, or nominal ICT investment divided by real ICT investment.

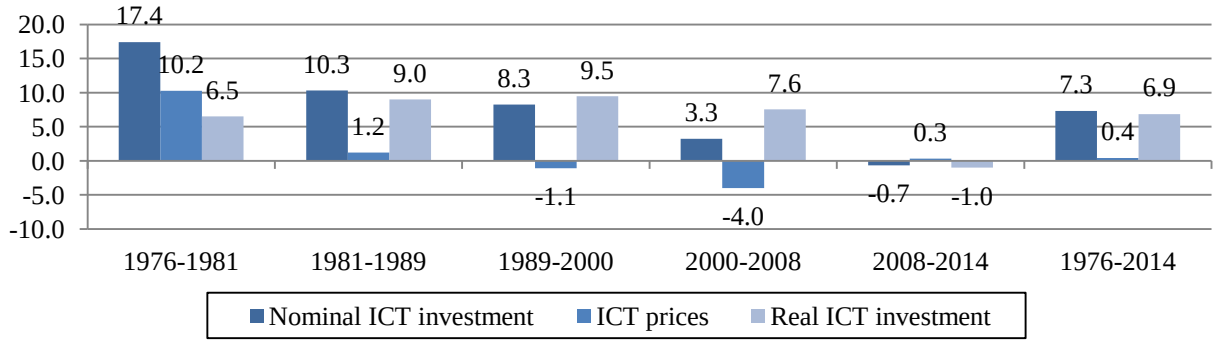
Table 2: Growth in Nominal ICT Investment, Nominal ICT Investment Per Job, ICT Prices, Real ICT Investment, Real ICT Investment Per Job, and Employment, Total Economy, Compound Average Annual Growth, Per Cent, Canada, 2000-2014

	2000-2008	2008-2014	2000-2014	2013	2014
Nominal ICT investment	3.3	-0.7	1.5	-2.5	4.1
Nominal ICT investment per job	1.5	-1.4	0.2	-3.8	3.5
ICT prices	-4.0	0.3	-2.2	2.5	3.8
Real ICT investment	7.6	-1.0	3.8	-4.8	0.3
Real ICT investment per job	5.7	-1.8	2.4	-6.1	-0.3
Employment	1.7	0.8	1.3	1.3	0.6

Source: CSLS ICT database.

The 2000-2014 period can be broken down into pre-recession and post-recession sub-periods. Over the 2000-2008 period, growth in nominal ICT investment was 3.3 per cent per year, substantially larger than growth in the 2008-2014 period at -0.7 per cent per year (Chart 2). In terms of real ICT investment, these growth rates were 7.6 per cent per year and -1.0 per cent per year respectively (Chart 3). Since ICT prices fell substantially in the first sub-period (-4.0 per cent per year) and increased in the second sub-period (0.3 per cent per year), it is not surprising that the gap in ICT investment growth rates between the two periods is greater for real ICT investment than under nominal ICT investment.

Chart 2: Nominal ICT Investment, ICT Prices, and Real ICT Investment, Canada, Total Economy, Compound Average Annual Growth, Per Cent, 1976-2014

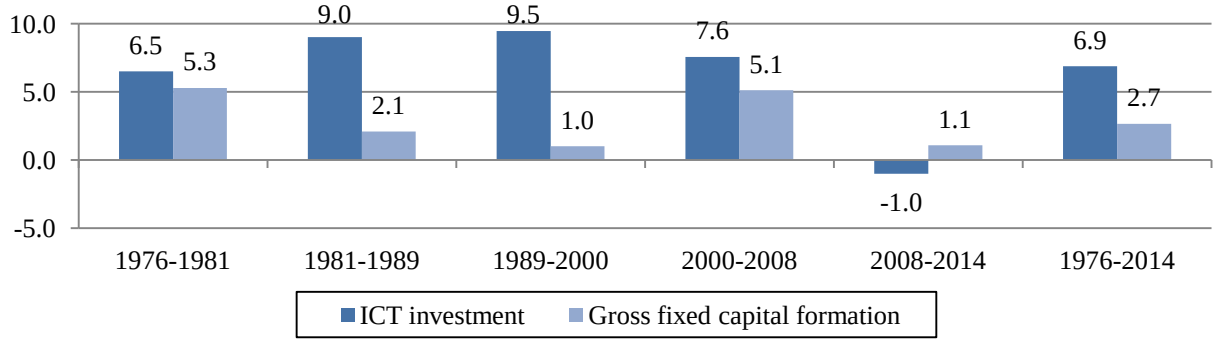


Source: CSLS ICT database.

Compared to past developments in gross fixed capital formation and real ICT investment, the period between 2008 and 2014 experienced extremely weak real ICT investment performance (Chart 3). In fact, this is the first period[14] since 1976 in which real ICT investment fell, and moreover, it was the first period since 1976 where real ICT investment growth was less than real gross fixed capital formation growth.

[14] The years 1981, 1989, 2000, 2008 were years of cyclical output peaks for peak-to-peak comparisons of growth rates. The first year in the time series, 1976, was not a cyclical peak. Nor was the last year in the series, 2014.

Chart 3: Real ICT Investment and Real Gross Fixed Capital Formation, Total Economy, Canada, Compound Average Annual Growth, Per Cent, 1976-2014

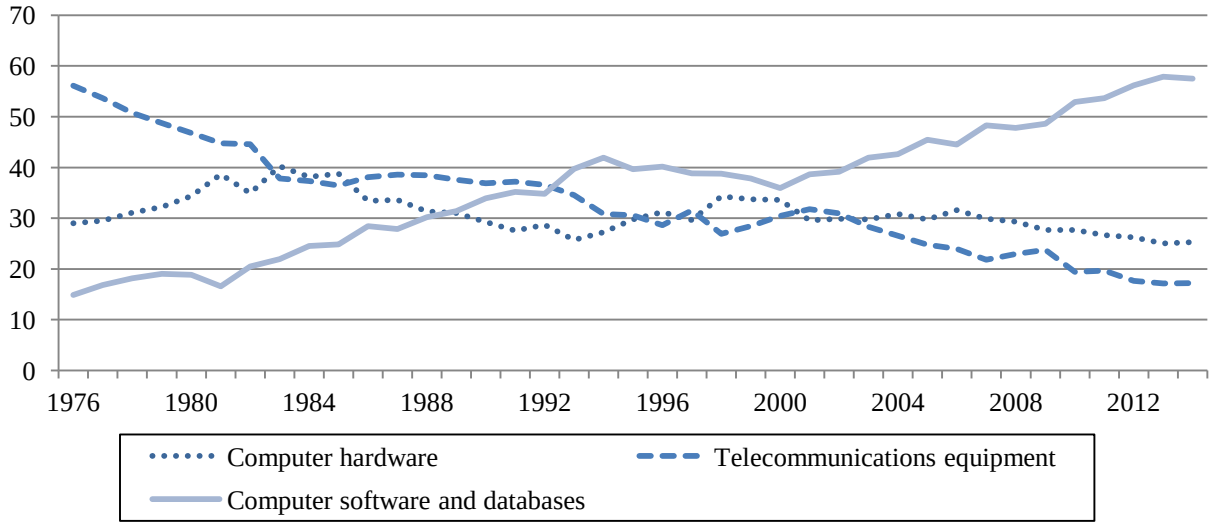


Source: CSLS ICT database.

B. ICT Investment by Component

ICT investment consists of three components: computer hardware, telecommunications equipment, and computer software and databases. Since 1993, computer software and databases has represented the largest proportion of nominal ICT investment, accounting for approximately 58 per cent in 2014 (Chart 4). Since the early-2000s, computer hardware has represented the second largest proportion, accounting for 25.3 per cent in 2014. Telecommunications equipment followed with 17.2 per cent. In 1976, telecommunications equipment was the most important component of ICT investment, representing about 56 per cent.

Chart 4: Share of Nominal ICT Investment by Component, Canada, Total Economy, Per Cent, 1976-2014



Source: CSLS ICT database.

Table 3: Growth in Nominal ICT Investment, Nominal ICT Investment Per Job, ICT Prices, Real ICT Investment, Real ICT Investment Per Job, and Employment by Component of ICT, Total Economy, Compound Average Annual Growth, Per Cent, Canada, 2000-2014

	ICT investment	Computer hardware	Telecommunications equipment	Computer software and databases
Nominal ICT investment				
2000-2008	3.3	1.5	-0.4	7.0
2008-2014	-0.7	-3.1	-5.3	2.4
2000-2014	1.5	-0.5	-2.5	5.0
Nominal ICT investment per job				
2000-2008	1.5	-0.2	-2.0	5.2
2008-2014	-1.4	-3.9	-6.0	1.7
2000-2014	0.2	-1.8	-3.8	3.6
ICT prices				
2000-2008	-4.0		-7.3*	0.4
2008-2014	0.3		-1.3*	1.6
2000-2014	-2.2		-4.8*	0.9
Real ICT investment				
2000-2008	7.6		8.5*	6.5
2008-2014	-1.0		-2.7*	0.8
2000-2014	3.8		3.6*	4.0
Real ICT investment per job				
2000-2008	5.7		6.7*	4.7
2008-2014	-1.8		-3.5*	0.0
2000-2014	2.4		2.2*	2.7
Employment				
2000-2008			1.7	
2008-2014			0.8	
2000-2014			1.3	

* For ICT investment prices, the OECD only provides an aggregate of computer hardware and telecommunications.
Source: CSLS ICT database.

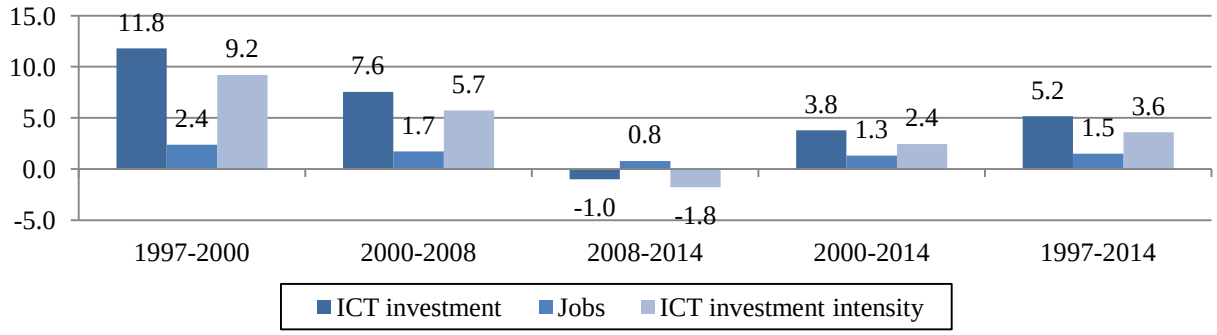
Over the 2000-2008 period, real ICT investment grew by 7.6 per cent per year. This can be broken down into growth in ICT equipment of 8.5 per cent per year and growth in computer software and databases of 6.5 per cent per year. In 2008-2014 real ICT investment growth of -1.0 per cent per year can be decomposed into a 0.8 per cent increase in computer software and databases and a 2.7 per cent fall in computer equipment.

These growth rates can in turn be broken down into price changes and changes in nominal ICT investment. For example, the real growth of 8.5 per cent per year in ICT equipment in 2000-2008 is a result of increases in nominal computer hardware investment of 1.5 per cent per year, decreases in nominal telecommunications equipment of 0.4 per cent per year, and decreases in ICT equipment prices of 7.3 per cent per year. Growth of 6.5 per cent per year in computer software and databases reflects increases of 7.0 per cent per year in nominal computer software and databases investment and increases of 0.4 per cent per year in prices.

C. ICT Investment per Job

ICT investment intensity is defined as nominal total ICT investment divided by the number of jobs. ICT investment per job is important because ICT per job affects labour productivity.[15] In 2014, nominal ICT investment rose by 4.1 per cent, while the number of jobs rose by 0.6 per cent. As a result, nominal ICT investment per job rose by 3.5 per cent. Since real ICT investment only increased by 0.3 per cent in 2014, real ICT investment per job fell 0.3 per cent. In absolute terms, real ICT investment intensity was $2,256 (2007 dollars) per job in 2014, lower than the 2008 peak of $2,510 (2007 dollars) per job.

Chart 5: Real ICT Investment, Employment, and Real ICT Investment Per Job, Canada, Compound Average Annual Growth, 1976-2014



Source: CSLS ICT database.

