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The Canadian Productivity Review

Intangible Capital and Productivity Growth in Canada

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Symbols

The following standard symbols are used in Statistics Canada publications:

.	not available for any reference period
..	not available for a specific reference period
…	not applicable
0	true zero or a value rounded to *0* (zero)
0^s	value rounded to *0* (zero) where there is a meaningful distinction between true zero and the value that was rounded
^{p}	preliminary
^{r}	revised
x	suppressed to meet the confidentiality requirements of the *Statistics Act*
^{E}	use with caution
F	too unreliable to be published
*	significantly different from reference category ($p<0.05$)

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Abstract

This paper develops a measure of intangible capital and examines the contribution of intangibles to labour productivity growth in the Canadian business sector. It applies the methodology developed by Corrado *et al.* (2005, 2009) for the United States. The paper finds that investment in intangibles totalled an estimated $151 billion in the Canadian business sector in 2008, which represents 13.2% of gross domestic product in that year. Investment in intangibles has increased much faster than investment in tangibles over time, and the ratio of intangible investment to tangible investment increased from 0.23 in 1976 to 0.66 in 2008. The paper shows that intangibles made a significant contribution to labour productivity growth and that the contribution of intangibles to labour productivity growth was only slightly lower than the contribution of tangibles in the Canadian business sector. The contribution of intangibles to labour productivity growth was lower in Canada than in the United States for the post-1995 period, as a result of Canada's lower investment in intangibles (software as well as research and development) in recent years.

Key words: productivity, intangible capital.

More studies related **National Economic Accounts and Macro-Economy** and to **Productivity** are available in **Update on Economical analysis** (www.statcan.gc.ca/economicanalysis).

Executive summary

Intangible capital consists of investments that do not take on the solid, physical characteristics of machinery and equipment or buildings. Nevertheless, such investments have some of the properties of other types of investments in that they yield long-lasting benefits as a result of expenditures that are made today. In the National Accounts, these expenditures need to be capitalized rather than expensed as intermediate materials for purposes of estimating gross domestic product (GDP).

Recent papers have considered issues surrounding the measurement of intangibles. Baldwin *et al.* (2005) discussed issues surrounding research and development (R&D). They noted that R&D is only one of the components of innovation expenditures. Baldwin *et al.* (2009) extended the measurement of intangible investments beyond that of just R&D. At the heart of intangible investments, of course, are software and R&D. However, intangible investments also consist of purchased science services, own-account scientific services, exploration expenses in the resource sector, and advertising expenditures, because these create an intangible asset and yield long-term benefits.

This paper extends the authors' previous work in three ways. First, it expands it into several new areas—what are referred to as *economic competencies*. These involve primarily investments in human capital—via management and training investments as well as management consulting services. This not only provides broader coverage; it also allows cross-country comparisons of Canada to the United States.

Second, this paper moves from just measuring investment to also developing capital stock estimates. This requires assumptions about depreciation rates. In both instances, the paper adopts assumptions similar to those used elsewhere in developing estimates for the United States, in order to ensure comparability.

Third, the paper incorporates the estimates of intangible capital into the growth-accounting framework so as to understand how it is related to productivity growth. A comparison of Canada and the United States in this regard is also provided.

The paper focuses on four questions:

How important is investment in intangibles?

As was reported in Baldwin *et al.* 2009, business investment in intangibles is large. In 2008, it stood at about 66% of tangible investment in the business sector. Total investment in intangibles has grown more rapidly than total investment in tangibles over time. The ratio of intangible investment to tangible investment increased from 0.23 in 1976 to 0.66 in 2008.

The largest component of intangible investment was economic competencies. Total investment in economic competencies in 2008 accounted for 60% of overall intangible investment. The second-largest component was innovative property, which accounted for about 30% of overall intangible investment in 2008. Business investment in R&D accounted for about one-third of total investment in innovative property. Software investment was the third-largest component. Investment in computerized information was the smallest component.

Of the intangible assets, software investment increased the fastest, followed by purchased organizational capital. Over the 1976-to-2008 period, real software investment increased by 11.9% per year, and investment in organizational capital increased by 10.2% per year.