Over the 2000-2014 period, the compound average annual growth rate for real ICT investment intensity was 2.4 per cent per year, reflecting the fact that real ICT investment grew at 3.8 per cent per year while the number of jobs grew at 1.3 per cent per year (Chart 5). This growth can be further decomposed into the 2000-2008 and 2008-2014 sub-periods. In particular, between 2000 and 2008, real ICT investment per job grew at 5.7 per cent per year because of strong 7.6 per cent per year real ICT investment growth and a 1.7 per cent per year increase in the number of jobs. This strong growth in 2000-2008 was completely reversed after 2008, with real ICT investment per job falling at a 1.8 per cent per year, reflecting the massive fall-off in real ICT investment (8.6 percentage points to -1.0 per cent).

The changes in real ICT investment can be further decomposed into the effects from changes in:

1. nominal computer hardware investment;
2. nominal telecommunications equipment investment;
3. nominal computer software and databases investment;
4. ICT equipment prices; and

[15] ICT investment per job may differ from ICT investment per worker, which the CSLS used to report in previous editions, because ICT investment per job captures what each worker has at his or her disposal in each of their jobs. For most workers, since they only occupy one job, there is no difference between ICT investment per worker and ICT investment per job. However, there may be a difference ICT investment per worker and ICT investment per job, particularly for industries where there are large numbers of multiple jobholders. At the aggregate level, there is little difference in trends in jobs and employment so growth rates for the ICT investment per worker and per job are virtually the same.

5. computer software and databases prices.

Table 4: Contributions to Real ICT Investment Per Job Growth, Canada, Total Economy, 2000-2014

	Per Cent Per Year	Percentage Point Contribution
Real ICT investment per job	2.4	2.4
Real ICT investment	3.8	3.8
Nominal ICT investment	1.5	1.5*
Computer hardware	-0.5	-0.1
Telecommunications equipment	-2.5	-0.6
Computer software and databases	5.0	2.4
ICT prices	-2.2	-2.2*
ICT equipment	-4.8	-2.5
Computer software and databases	0.9	0.5
Jobs	1.3	1.3

* The sum of the components of ICT will not equal the overall change in nominal ICT investment and ICT prices because this is only an approximate procedure.
Note: To determine the percentage point contributions of the components of ICT investment to nominal ICT investment and ICT prices, we used the average share of each component in total ICT investment between 2000 and 2014. We could also have used the share of each component in total ICT investment from 2000 or 2014 or any year in between. We chose the average, since it accounts for potential changes in the importance of each component over time.
Source: CSLS calculations.

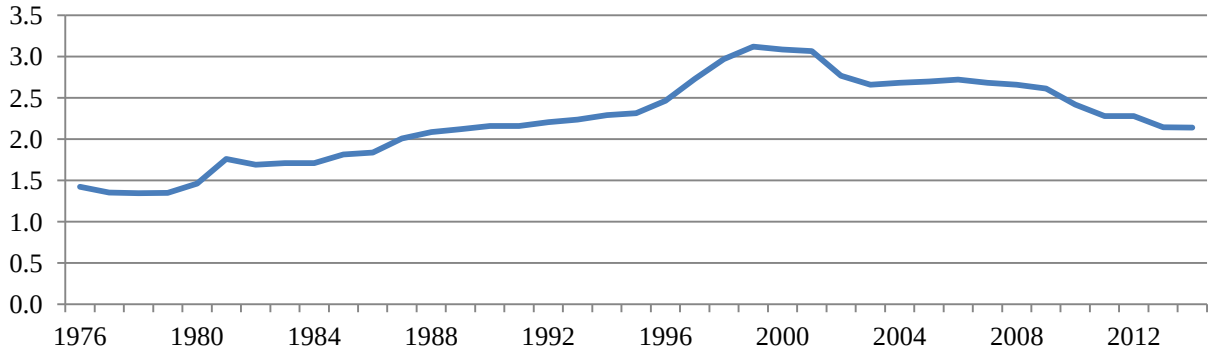
For example, consider the 2000-2014 period, when real ICT investment intensity increased by 2.4 per cent per year. This can be broken down into (1) positive contributions from computer software and databases investment (2.4 percentage points per year) and ICT equipment prices (2.5 percentage points per year, and (2) negative contributions from telecommunication equipment investment (0.6 percentage points per year), computer hardware investment (0.1 percentage points per year), computer software and databases prices (0.5 percentage points per year), and jobs (1.3 percentage points per year). If we sum the positive contributions, and subtract from this sum the negative contributions, we obtain the total change in real ICT investment per job (2.4 per cent per year).[16]

D. ICT Investment as a Share of GDP

In many ways, tracking ICT investment's share of GDP is more informative than ICT investment per job. This is especially the case when doing cross-country comparisons because ICT investment as a share of GDP takes into account differences in income levels, whereas ICT investment per job does not.

[16] Please note that this method is approximate. The contributions will not necessarily completely sum to the total change in real ICT investment per job.

Chart 6: Nominal ICT Investment as a Share of Nominal GDP, Total Economy, Canada, 1976-2014



Source: CSLS ICT database.

Chart 6 shows that nominal ICT investment as a share of GDP increased steadily between 1976 and 1999 from 1.42 per cent to 3.12 per cent. Shortly thereafter, this measure of ICT investment began to track downward fairly consistently, falling to 2.14 per cent by 2014.

E. ICT Investment by Industry

ICT investment data were available for 12 of the 19 two-digit NAICS industries in Canada in 2014.[17] Data for the other 7 industries were suppressed by the OECD. The industry with the highest level of ICT investment in 2014 was public administration and defence at $7,430 million, followed by information and communication at $4,545 million and wholesale and retail trade at $4,504 million (Table 5). The lowest level of ICT investment was $367 million in other service activities, followed by $380 million in accommodation and food services.

In terms of nominal ICT investment per job in 2014, information and communication leaps into the top spot with $7,828 per job ahead of public administrative and defence with $6,714 per job (Table 5). These two were followed by professional, scientific and technical activities with $3,687 per job. The industries with the lowest levels of nominal ICT investment per job were accommodation and food services at $310 per job and construction at $345 per job.

[17] Statistics Canada releases estimates of ICT investment by industry for 2014 for 12 of 16 two-digit NAICS industries. For computer and electronic product investment, the missing industries are agriculture; mining, quarrying and oil and gas extraction; utilities; and arts, entertainment and recreation. For software, Statistics Canada does not release estimates for health care and social assistance and educational services.

Table 5: Nominal ICT Investment and ICT Investment per Job by Industry, Canada, Millions or Per Cent, Canada, 2000, 2008 and 2014

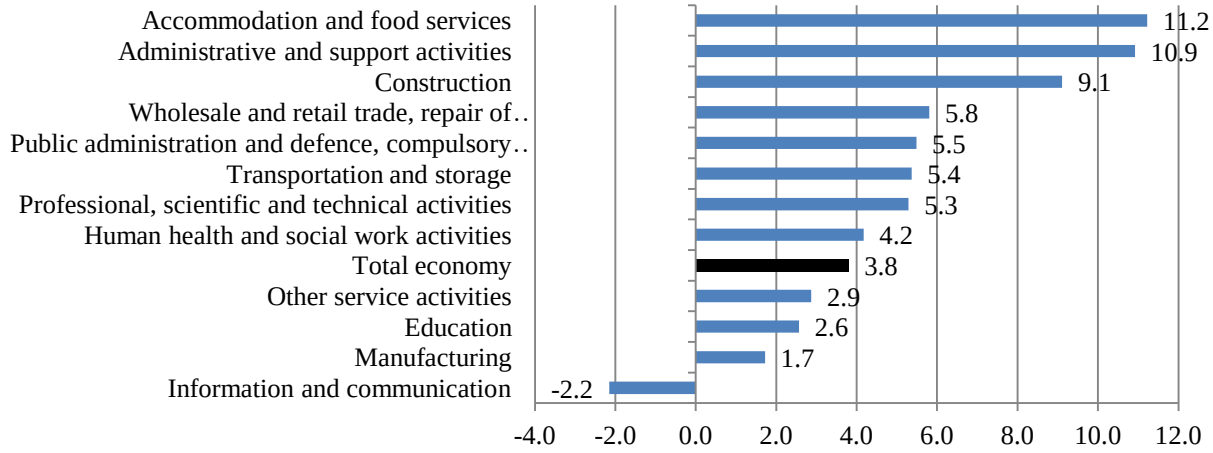
	Nominal ICT Investment			Nominal ICT Investment Per Job		
	2000	2008	2014	2000	2008	2014
Total economy	34,001	43,915	42,158	2,257	2,541	2,328
Agriculture	113	132	..	258	369	..
Mining and quarrying	377	870	..	2,850	4,025	..
Manufacturing	2,712	2,628	2,835	1,250	1,425	1,691
Electricity, gas, steam and air conditioning supply	1,490	1,651	..	17,302	16,711	..
Water supply, sewage, waste management and remediation activities	..	..	..	..	..	..
Construction	261	311	535	301	237	345
Wholesale and retail trade, repair of motor vehicles and motorcycles	2,724	4,853	4,504	1,066	1,661	1,493
Transportation and storage	1,470	2,160	2,284	2,094	2,818	2,746
Accommodation and food services	123	223	380	125	198	310
Information and communication	8,243	7,566	4,545	16,809	13,645	7,828
Financial and insurance activities	..	..	..	..	..	..
Real estate activities	..	..	..	..	..	..
Professional, scientific and technical activities	3,085	2,014	3,274	4,688	2,353	3,687
Administrative and support activities	504	851	1,215	653	861	1,230
Public administration and defence, compulsory social security	4,172	5,684	7,430	4,935	5,384	6,714
Education	1,181	1,399	1,332	1,162	1,156	1,020
Human health and social work activities	930	1,497	1,219	654	895	657
Arts, entertainment and recreation	350	494	..	1,292	1,560	..
Other service activities	353	419	367	812	858	685

Source: CSLS ICT database.

Over the 2000-2014 period, there were three industries that displayed strong real ICT investment growth: accommodation and food services at 11.2 per cent per year, administrative and support activities at 10.9 per cent per year and construction at 9.1 per cent per year (Chart 7). It is not surprising that these industries had the highest growth rates given their low level of real ICT investment in 2000. There was only one industry that saw negative growth during this period: surprisingly, information and communication at -2.2 per cent per year.[18]

[18] These growth rates can be broken down into changes due to nominal ICT investment growth and ICT prices. A discussion of this decomposition is not included in this report. The CSLS ICT database contains all of these growth rates and analysis can be performed using these data.

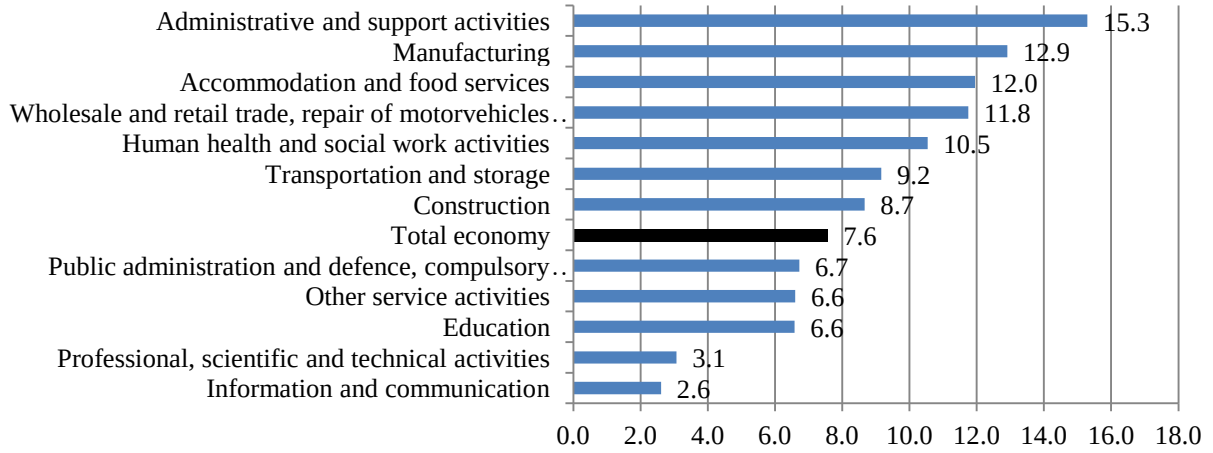
Chart 7: Real ICT Investment by Industry, Compound Average Annual Growth, Canada, 2000-2014



Source: CSLS ICT database.

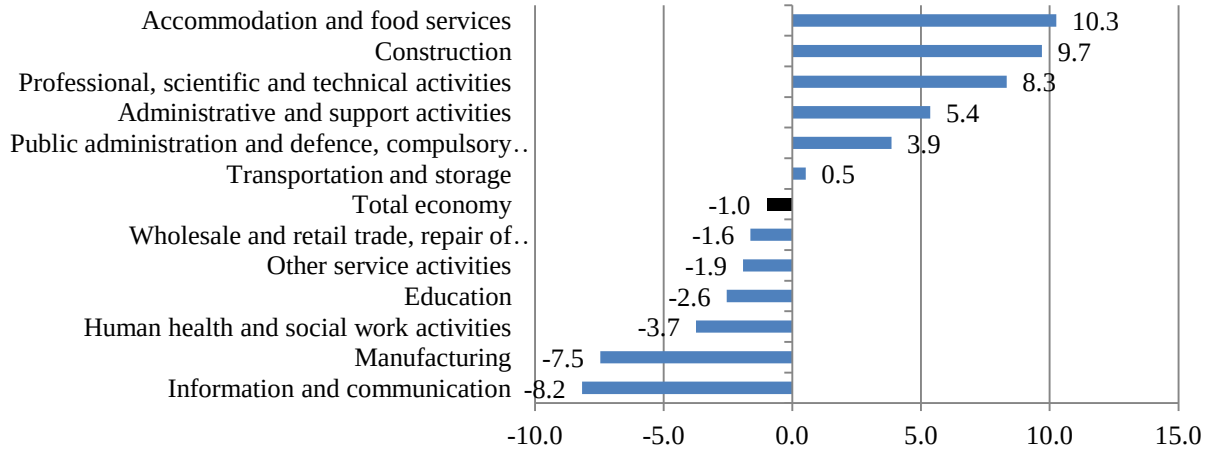
Chart 7a provides growth rates for real ICT investment by industry in the 2000-2008 sub-period, Chart 7b for the 2008-2014 sub-period, and Chart 7c for changes between periods. Almost all industries experienced much slower real ICT investment after 2008. The largest fall-off was in manufacturing, with annual growth 20.4 percentage points slower (12.9 per cent in 2000-2008 versus -7.5 per cent in 2008-2014). The only two industries that enjoyed more rapid real ICT investment growth after 2008 were professional, scientific and technical services and construction.

Chart 7a: Real ICT Investment by Industry, Compound Average Annual Growth, Canada, 2000-2008



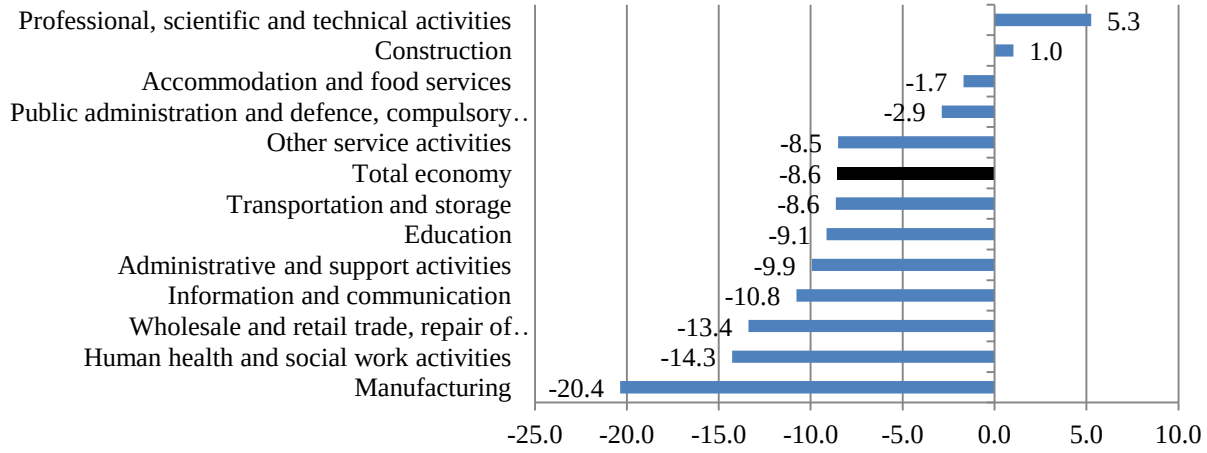
Source: CSLS ICT database.

Chart 7b: Real ICT Investment by Industry, Compound Average Annual Growth, Canada, 2008-2014



Source: CSLS ICT database.

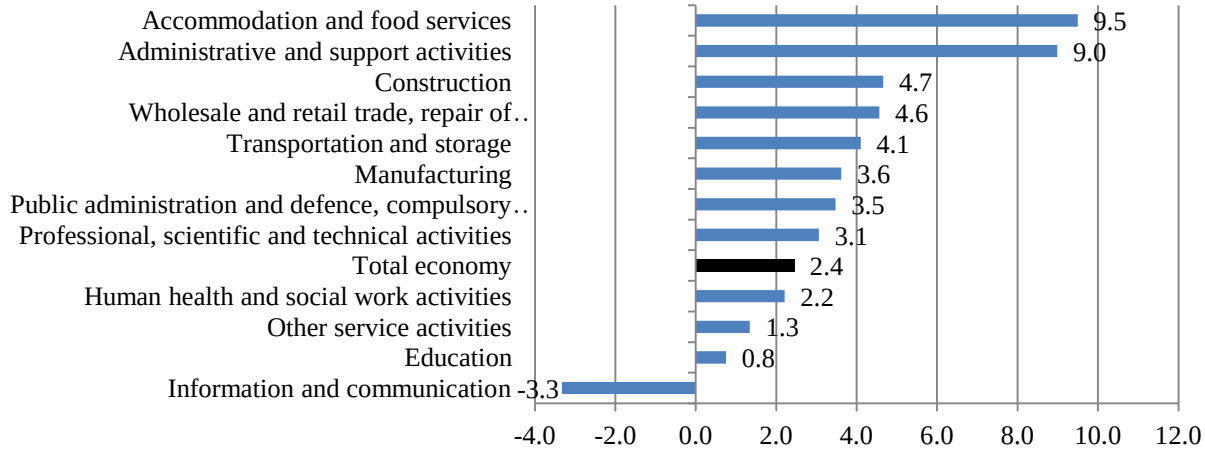
Chart 7c: Real ICT Investment by Industry, Compound Average Annual Growth, Canada, Change from 2000-2008 Period to 2008-2014 Period



Source: CSLS ICT database.

Chart 8 shows that using real ICT investment per job to measure growth between 2000 and 2014 does not change the results for the top three industries: accommodation and food services, administrative and support activities, and construction saw the fastest growth rates. In addition, information and communication is still the only industry to show negative growth.

Chart 8: Real ICT Investment per Job by Industry, Compound Average Annual Growth, Canada, 2000-2014



Source: CSLS ICT database.

IV. An Overview of ICT Investment in the United States

This section provides an overview of developments in ICT investment in the United States.

A. ICT Investment

In 2014, nominal ICT investment in the United States grew 3.6 per cent to $539.8 billion from $521.2 billion in 2013. Since ICT prices fell 0.2 per cent in 2014, real ICT investment grew 3.7 per cent from $542.4 billion (2009 dollars) in 2013 to $562.5 billion (2009 dollars) in 2014.

From a longer-term perspective, growth in real ICT investment was 4.3 per cent per year between 2000 and 2014 (Table 6), driven by falling ICT prices (2.8 per cent per year) and increased nominal ICT investment (1.4 per cent per year).

Table 6: Growth in Nominal ICT Investment, Nominal ICT Investment Per Job, ICT Prices, Real ICT Investment, Real ICT Investment Per Job, and Employment, Total Economy, Compound Average Annual Growth, Per Cent, United States, 2000-2014

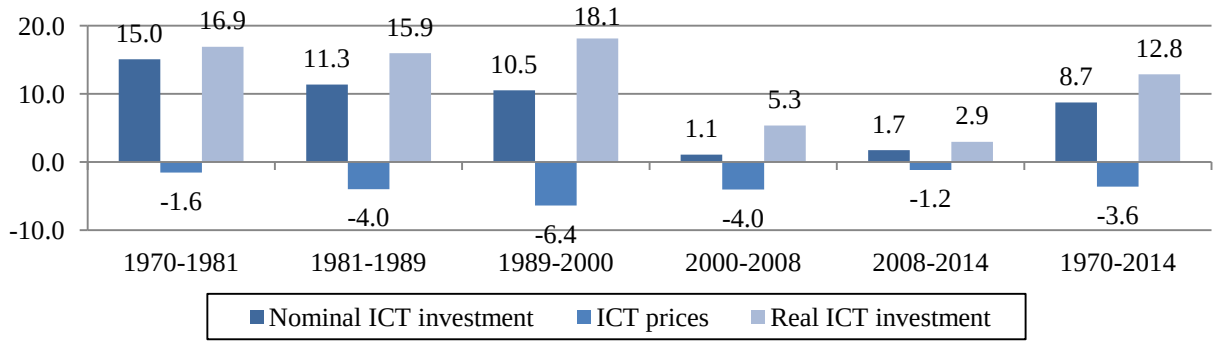
	2000-2008	2008-2014	2000-2014	2013	2014
Nominal ICT investment	1.1	1.7	1.4	3.8	3.6
Nominal ICT investment per job	0.6	1.6	1.0	2.3	1.7
ICT prices	-4.0	-1.2	-2.8	-0.1	-0.2
Real ICT investment	5.3	2.9	4.3	3.9	3.7
Real ICT investment per job	4.9	2.8	4.0	2.4	1.8
Employment	0.5	0.1	0.3	1.5	1.9

Source: CSLS ICT database.

The 2000-2014 period can be broken down into pre-recession and post-recession components. In the 2000-2008 sub-period, growth in nominal ICT investment was 1.1 per cent per year, slightly less than growth in 2008-2014 at 1.7 per cent per year (

Chart 9). In contrast to the relative stability of nominal ICT investment growth, real ICT investment growth was slower after 2008: 2.9 per cent versus 5.3 per cent. This reflected the smaller rate of decline in ICT prices: 1.2 per cent in 2008-2014 versus 4.0 per cent in 2000-2008.

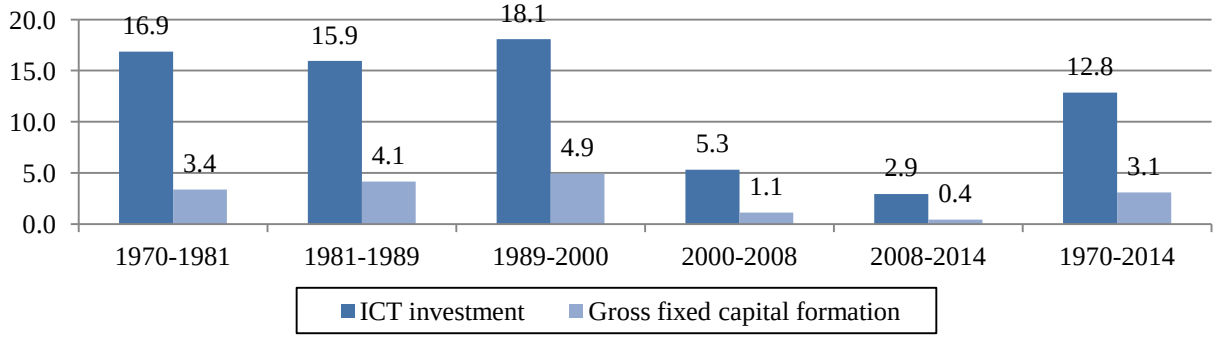
Chart 9: Nominal ICT Investment, ICT Prices, and Real ICT Investment, United States, Total Economy, Compound Average Annual Growth, Per Cent, 1976-2014



Source: CSLS ICT database.

Compared to gross fixed capital formation, real ICT investment performance has been steadily weakening. In fact, the twenty-first century marked a turning point: the growth differential between ICT investment and gross fixed capital formation shrunk enormously (Chart 10). For example, between 1970 and 2000, the growth differential was always more than 10 percentage points per year. Since 2000, this growth differential has plummeted to about 4 percentage points per year or less.