Does the capitalization of intangibles increase the rate of GDP and productivity growth?

When expenditures on intangibles in the National Accounts, which are currently treated as intermediate expenditures, are instead treated as investments, estimates of GDP can change. This paper addresses how these changes affect the growth of GDP and, more importantly, how they affect our understanding of the growth process.

The results suggest that GDP and labour productivity growth would be 0.2-percentage-points higher over the 1976-to-2000 period if intangibles that are not presently included in the National Accounts as investment were counted as investment (that is, those intangibles other than software and mineral exploration that are presently capitalized).

The capitalization of intangibles also increases the contribution of capital deepening to labour productivity growth. For the 1976-to-2000 period, the effect of capital deepening on labour productivity growth increases from 1.1 percentage points to 1.3 percentage points per year. Intangible capital is found to account for about 40% of the total capital deepening effects during that period. Of the three main categories of intangible capital, innovative property and economic competencies each contributed between 0.2 percentage points and 0.3 percentage points to annual labour productivity growth in the Canadian business sector. Investment in computerized information contributed 0.1 percentage points to annual labour productivity growth.

However, the inclusion of intangible capital and the recalculation of GDP do not increase multifactor productivity growth. Rather, for the 2000-to-2008 period, multifactor productivity is estimated to decline by 0.8% per year, compared to the 0.6% rate of decline per year previously estimated.

What is the impact of including intangibles on comparisons of productivity growth between Canada and the United States?

The relative importance of sources of aggregate labour productivity growth in Canada and the United States remains unchanged after intangibles are included in the growth-accounting framework in both countries. The most important source of labour productivity growth is capital deepening for both Canada and the United States. For the 1995-to-2003 period, capital deepening from intangibles and tangibles contributed 1.4 percentage points, or about 70%, of labour productivity growth in Canada, compared to 1.7 percentage points, or about 60% in the United States.

Multifactor productivity growth contributed positively to labour productivity growth in both countries after 1995. However, it was a much more important source of labour productivity growth in the United States than in Canada. For the 1995-to-2003 period, multifactor productivity growth accounted for 0.4 percentage points, or about 20%, of labour productivity growth in Canada. The rate of multifactor productivity growth in the United States was more than twice that in Canada.

The contribution of changes in labour composition and worker skills to aggregate labour productivity growth was slightly higher in Canada than in the United States over the period from the mid-1970s to 1995, but was similar after 1995.

What is the difference in the contribution of intangible capital to labour productivity growth between Canada and the United States?

The contribution of intangible capital to labour productivity growth was similar in Canada and the United States for the period from the mid-1970s to 1995. After 1995, the contribution of intangibles was lower in Canada than in the United States. This was due to the lower contribution of software capital in Canada over that period. The contribution of firm-specific resources (arising from organization development and management capital) was similar in the two countries. The contribution of innovative property was also similar in the two countries.

R&D capital made a small contribution to labour productivity growth, compared with the overall contribution of intangibles to labour productivity growth for both Canada and the United States. None the less, the contribution of R&D capital to labour productivity growth was lower in Canada than in the United States.

1 Introduction

Empirical studies of economic growth and the System of National Accounts (SNA) often focus on the importance of investment in tangible capital, such as machinery and equipment and building structures, and on the changing nature of this type of investment. Those studies find that investment in tangible capital is the dominant source of labour productivity growth in advanced countries (Jorgenson *et al.* 2005; van Ark *et al.* 2008; Baldwin and Gu 2009).

In recent years, attention has been shifted to other types of investment—investment that provides fewer tangible assets. One main type of intangible capital that has received much attention is research and development (R&D), which consists mainly of expenditures on the wages of scientists. Those R&D expenditures soon will be included in the National Accounts of Canada and the National Accounts of many other developed countries as part of revisions to implement the recommendations contained in the *System of National Accounts 2008* (SNA 2008) (Inter-Secretariat Working Group on National Accounts 2009).