Chart 10: Real ICT Investment and Real Gross Fixed Capital Formation, Total Economy, United States, Compound Average Annual Growth, Per Cent, 1976-2014

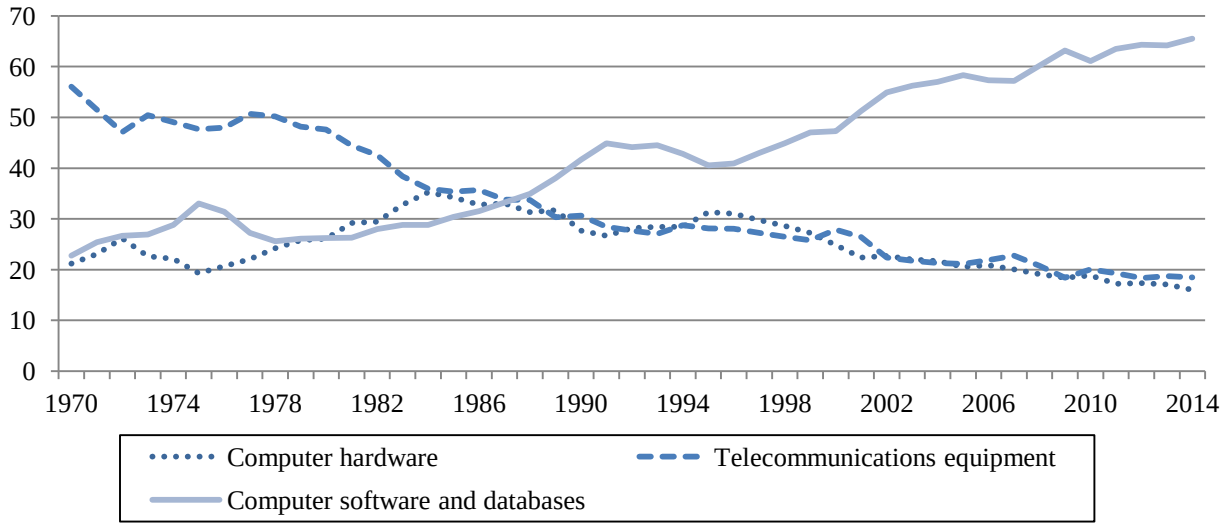


Source: CSLS ICT database.

B. ICT Investment by Component

In the United States, software has represented the largest proportion of nominal ICT investment since 1988, accounting for about 66 per cent or two-thirds in 2014 (Chart 11). Since the mid-1980s, telecommunications equipment and computer hardware have represented similar shares of overall ICT investment. In 2014, telecommunications equipment at 18.5 per cent represented slightly more than computer hardware at 16.0 per cent. This differs from the Canadian situation, where computer hardware investment has consistently represented a larger share of ICT investment than telecommunications equipment since the early-2000s. In the United States in 1970, telecommunications equipment was the most important component of ICT investment, representing about 56 per cent.

Chart 11: Share of Nominal ICT Investment by Component, United States, Total Economy, Per Cent, 1976-2014



Source: CSLS ICT database.

The overall increase in real ICT investment of 3.7 per cent in 2014 in the United States is a product of the increases in real telecommunications equipment and computer software and databases of 2.6 per cent and 5.9 per cent. Computer hardware investment offset these increases by shrinking in real terms by 3.1 per cent in 2014. These changes are themselves products of changes in their respective prices and nominal investment levels. In particular, computer software and databases saw its nominal investment increase by 5.8 per cent in 2014, while its prices fell by 0.1 per cent. In a similar vein, nominal telecommunications equipment investment increased by 2.1 per cent, while its prices fell by 0.5 per cent. In contrast, nominal computer software and databases investment fell 3.1 per cent, while prices for this component were virtually unchanged at 0.0 per cent.

Table 7: Growth in Nominal ICT Investment, Nominal ICT Investment Per Job, ICT Prices, Real ICT Investment, Real ICT Investment Per Job, and Employment by Component of ICT, Total Economy, Compound Average Annual Growth, Per Cent, United States, 2000-2014

	ICT investment	Computer hardware	Telecommunications equipment	Computer software and databases
		Nominal ICT investment		
2000-2008	1.1	-2.2	-2.6	4.2
2008-2014	1.7	-1.2	-0.2	3.2
2000-2014	1.4	-1.8	-1.6	3.7
2013	3.8	2.4	5.9	3.6
2014	3.6	-3.1	2.1	5.8
		Nominal ICT investment per job		
2000-2008	0.6	-2.6	-3.1	3.7
2008-2014	1.6	-1.3	-0.3	3.1
2000-2014	1.0	-2.1	-1.9	3.4
2013	2.3	0.1	4.3	2.1
2014	1.7	-4.9	0.2	3.8
		ICT prices		
2000-2008	-4.0	-11.9	-4.9	-0.4
2008-2014	-1.2	-3.4	-2.3	-0.2
2000-2014	-2.8	-8.4	-3.8	-0.3
2013	-0.1	-0.7	-2.0	0.6
2014	-0.2	0.0	-0.5	-0.1
		Real ICT investment		
2000-2008	5.3	11.1	2.5	4.6
2008-2014	2.9	2.2	2.1	3.4
2000-2014	4.3	7.2	2.3	4.1
2013	3.9	3.1	8.0	3.0
2014	3.7	-3.1	2.6	5.9
		Real ICT investment per job		
2000-2008	4.9	10.6	2.0	4.1
2008-2014	2.8	2.1	2.0	3.3
2000-2014	4.0	6.8	2.0	3.7
2013	2.4	1.6	6.5	1.5
2014	1.8	-4.9	0.7	3.9
		Employment		
2000-2008		0.5		
2008-2014		0.1		
2000-2014		0.3		
2013		1.5		
2014		1.9		

Source: CSLS ICT database.

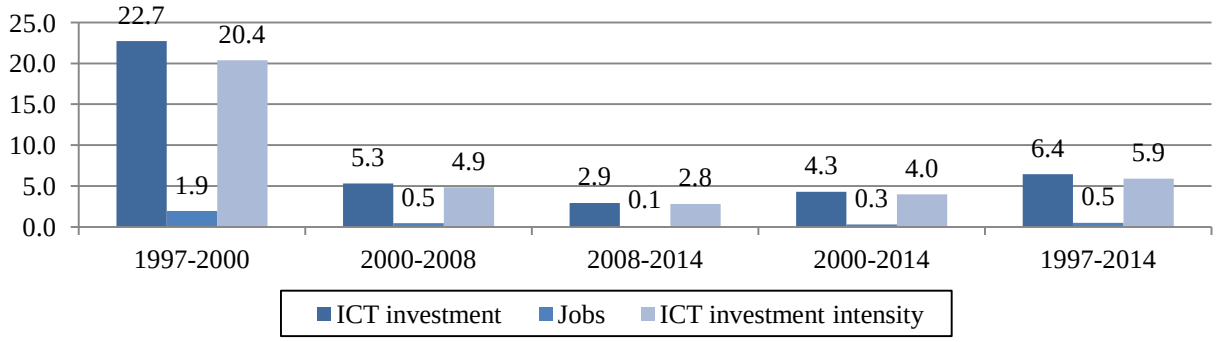
These same decompositions can also be done for other time periods. For example, over the 2000-2008 period, real ICT investment grew by 5.3 per cent per year. This can be broken down into growth of 11.1 per cent per year in computer hardware, 2.5 per cent per year in telecommunications equipment, and growth of 4.6 per cent per year in computer software and databases. These growth rates can in turn be broken down into price changes and changes in nominal ICT investment. In particular, growth of 11.1 per cent per year in computer hardware is a result of decreases in nominal computer hardware investment of 2.2 per cent per year and

decreases in prices of 11.9 per cent per year. Growth of 4.6 per cent per year in computer software and databases reflects increases of 4.2 per cent per year in nominal computer software and databases investment and decreases of 0.4 per cent per year in prices. Telecommunications equipment behaved similarly to computer hardware: decreasing nominal investment (2.6 per cent per year) was offset by decreasing prices (4.9 per cent per year).

C. ICT Investment per Job

Nominal ICT investment rose by 3.6 per cent in 2014 in the United States. The number of jobs rose by 1.9 per cent. Consequently, nominal ICT investment per job rose 1.7 per cent. Since real ICT investment increased by 3.7 per cent in 2014, real ICT investment per job increased by 1.8 per cent from $3,576 (2009 dollars) per job in 2013 to $3,640 (2009 dollars) per job in 2014, higher than the pre-recession value of $3,082 (2009 dollars) per job.

Chart 12: Real ICT Investment, Employment, and Real ICT Investment Per Job, United States, Compound Average Annual Growth, 1976-2014



Source: CSLS ICT database.

Over the 2000-2014 period, the compound average annual growth rate for real ICT investment intensity was 4.0 per cent per year, reflecting the fact that real ICT investment grew at 4.3 per cent per year while the number of jobs grew at 0.3 per cent per year (Chart 12). This growth can be further decomposed into the 2000-2008 sub-period and the 2008-2014 sub-period. In particular, between 2000 and 2008, real ICT investment per job grew at 4.9 per cent per year because of a 5.3 per cent per year increase in real ICT investment growth and a 0.5 per cent per year increase in the number of jobs. This strong real ICT investment intensity fell after 2008. Real ICT investment per job increased at 2.8 per cent per year between 2008 and 2014 due to growth in jobs of 0.1 per cent per year and weaker increases in real ICT investment of 2.9 per cent per year.

The changes in real ICT investment can be further decomposed into the effects from changes in:

1. nominal computer hardware investment;
2. nominal telecommunications equipment investment;
3. nominal computer software and databases investment; and
4. computer hardware prices;
5. telecommunications equipment prices; and

6. computer software and databases prices.

Table 8: Contributions to Real ICT Investment Per Job Growth, United States, Total Economy, 2000-2014

	Per Cent Per Year	Percentage Point Contribution
Real ICT investment per job	4.0	4.0
Real ICT investment	4.3	4.3
Nominal ICT investment	1.4	1.4*
Computer hardware	-1.8	-0.4
Telecommunications equipment	-1.6	-0.3
Computer software and databases	3.7	2.2
ICT prices	-2.8	-2.8*
Computer software and databases	-0.3	-0.2
Telecommunications equipment	-3.8	-0.8
Computer hardware	-8.4	-1.6
Jobs	0.3	0.3

* The sum of the components of ICT will not equal the overall change in nominal ICT investment and ICT prices because this is only an approximate procedure.
Note: To determine the percentage point contributions of the components of ICT investment to nominal ICT investment and ICT prices, we used the average share of each component in total ICT investment between 2000 and 2014. We could also have used the share of each component in total ICT investment from 2000 or 2014 or any year in between. We chose the average, since it accounts for potential changes in the importance of each component over time.
Source: CSLS calculations.

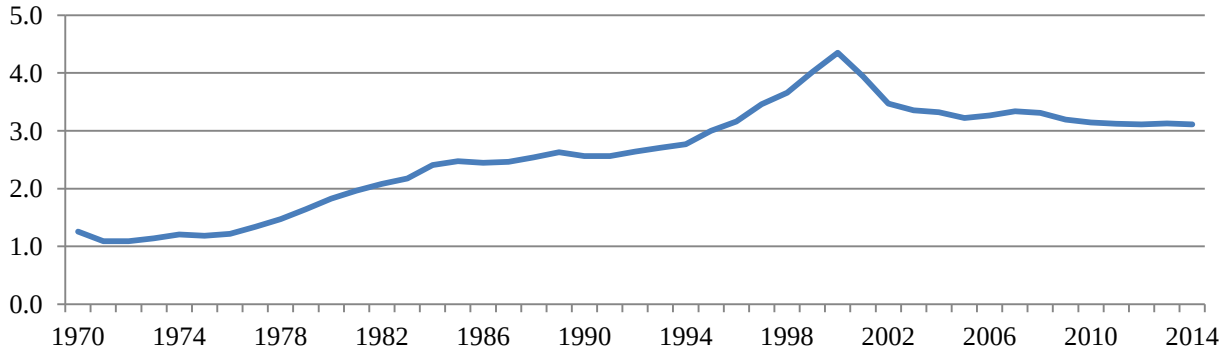
For example, consider the 2000-2014 period, when real ICT investment intensity increased by 4.0 per cent per year. This can be broken down into (1) positive contributions from computer software and databases investment (2.2 percentage points per year), computer software and databases prices (0.2 percentage points per year), telecommunications equipment prices (0.8 percentage points per year), and computer hardware prices (1.6 percentage points per year), and (2) negative contributions from telecommunications equipment investment (0.3 percentage points per year), computer hardware investment (0.4 percentage points per year), and the number of jobs (0.3 percentage points per year). If we sum the positive contributions, and subtract from this sum the negative contributions, we obtain the total change in real ICT investment per job (4.0 per cent per year).[19]

D. ICT Investment as a Share of GDP

Chart 13 shows that nominal ICT investment as a share of GDP increased steadily between 1970 and 2000 from 1.26 per cent to 4.35 per cent. Shortly thereafter, this measure of ICT investment began to track downward, falling to 3.11 per cent by 2014.

[19] Please note that this method is approximate. The contributions will not necessarily completely sum to the total change in real ICT investment per job.

Chart 13: Nominal ICT Investment as a Share of Nominal GDP, Total Economy, United States, 1976-2014



Source: CSLS ICT database.

E. ICT Investment by Industry

ICT investment data were available for all 19 two-digit NAICS industries in 2014 in the United States. The industry with the highest level of ICT investment in 2014was information and communication at $146,914 million, followed by professional, scientific and technical services at $81,611 million and financial and insurance activities at $67,993 million (Table 9). The industries with the lowest levels of nominal ICT investment were (1) water supply, sewage, waste management and remediation services at $472 million and (2) agriculture with $511 million.

In terms of nominal ICT investment per job in 2014, information and communication continues to hold the top spot with $30,697 per job, far surpassing the next highest investment level in financial and insurance activities with $11,029 per job. These two were followed by electricity, gas, steam and air conditioning supply with $10,455 per job. The industries with the lowest levels of nominal ICT investment per job were accommodation and food services at $200 per job and agriculture at $239 per job.

Table 9: Nominal ICT Investment and ICT Investment per Job by Industry, United States, 2000, 2008 and 2014

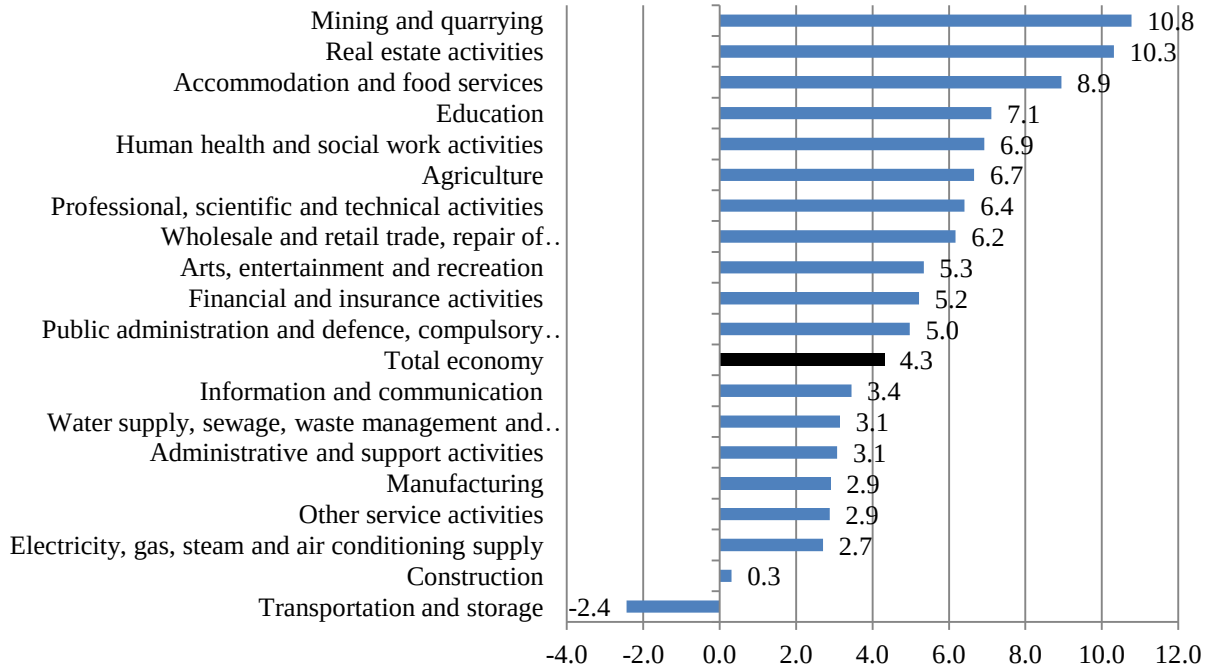
	Nominal ICT Investment (millions)			Nominal ICT Investment Per Job		
	2000	2008	2014	2000	2008	2014
Total economy	447,188	486,740	539,759	3,023	3,174	3,493
Agriculture	389	397	511	167	188	239
Mining and quarrying	2,184	4,006	5,425	4,121	5,473	6,323
Manufacturing	47,914	55,582	52,599	2,721	4,048	4,216
Electricity, gas, steam and air conditioning supply	6,249	6,140	5,750	10,380	10,984	10,455
Water supply, sewage, waste management and remediation activities	395	347	472	1,193	918	1,148
Construction	4,714	3,360	2,814	547	363	359
Wholesale and retail trade, repair of motorvehicles and motorcycles	33,604	44,858	51,348	1,494	1,984	2,311
Transportation and storage	22,448	8,273	8,684	3,880	1,423	1,517
Accommodation and food services	1,428	3,042	2,575	138	257	200
Information and communication	142,547	117,413	146,914	27,535	24,907	30,697
Financial and insurance activities	56,109	63,337	67,993	9,239	9,998	11,029
Real estate activities	2,793	6,027	5,362	1,547	3,056	2,764
Professional, scientific and technical activities	40,884	73,711	81,611	4,905	7,846	8,348
Administrative and support activities	29,850	21,691	29,046	3,212	2,349	2,990
Public administration and defence, compulsory social security	37,228	51,580	52,741	2,924	3,753	3,960
Education	4,223	7,869	7,811	351	580	560
Human health and social work activities	8,204	12,155	12,487	588	723	656
Arts, entertainment and recreation	1,493	1,538	1,641	694	631	637
Other service activities	4,530	5,413	3,946	694	799	583

Source: CSLS ICT database.

Over the 2000-2014 period, there were three industries that displayed strong real ICT investment growth: mining and quarrying at 10.8 per cent per year, real estate activities at 10.3 per cent per year, and accommodation and food services at 8.9 (Chart 14). There was only one industry that saw negative growth during this period: transportation and storage at -2.4 per cent per year.[20]

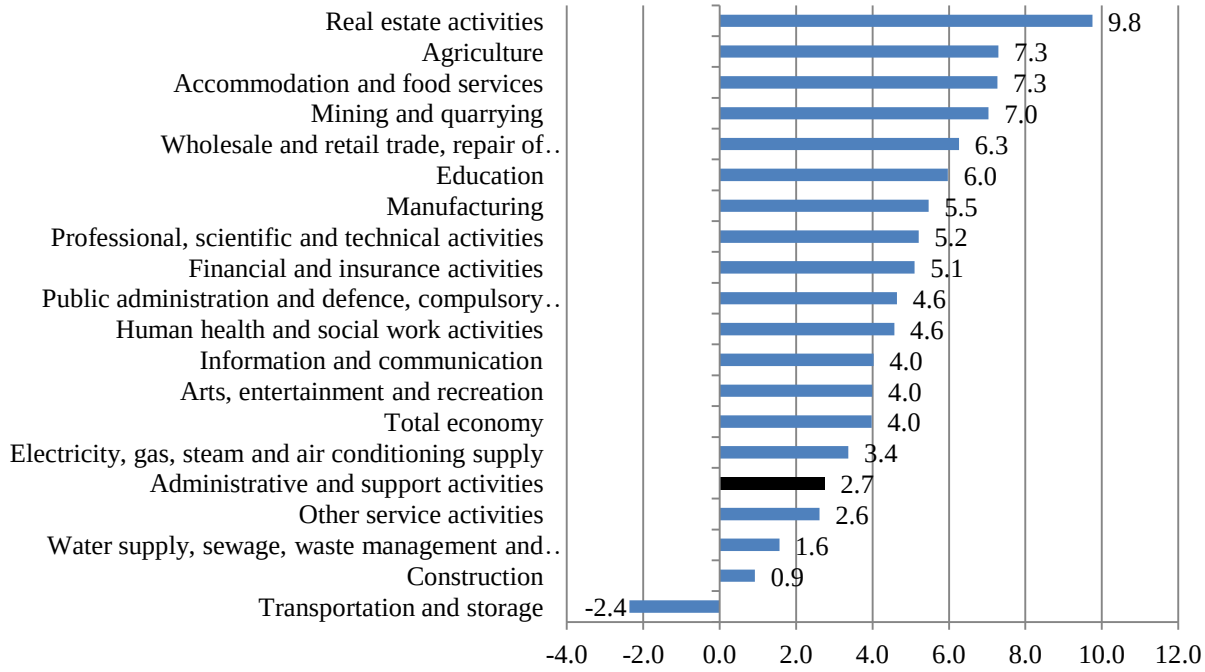
[20] These growth rates can be broken down into changes due to nominal ICT investment growth and ICT prices. A discussion of this decomposition will not be carried out in this report. The CSLS ICT database contains all of these growth rates and analysis can be performed using these data.

Chart 14: Real ICT Investment by Industry, Compound Average Annual Growth, United States, 2000-2014



Source: CSLS ICT database.

Chart 15: Real ICT Investment per Job by Industry, Compound Average Annual Growth, United States, 2000-2014



Source: CSLS ICT database.

Chart 15 shows that accommodation and food services and real estate activities continue to have the highest growth rates when we switch to growth in real ICT investment per job. However, mining and quarrying loses its place in the top three to agriculture. It is not surprising that these are the three industries to see the strongest growth in real ICT investment per job given that they were among the industries with the lowest levels of real ICT investment per job in 2000. Transportation and storage is still the only industry to show negative growth.

V. Total Economy Relative Canada-U.S. ICT Investment

The aim of this section is to provide an overview of recent developments in the total economy ICT investment gap between Canada and the United States. Canada has historically had a large gap in the level of ICT investment per job relative to the United States. In the past, Canada's lower labour productivity level and weaker labour productivity growth has often been linked to this phenomenon. Consequently, it is important to monitor (and explain) developments in this gap as part of an overall analysis of Canada's productivity performance.

This section is broken down into two subsections: (1) Canada-U.S. total economy nominal ICT investment per job and (2) Canada-U.S. nominal ICT investment as a share of nominal gross domestic product (GDP).[21]

A. Relative Canada-U.S. Nominal ICT Investment per Job

Changes in Canada-U.S. nominal ICT investment per job is determined by three factors:

1. relative nominal ICT investment growth;
2. relative job growth in the total economy; and
3. changes in the machinery and equipment (M&E) purchasing power parity (PPP).[22]

ICT investment per job was US$1,965 in Canada in 2014. In the United States, it amounted to US$3,493 (Table 10). This can be broken down into the three components:

- Computer hardware investment per job was $497 in Canada and $559 in the United States.

- Telecommunications equipment investment per job was $338 in Canada and $645 in the United States.

- Computer software and databases investment per job was $1,130 in Canada and $2,289 in the United States.

[21] In this report, relative Canada-U.S. ICT investment is a measure of ICT investment in Canada as a proportion of ICT investment in the United States. The ICT investment gap is the difference, namely: one hundred minus the relative measure.

[22] The annual PPP for M&E (obtained from Statistics Canada, CANSIM 380-0057) is applied to nominal ICT investment in Canada. This adjustment in principle allows for comparisons of ICT investment in Canada and the United States in terms of the same ICT prices in both countries.

Table 10: Nominal ICT Investment Per Job, Canada and the United States, Current US Dollars, 1998-2014

	ICT Investment Per Job		Computer Hardware Investment Per Job		Telecommunications Investment Per Job		Computer Software and Databases Per Job	
	U.S.	Canada	U.S.	Canada	U.S.	Canada	U.S.	Canada
1998	2,336	1,273	669	437	619	342	1,048	494
1999	2,676	1,366	729	461	689	389	1,258	516
2000	3,023	1,523	750	511	843	464	1,430	548
2001	2,834	1,578	634	467	748	502	1,452	610
2002	2,598	1,479	590	442	582	458	1,427	579
2003	2,634	1,512	580	450	573	429	1,482	634
2004	2,751	1,627	597	502	587	432	1,567	694
2005	2,808	1,746	577	519	593	433	1,638	794
2006	2,962	1,921	617	606	648	460	1,697	854
2007	3,135	2,075	629	620	713	453	1,793	1,002
2008	3,174	2,172	606	637	658	498	1,910	1,037
2009	3,134	1,947	577	538	578	462	1,979	946
2010	3,234	1,988	610	550	647	386	1,976	1,052
2011	3,296	2,001	568	533	635	393	2,093	1,074
2012	3,359	2,027	582	532	617	357	2,160	1,138
2013	3,436	1,899	587	475	644	326	2,205	1,099
2014	3,493	1,965	559	497	645	338	2,289	1,130
Compound Average Annual Growth								
1998-2000	13.8	9.4	5.9	8.2	16.7	16.4	16.8	5.4
2000-2008	0.6	4.5	-2.6	2.8	-3.1	0.9	3.7	8.3
2008-2014	1.6	-1.7	-1.3	-4.1	-0.3	-6.2	3.1	1.4
2000-2014	1.0	1.8	-2.1	-0.2	-1.9	-2.2	3.4	5.3
1998-2014	2.5	2.8	-1.1	0.8	0.3	-0.1	5.0	5.3

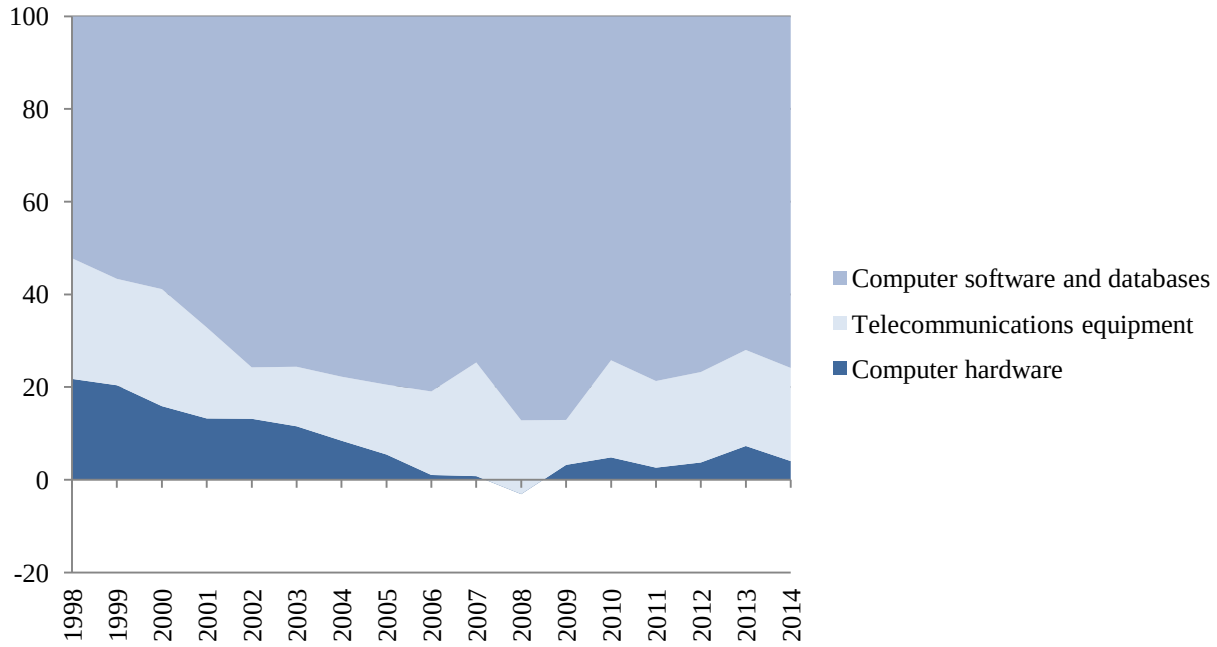
Source: CSLS ICT database.

The largest gaps in ICT investment per job in Canada relative to the United States occur in telecommunications equipment and computer software and databases. In fact, computer hardware investment only contributed 4.1 per cent to the Canada-U.S. gap in ICT investment in 2014. In contrast, telecommunications equipment contributed 20.1 per cent and computer software and databases contributed 75.8 per cent (Chart 16). Since 1998, computer software and databases has always been the largest contributor to the Canada-U.S. ICT investment gap, although its contribution has increased to its current level from only 52.2 in 1998.

Canada-U.S. nominal ICT investment per job increased by 1.0 percentage points in 2014 to 56.3 per cent from 55.3 per cent in 2013 (Chart 17). This represents a decline in the gap from 44.7 percentage points to 43.7 points. If we look at the components of ICT investment, both computer hardware and telecommunications equipment contributed positively to increased relative Canada-U.S. ICT investment, while computer software and databases contributed negatively.

In particular, Canada-U.S. computer hardware increased from 80.8 per cent to 88.9 per cent between 2013 and 2014; Canada-U.S. telecommunications equipment increased from 50.5 per cent to 52.4 per cent; and computer software and databases decreased from 49.8 per cent to 49.4 per cent (Chart 17). This last point is a disappointing development given the importance of software in overall ICT.

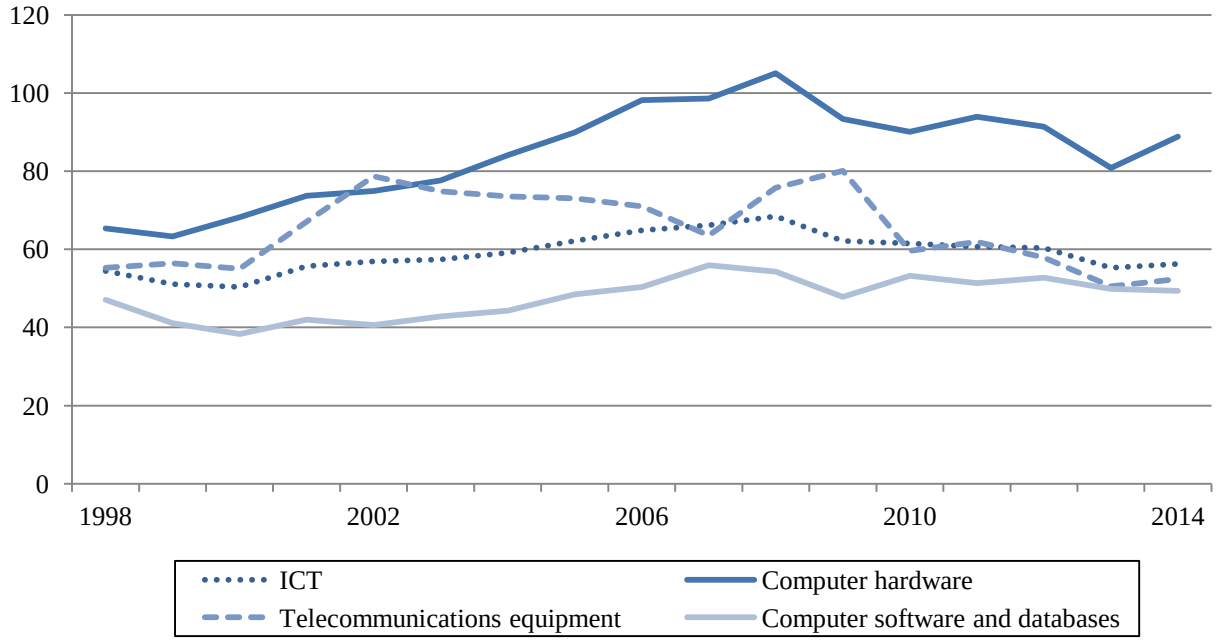
Chart 16: Component Contributions to Nominal Canada-U.S. ICT Investment Gap, Per Cent, 1998-2014



Source: CSLS ICT database.

Returning to the three drivers of developments in Canada-U.S. ICT investment per job, we find that relatively stronger growth in ICT investment in Canada (4.1 per cent) compared to the United States (3.6 per cent) helped reduce the gap measure in 2014, as did relatively weaker employment growth in Canada (0.6 per cent) than in the United States (1.9 per cent). There was no contribution from the M&E PPP since its value did not change between 2013 and 2014.

Chart 17: Nominal ICT Investment Per Job in Canada as a Proportion of the United States, Per Cent, 1998-2014



Source: CSLS ICT database.

Over the 1998-2014 period, there was little change in relative Canada-U.S. ICT investment; it increased by 1.8 percentage points from 54.5 per cent to 56.3 per cent. This can be broken down into changes in the three component parts of ICT investment. In particular, Canada-U.S. computer hardware saw the largest increase (23.5 percentage points) from 65.3 per cent in 1998 to 88.9 per cent in 2014. Offsetting this massive increase were the other two components, which saw almost no changes: telecommunications equipment decreased by 2.9 percentage points from 55.3 per cent to 52.4 per cent, while computer software and databases increased by 2.3 percentage points from 47.1 per cent to 49.4 per cent.

Table 11: Nominal ICT Investment, Employment and M&E PPP, Compound Average Annual Growth, Canada and the United States, Total Economy, Per Cent, 1998-2014

	ICT investment			Employment			M&E PPP
	Canada	United States	Canada-United States	Canada	United States	Canada-United States	
1998-2014	2.6	0.5	2.1	1.5	3.1	-1.6	1.6
1998-2000	10.6	16.0	-5.4	2.5	1.9	0.6	1.4
2000-2008	3.3	1.1	2.2	1.7	0.5	1.2	3.0
2008-2014	-0.7	1.7	-2.4	0.8	0.1	0.7	-0.2
2000-2014	1.5	1.4	0.1	1.3	0.3	1.0	1.6

Source: CSLS ICT database.

On the basis of factor contributions to the gap, we find that ICT investment growth in Canada between 1998 and 2014 (2.6 per cent per year) was weaker than in the United States (3.1 per cent per year), while employment growth was stronger (1.5 per cent per year in Canada versus 0.5 per cent per year in the United States). Offsetting these negative impacts on Canada-U.S. ICT investment per job was strong positive growth in the M&E PPP (1.6 per cent per year).

How do industries contribute to the Canada-U.S. ICT investment gap? Using the methodology from Thomas (2016), we find that information and communication accounted for 49.7 per cent of the gap in 2014, followed by professional, scientific and technical activities and manufacturing, which accounted for 19.2 per cent of the gap and 15.8 per cent of the gap respectively. Given the fact there were data missing for seven industries in Canada in 2014: agriculture, mining and quarrying, electricity, gas, steam and air conditioning supply, water supply, sewage, waste management and remediation activities, financial and insurance activities, real estate activities, and arts, entertainment and recreation, we could only account for 91.7 per cent of the overall gap. Some of these industries for which there are no data will have made positive contributions, while others will have made negative contributions. Unfortunately, without the data we cannot determine the size or the sign of each specific missing industry's contribution.

Table 12: Industry Contribution to Canada-U.S. ICT Investment Gap, Per Cent, 2008 and 2014

	2008	2014
Total economy	100.0	100.0
Agriculture	-0.2	..
Mining and quarrying	1.8	..
Manufacturing	27.7	15.8
Electricity, gas, steam and air conditioning supply	-1.5	..
Water supply, sewage, waste management and remediation activities	..	..
Construction	1.1	0.3
Wholesale and retail trade, repair of motorvehicles and motorcycles	8.9	10.7
Transportation and storage	-4.0	-2.2
Accommodation and food services	0.6	-0.3
Information and communication	41.5	49.7
Financial and insurance activities	..	..
Real estate activities	..	..
Professional, scientific and technical activities	32.3	19.2
Administrative and support activities	9.4	7.5
Public administration and defence, compulsory social security	-6.4	-8.2
Education	-3.2	-1.6
Human health and social work activities	-0.4	0.7
Arts, entertainment and recreation	-1.2	..
Other service activities	0.2	0.0

Note: The methodology assumes that the absolute nominal ICT investment gap in US dollars in each industry is weighted by its employment share and then subsequently divided by the total economy gap. We chose to use the average of the employment shares in Canada and the United States to ensure that we account for differences in the employment structure of the two economies. However, it is also possible to use only Canadian employment shares or only U.S. employment shares.
Source: CSLS ICT calculations based on CSLS ICT database.

If we look at 2008, there are only three missing industries: water supply, sewage, waste management and remediation activities, financial and insurance activities, and real estate activities, so it is possible to develop a broader understanding of the contribution of those missing industries relative to the three big contributors. The most important finding is that information and communication, professional, scientific and technical services, and manufacturing, continue to make massive contributions relative to the rest of the industries.

Since 2008, relative Canada-U.S. ICT investment per job has fallen from 68.4 per cent, the highest value it had ever achieved, to 56.3 per cent. This was the result of stronger ICT investment in the United States than in Canada, stronger employment growth in Canada than in the United States, and a declining M&E PPP. The three factors that contribute to determining the growth of Canada-U.S. ICT investment per job were all driving it downward during this period.

Compared to the most recent previous CSLS research report on ICT investment trends (Thomas, 2015), when nominal relative Canada-U.S. ICT investment per worker was estimated at 59.6 per cent, the estimate of 68.4 per cent in 2008 is significantly higher. This is likely the result of a shift from the business sector to the total economy. In previous CSLS research reports, we compared the business sector in Canada to the business sector in the United States. This meant that we excluded health care and social assistance, educational services, and public

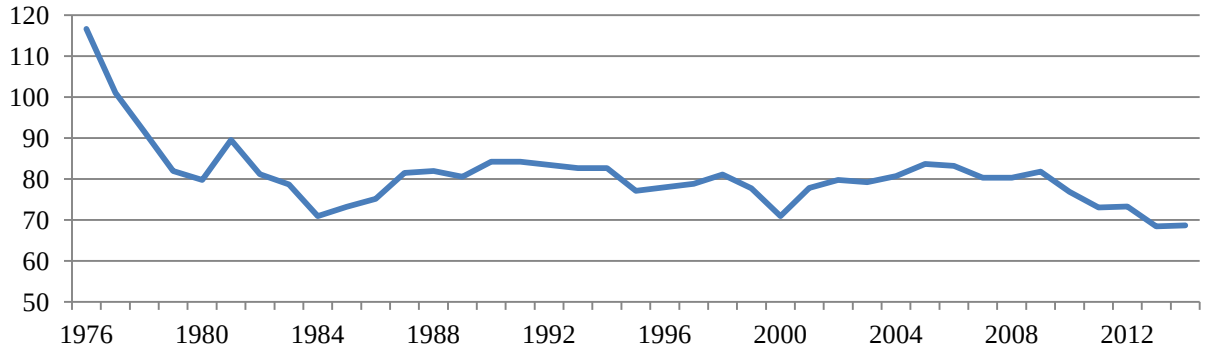
administration. If we look at the value of nominal Canada-U.S. ICT investment per job in these industries in 2008 in the current database, we find that public administration and defense investment in ICT per job in Canada was 122.7 per cent of that of the United States, education was 170.5 per cent, and human health and social work activities was 105.9 per cent. Since each of these industries invested more in Canada than in the United States in 2008 according to our new databases, it is not a surprise that excluding these industries pulled down the Canada-U.S. ICT investment per worker relative.[23]

B. Relative Canada-U.S. ICT Investment as a Share of GDP

Canada-U.S. ICT investment as a share of GDP was 0.2 percentage points higher in 2014 at 68.7 per cent than in 2013 at 68.4 per cent (Chart 18). Despite improvement in 2014, this measure of relative Canada-U.S. ICT investment has been on a downward trend since the 2008 recession when its value was 80.3 per cent. Before 2008, this measure of relative Canada-U.S. ICT investment appeared to be show signs of cyclicality, plummeting after the 1981 recession, and falling significantly in 2000 during the dot-com boom. This suggests that ICT investment in Canada responded more sharply to economic downturns than that of the United States. The one exception appears to be the recession of 1989.

It is unclear whether the high level of Canada-U.S. ICT investment in the late-1970s actually reflects stronger ICT investment in Canada than in the United States or whether it indicates potential measurement errors in the earlier part of the time series. The latter explanation may be more likely given how quickly this measure fell from 116.6 per cent in 1976 to 82.0 per cent in 1979.

Chart 18: Nominal ICT Investment as a Share of Nominal GDP, Canada as a Proportion of the United States, 1976-2014



Source: CSLS ICT database.

[23] Another factor that may have affected these results is the switch to jobs from workers. If workers in the United States are more likely to work multiple jobs than workers in Canada, we would see a decrease in the measure of relative Canada-U.S. employment growth, and hence, an increase in the relative Canada-U.S. ICT investment measure. Even if Canadians are less likely to work multiple jobs than Americans, it is extremely unlikely however that this factor accounts for a large portion of the change in this measure of relative Canada-U.S. ICT investment given that multiple job holders represent only a very small portion of total economy employment.

Changes in this measure of Canada-U.S. ICT investment are a result of two factors: nominal ICT investment growth and nominal GDP growth.

Table 13 shows that over the 1976-2014 period, nominal ICT investment growth in Canada at 7.3 per cent per year was lower than ICT investment growth in the United States at 8.7 per cent per year. This negative contribution to the relative measure of ICT investment as a share of GDP was only slightly offset by Canada's stronger growth in GDP relative to the United States (6.2 per cent per year versus 6.0 per cent per year). Thus, it comes as no surprise that relative Canada-U.S. ICT investment as a share of GDP fell over the 1976-2014 period.

Table 13: Nominal ICT Investment and Nominal GDP, Canada and the United States, Compound Average Annual Growth, 1976-2014

	Nominal ICT investment			GDP		
	Canada	United States	Canada-United States	Canada	United States	Canada-United States
1976-2014	7.3	8.7	-1.4	6.2	6.0	0.1
1976-1981	17.4	22.5	-5.1	12.5	11.3	1.2
1981-1989	10.3	11.3	-1.0	7.8	7.3	0.5
1989-2000	8.3	10.5	-2.2	4.6	5.6	-0.9
2000-2008	3.3	1.1	2.2	5.2	4.6	0.6
2008-2014	-0.7	1.7	-2.4	3.0	2.8	0.2
1976-2000	10.8	13.2	-2.4	7.3	7.3	-0.1
2000-2014	1.5	1.4	0.2	4.2	3.8	0.4

Source: CSLS ICT database.

We can perform a similar analysis for the three other relevant periods: 1976-2000, 2000-2008 and 2008-2014. Over the 1976-2000 period, relative Canada-U.S. ICT investment as a share of GDP fell. This was the result of weaker growth in nominal ICT investment in Canada and weaker growth in GDP in Canada than in the United States. Between 2000 and 2008, there was an increase in nominal Canada-U.S. ICT investment as a share of GDP. This was the product of faster growth in both nominal ICT investment and GDP in Canada than in the United States. For the 2008-2014 period, we see Canada-U.S. ICT investment as a share of GDP decline because of slower ICT investment growth in Canada relative to the United States that was only slightly offset by stronger GDP growth in Canada.

This report has focused on ICT investment trends in Canada and the United States, highlighting the greater spending south of the border. It is also useful to put Canada's performance in a wider context by comparing it to that of other OECD countries. Appendix Table 3 provides estimates of ICT investment, in both domestic currency and as a share of nominal GDP, for selected OECD countries for which data were available in 2013. At 2.16 per cent of GDP ICT investment in Canada ranked 9th out of the 14 countries. Perhaps surprisingly, at 3.12 per cent of GDP, the United States ranked fourth, with the Czech Republic, Netherlands and Austria higher.

VI. The Future of Tracking ICT Spending

The ICT landscape has changed enormously since the 1970s, when the types of data presented in this paper became available. In fact, "recent ICT developments are a new era in which mobile and cloud platforms, enabled by high-speed broadband, are transforming the means organizations use to interact with both customers and employees" (Byrne and Corrado, 2016:2).

> *"Some prominent technologies in this transformation enable server and storage consolidation (virtualization) and more efficient development and deployment of apps (containers). The standard narrative used to analyze the diffusion of ICT technology in economies does not capture the uptake of these technologies, and the activities touched most directly by them are not very evident in official statistics" (Byrne and Corrado, 2016:2).*

This suggests that unless major changes are made to the measurement of ICT to capture ICT services, such as cloud computing, the continued analysis of ICT investment and its contribution to labour productivity may be futile.

Byrne and Corrado (2016) attempt to remedy this situation by introducing new ICT asset prices and incorporating ICT services in the modeling and quantitative analysis of the contribution of ICT to labour productivity. Their findings suggest that "ongoing ICT technological change potentially contributes as much as 1.4 percentage points per year to labour productivity growth in the United States and that trends in official ICT prices suffer from substantial mismeasurement, especially recently, and especially in software, which accounts for more than half of ICT investment" (Byrne and Corrado, 2016:3).

Other challenges arise in the measurement of ICT as well. For example, the OECD (2014:128) states that "a growing share of ICT expenditure by businesses might be non-capitalized." Even more importantly, "as ICT products, in particular software, are often included as intermediates to non-ICT capital goods, estimates of investment in ICT may understate the underlying importance of ICTs to overall investment" (OECD, 2014:128). In fact, the OECD goes on to say that particular care is needed when "comparing investment in software across countries and years, as levels may be affected by the degree to which software is bundled with other products, including other ICT equipment, and so,…not recorded as software investment" (OECD, 2014:128).

The above suggests that tracking ICT investment, as it stands, may not accurately represent the state of ICT use in any given economy. We must move beyond simple analysis of ICT investment if we want to capture more fully the impact the digitalization is having on the economy.

Ahmad and Schreyer (2016:4), however, take a more positive approach, as they believe that "on balance, the accounting framework…looks to be up to the challenges posed by digitalization." They admit that there are "many practical measurement issues that remain," especially "concerning prices changes" and "in the context of cross-border flows, such as intra-

firm flows of intellectual property," but conceptually, the national accounts "[do] not look to be deficient" (Ahmad and Schreyer, 2016:4, 25).

VII. Conclusion

Canadian productivity growth is in part a product of our innovative activity, namely how well we invest in ICT. This report examines ICT investment in Canada comparing it to ICT investment in the United States. The main finding is that, since the recession, Canada has yet to regain its peak level of ICT investment, while the United States has far surpassed that threshold. In fact, since 2008, ICT investment in Canada has fallen at a rate of 1.0 per cent per year, while it has increased at a rate of 2.9 per cent per year in the United States.

We also find that employment growth in Canada has far outpaced employment growth in the United States. Although a positive development on its own, without accompanying growth in ICT investment, this has only contributed to the decline in Canada-U.S. ICT investment per job from 68.4 per cent in 2008 to 56.3 per cent in 2014. In addition, the M&E PPP was declining during this time period, adding to the downward drag on relative ICT investment.

The important characteristic of the gap in Canada-U.S. ICT investment per job is the exceptionally large contribution from computer software and databases. In 2014, computer software and databases accounted for 75.8 per cent of the overall gap in ICT investment per job in Canada relative to the United States.

This discussion emphasizes that when comparing Canada and the United States performance in the digital economy, the key is computer software and databases. In light of this, future research on ICT investment should focus closely on computer software and databases. Are we mismeasuring computer software and databases? Are we capturing ICT services, such as cloud computing, properly and accurately? Are we appropriately measuring ICT prices, especially for new products and services? What are the challenges of the digital economy for the national accounts? Is there a way to measure ICT, especially computer software and databases, more appropriately with digitalization?

Many researchers have already begun to address these questions and concerns, including Ahmad and Schreyer (2016), OECD (2014), and Byrne and Corrado (2016), Conference Board (2016), among others. But further research is needed.

VII. References

Ahmad, Nadim and Paul Schreyer (2016) "Are GDP and Productivity Up to the Challenges of the Digital Economy?" *International Productivity Monitor*, 30, Sping, pp. 4-27.

Bryne, David and Carol Corrado (2016) "ICT Prices and ICT Services: What Do They Tell Us about Productivity and Technology?" Economics Program Working Paper Series (EPWP) No. 16-05, The Conference Board, May.

Capeluck, Evan (2012) *Overview of Developments in ICT Investment in Canada, 2011*, CSLS Research Note 2012-02, http://www.csls.ca/notes/Note2012-2.pdf.

Capeluck, Evan (2013a) *Canada-U.S. ICT Investment in 2011: The Gap Narrows*, CSLS Research Note 2013-01, http://www.csls.ca/notes/Note2013-1.pdf.

Capeluck, Evan (2013b) *Overview of Developments in ICT Investment in Canada, 2012*, CSLS Research Note 2013-02, http://www.csls.ca/notes/Note2013-2.pdf.

Centre for the Study of Living Standards (2008) *The Canada-U.S. ICT Investment Gap in 2007: Narrowing but Progress Still Needed*, CSLS Research Note 2008-01, http://www.csls.ca/notes/Notes2008-1.pdf.

Centre for the Study of Living Standards (2016) "Table 7: Relative Productivity Levels in the Total Economy, Canada and the United States, 1961-2015," *Aggregate Income and Productivity Trends: Canada vs. United States.*

Conference Board (2016) "Navigating the New Digital Economy: Driving Digital Growth and Productivity from Installation to Deployment," (New York).

OECD (2014) *Measuring the Digital Economy: A New Perspective*. OECD Publishing, Paris.

Sharpe, Andrew (2005) *What Explains the Canada-US ICT Investment Gap?* CSLS Research Report 2005-06, http://www.csls.ca/reports/csls2005-06.pdf.

Sharpe, Andrew. (2006). *The Relationship between ICT Investment and Productivity in the Canadian Economy: A Review of the Evidence.* CSLS Research Report 2006-05. Retrieved from: http://www.csls.ca/reports/csls2006-05.pdf.

Sharpe, Andrew (2010) *The Canada-U.S. ICT Investment Gap in 2008: Gains in Communications Equipment and Losses in Computers*, CSLS Research Note 2010-01, http://www.csls.ca/notes/Note2010-01.pdf.

Sharpe, Andrew (2014) *What Explains the Canada-U.S. Software Investment Intensity Gap?* CSLS Research Report 2014-04, http://www.csls.ca/reports/csls2014-04.pdf.

Sharpe, Andrew and Andrews, Brendon (2012) *The Canada-U.S. ICT Investment Gap in 2010: The Widening Continues,* CSLS Research Note 2012-01, http://www.csls.ca/notes/Note2012-1.pdf.

Sharpe, Andrew and Jean-Francois Arsenault (2008a) *ICT Investment and Productivity: A Provincial Perspective,* CSLS Research Report 2008-06, http://www.csls.ca/reports/csls2008-6.pdf.

Sharpe, Andrew and Jean-Francois Arsenault (2008b) *The Canada-U.S. ICT Investment Gap: An Update,* CSLS Research Report 2008-01, http://www.csls.ca/reports/csls2008-1.pdf.

Sharpe, Andrew and Ricardo De Avillez (2010) *Canada-U.S. ICT Investment in 2009: The ICT Investment per Worker Gap Widens,* CSLS Research Report 2010-08, http://www.csls.ca/reports/csls2010-08.pdf.

Sharpe, Andrew and Dylan Moeller (2011) *Overview of Developments in ICT Investment in Canada, 2010: Rebounding from the Recession,* CSLS Research Note 2011-02, http://www.csls.ca/notes/Note2011-2.pdf.

Sharpe, Andrew and Vikram Rai (2013) *Can the Canada-U.S. Investment Gap be a Measurement Issue?* CSLS Research Report 2013-03, http://www.csls.ca/reports/csls2013-03.pdf.

Thomas, Jasmin (2015) *An Analysis of the Canada-U.S. ICT Investment Gap: An Update to 2013*, CSLS Research Report 2015-01, http://www.csls.ca/reports/csls2015-01.pdf.

Thomas, Jasmin (2016) *Explaining Industry Differences in IT Investment Per Worker Between Canada and the United States, 2002-2013*, CSLS Research Report 2016-01, http://www.csls.ca/reports/csls2016-01.pdf.

United Nations (2008) *System of National Accounts 2008 – SNA 2008*, available at http://unstats.un.org/unsd/nationalaccount/sna2008.asp.

VIII. Appendix Tables

Appendix Table 1: Detailed List of Assets in Computer and Telecommunications Equipment Investment, United States

NIPA category code or I-O item code	NIPA Investment Category and I-O Commodity & Item Descriptions
B935RC	Computers and peripheral equipment
334111	**Electronic computer manufacturing**
	Large and Medium Scale Host Computers (mainframes, super miniclass, UNIX servers, server appliances and other)
	PC Servers (excluding UNIX servers)
	Personal Computers
	Workstations, Microprocessor-based, Single-user systems
	Laptops (AC/DC)
	Tablets, Notebooks and Subnotebooks (battery operated)
	Personal Digital Assistants (PDAs)
	Single-use Computers, Portable Types (palmtops, etc.)
	Single-use Computers, Other Types
	Other Computers, including Array and Other Analog, Hybrid, and Special Purpose
	Electronic Computers nsk, total
334112	**Computer storage device manufacturing**
	Magnetic Disk Drives (rigid and flexible) and Other Direct Access Storage Equipment
	Optical Disk Drives including CD-ROM, DVD, MO, and Other Optical
	Multiuser System Storage Devices inc. Disk & Optical Subsystems, Disk Arrays, and Auxiliary Storage (exc. disk and tape)
	Serial Access Storage Equipment (e.g. tape drives)
	Parts, Attachments, and Accessories for Computer Storage Devices
	Computer Storage Device, nsk, total
33411A	**Computer terminals and other computer peripheral equipment manufacturing**
	Display Terminals
	Teleprinters
	Computer terminals, nsk, total
	Keyboards, Memory Cards, Readers, Keying Equipment, Mice, Digitizers, Light Pen Tablets, Input/Output Dev., Perip. Share
	Optical Scanning Devices (bar code, flat bed, etc), Plotters, COM Equipment, Media Copying and/or Conversion Equipment
	Impact Computer Printers, including Line and Serial Type
	Printers, Non-impact (including laser, inkjet, thermal, ion deposition, etc.)
	Computer Monitors
	Accessories for Computer Peripherals (device supports, ergonomic aids, etc.)
	Other computer peripheral equipment, nsk, total
541512	**Computer system design services**
	Computer Systems Integrators
	Computer Systems Consultants
S00402	**Used and secondhand goods**
	Used computing equipment
C275RC	Communications equipment
33411A	**Computer terminals and other computer peripheral equipment manufacturing**
	Teleprinters
334210	**Telephone apparatus manufacturing**
	Telephone Switching Equipment
	Carrier Line Equipment & Nonconsumer Modems
	Telephone Sets
	Data Communications Equipment (including routers, gateways, bridges, terminal servers, and concentrators)
	Voice Messaging, Voice Frequency, and Call Processing Equipment
	Facsimile Communication Equipment
	Other Telephone and Telegraph Equipment

NIPA category code or I-O item code	NIPA Investment Category and I-O Commodity & Item Descriptions
	Telephone Apparatus, nsk
334220	**Broadcast and wireless communications equipment**
	Fixed Radio Station Communications Systems and Equipment
	Cellular System Equipment
	Amateur Radio Station Communications Systems and Equipment
	Radionavigational and Locational Radio Station Communications Systems and quipment
	Aeronautical Radio Station Communications Systems and Equipment
	All Other Radio Station Communications Systems and Equipment
	Fiber Optics Equipment
	All Other Communication Systems and Equipment
	Broadcast, Studio, & Related Electronic Equipment
	Radio and TV Broadcasting and Wireless Communications Equipment, nsk
334290	**Other communications equipment manufacturing**
	Electric Railway Signals and Attachments
	Intercommunications Systems, including Inductive Paging Systems (selective paging), except Telephone and Telegraph
	Other Communications Equipment, nsk
334300	**Audio and video equipment manufacturing**
	Television Receivers, including Combination Models
	Speakers and Speaker Systems
334511	**Search, detection, and navigation instruments manufacturing**
	Search, Detection, Navigation, and Guidance Systems
	Search, Detection, Navigation, and Guidance Systems, nsk
335920	**Communication and energy wire and cable manufacturing**
	Telephone and telegraph wire and cable, made of nonferrous metals (purchased wire)
336414	**Guided missile and space vehicle manufacturing**
	All other services on complete space vehicles for other customers
517000	**Telecommunications**
	Force account, telephone equipment installation
541300	**Architectural, engineering, and related services**
	Engineering Services
S00402	**Used and secondhand goods**
	Used communication equipment

Source: U.S Bureau of Economic Analysis

Appendix Table 2: Detailed List of Assets in Computer and Telecommunications Equipment Investment, Canada

NAPCS 2012	NAPCS Title
	Computers, computer peripherals and parts
3611111	Desktop and similar computers
3611112	Laptop and portable computers
3611113	Servers and other host computers
3611121	Point-of-sale terminals and funds-transfer devices
3611122	Data storage devices (including flash media)
3611123	Computer monitors and computer printers
3611124	Computer peripherals, not elsewhere classified
3713111	Parts of computers and computer peripherals (except printed circuit assemblies)
	Telephone apparatus
3621111	Telephones (except mobile phones), answering and fax machines
3621112	Telephone switching, switchboard and line equipment
3621121	Local area routers and data communications equipment (including wireless)
3621122	Data communications equipment (except local area)
3714111	Parts of wired telephone and wired data communications equipment (except printed circuit assemblies)
	Other communications equipment
3621131	Mobile telephones and mobile network devices
3621132	Space satellites
3621211	Broadcast and studio communications equipment
3621212	Satellite dishes and cable decoders
3621221	Alarm and security systems
3621222	Traffic control equipment
3621223	Intercom systems and remote control units
3714112	Parts of wireless telephone and wireless data communications equipment (except printed circuit assemblies)
3714121	Parts of broadcast, studio, alarm and signalling equipment (except printed circuit assemblies)
	Printed and integrated circuits, semiconductors and printed circuit assemblies
3711111	Bare printed circuit boards
3711121	Integrated circuits
3711131	Transistors, diodes, rectifiers and other basic semiconductor devices
3711132	Crystals, filters, piezo-electric, and related electronic devices
3711141	Printed circuit boards for automotive use
3711142	Motherboards and add-on cards for computers, and printed circuit assemblies for computer peripherals
3711143	Printed circuit boards (except for computers or automotive uses)
	Other electronic components
3711211	Electronic and fibre-optic connectors
3711221	Electronic capacitors, resistors, inducers and transducers
3711222	Electron tubes and parts
3711223	Mechanical switches for electronic circuitry
3711224	Electronic components, not elsewhere classified
	Audio and video equipment and unrecorded media
3622111	Audio speakers
3622112	Commercial sound equipment
3622121	Automotive audio equipment
3622122	Audio equipment, not elsewhere classified
3622123	Personal audiovisual equipment
3622124	Television receivers
3622125	Consumer video equipment, not elsewhere classified
3622126	Parts and accessories for audio and video equipment (except printed circuit assemblies)
4813311	Unrecorded optical and magnetic media, and media not elsewhere classified
	Navigational and guidance instruments
3621311	Aeronautical, nautical and navigational instruments
3621321	Search, detection, and guidance systems
3714131	Parts of aeronautical, nautical and navigational instruments and search, detection, and guidance systems (except printed circuit assemblies)
	Medical devices
3631311	Electronic hearing aids
3631312	Irradiation equipment

NAPCS 2012	NAPCS Title
3631313	Electromedical equipment
3714133	Parts of irradiation, electromedical, surgical and medical equipment (except printed circuit assemblies)
	Measuring, control and scientific instruments
3631211	Watches and parts of watches
3631212	Clocks and parts of clocks
3631221	Environmental and appliance control instruments
3631231	Electrical motor and circuit testing equipment
3631232	Instruments for measuring electrical current (except test equipment)
3631241	Integrating and totalizing meters for gas and liquids
3631242	Counting devices (except motor vehicle instruments)
3631243	Aircraft engine instruments (except navigational and guidance)
3631251	Process control instruments
3631261	Physical properties testing and inspection equipment and kinematic testing and measuring equipment
3631262	Laboratory type analytical and scientific instruments, not elsewhere classified
3631263	Geophysical, meteorological, survey, drafting and general-purpose instruments and equipment
3714132	Parts of measuring instruments, testing equipment and control systems (except printed circuit assemblies and motor vehicle instruments)

Source: Statistics Canada

Appendix Table 3: Comparison of ICT Investment as Share of GDP for Selected OECD Countries, 2013

Appendix Table 3: Comparison of ICT Investment as Share of GDP for Selected OECD Countries, 2013

Country	National Currency	Computer Hardware (1)	Tele-communications equipment (2)	ICT Equipment SNA08 (3, = 1 + 2)	Computer Software and Databases (4)	ICT Investment (5, = 4 + 3)	Nominal GDP (6)	ICT Investment Per Cent Share of GDP (7, = 5/6)
Czech Republic	Koruna	56,971.0	17,015.0	73,986.0	75,602.0	149,588.0	4,098,128.0	**3.65**
Netherlands	Euro	4,223.0	995.0	5,218.0	15,413.0	20,631.0	652,748.0	**3.16**
Austria	Euro	1,319.5	2,399.4	3,718.9	6,403.0	10,121.9	322,539.2	**3.14**
United States	US Dollar	89,086.0	97,679.0	186,765.0	334,445.0	521,210.0	16,691,517.0	**3.12**
France	Euro	3,982.0	4,349.0	8,331.0	54,893.0	63,224.0	2,115,256.0	**2.99**
Belgium	Euro	3,403.1	1,933.3	5,336.4	5,812.3	11,148.7	391,711.9	**2.85**
Denmark	Danish Krone	17,666.0	2,705.0	20,371.0	30,993.0	51,364.0	1,903,520.0	**2.70**
United Kingdom	Pound	7,030.0	1,095.0	8,125.0	29,423.0	37,548.0	1,739,563.0	**2.16**
Canada	Canadian Dollar	10,128.0	6,943.0	17,071.0	23,439.0	40,510.0	1,892,193.0	**2.14**
Australia	Australian Dollar	7,958.0	8,288.0	16,246.0	16,118.0	32,364.0	1,584,578.0	**2.04**
Italy	Euro	4,931.1	6,293.3	11,224.4	20,025.2	31,249.7	1,604,599.1	**1.95**
Finland	Euro	523.0	438.0	961.0	2,660.0	3,621.0	203,338.0	**1.78**
Norway	Norweigan Krone	25,489.0	4,650.0	30,139.0	21,859.0	51,998.0	3,071,134.0	**1.69**
Ireland	Euro	877.6	419.0	1,296.6	1,420.2	2,716.8	180,209.3	**1.51**

All prices are current prices in domestic currency. Source: OECD.Stat/National Accounts/Annual National Accounts/Detailed Tables and Simplified Accounts/8A. Capital Formation by Activity, ISIC, Rev4. https://stats.oecd.org/Index.aspx