Baldwin and Hanel (2003) note how innovation strategies and inputs to the innovation process differ substantially across manufacturing sectors. In some industries, innovation strategies are centered on R&D and the development of new products. In others, these strategies involve science-and-engineering activities such as incorporating new processes and making use of the new intermediate products developed in other industries. Baldwin *et al.* (2009) extend the definition of innovative activities to include all scientific and engineering expenditures─regardless of whether they are market-based or produced within a firm. They find that R&D expenditures account for a small portion (about one-quarter) of total expenditures for the purpose of innovation. Expenditures on own-account science and engineering and on purchased scientific and engineering services together exceed R&D expenditures.

Corrado *et al.* (2005, 2009) argue that a broader measure of intangible assets should consist of computerized information (software and computerized database), innovative property (scientific R&D and non-scientific R&D), and economic competencies (brand equity, training, and organizational capital). They construct a measure of those intangibles for the United States and examine their contribution to labour productivity growth in that country. Corrado *et al.* find that the rate of change in labour productivity in the United States increased more rapidly and that the contribution of capital deepening to labour productivity growth was larger when intangibles were counted as capital. The effect of intangibles on labour productivity growth has been about the same as the effect of tangibles in more recent years.

The methodology followed by Corrado *et al.* for the measurement of intangible capital has been applied in a number of countries, including Australia, the United Kingdom, Japan, Finland, and the Netherlands.[1] Van Ark *et al.* (2009) provide international comparisons of intangible capital and its contribution to labour productivity growth among eleven advanced countries. Those studies on intangibles conclude that investment in intangibles is large and has grown more rapidly than investment in tangibles. Investment in intangibles has made a significant contribution to economic growth and labour productivity growth. The contribution of intangibles to economic and labour productivity growth in those countries is often as big as that of tangibles (van Ark *et al.* 2009).

However, there is little empirical evidence that draws directly on data in the National Accounts to measure intangible capital and its contribution to labour productivity growth in Canada. This paper attempts to fill this gap. In particular, this paper has the following objectives. First, it extends a measure of intangibles discussed in Baldwin *et al.* (2009) to more recent years. Second, it examines the contribution of intangibles to labour productivity growth in Canada.

1. United Kingdom in Marrano *et al.* (2009); Japan in Fukao *et al.* (2009); Finland in Jalava *et al.* (2007); the Netherlands in van Rooijen-Horsten *et al.* (2008).

Third, the paper provides a comparison of intangible capital and its contribution to labour productivity growth between Canada and the United States.

While Belhocine (2009) constructed an estimate of intangible investment for Canada,[2] that paper relied primarily on the output of the main producing industries of intangibles in estimating intangible investment. This paper improves upon the data sources and measurement of intangibles. It uses the detailed input-output tables and microdata from business surveys and household surveys in order to derive the actual purchases of intangibles as estimates of intangible investment. As the intangibles are often produced outside of main producing industries and imported from abroad, the actual purchase of intangibles represents a more accurate estimate of intangible investment.[3] In addition, this paper covers a much longer period than that of Belhocine (2009) and examines the contribution of intangible capital to labour productivity growth.

It is important to note that this paper provides only rough estimates—not exact levels—of all aggregates being measured and primarily seeks to ask what the relative magnitude of the various components is and how those various components broadly compare to growth in similar categories in the United States. More work is required to refine the estimates of the various categories before conclusions can be drawn about exact differences in the *levels* of intangible capital between Canada and the United States. The data generated are useful, however, in understanding the differences in the trends in the two categories. For that reason, the paper examines primarily how intangibles, once capitalized, impact generally on output and productivity growth and whether their inclusion in the growth-accounting framework dramatically changes the conclusions about the underlying causes of productivity growth that have been generated by using only tangible capital.

The rest of the paper is organized as follows. In Section 2, the Corrado *et al*. framework for measuring intangible capital and its contribution to labour productivity growth is presented. In Section 3, estimates of intangible investment, capital stocks, and capital services are presented. In Section 4, the contribution of intangible capital to labour productivity growth in Canada is examined, and the paper's results for Canada are compared with the results for the United States from Corrado *et al.* (2009). A number of recent studies have focused on the role of management capital in Canada's productivity performance (Sharpe 2010; Martin and Milway 2005). Consequently, the relationship between management capital and productivity growth is examined in Section 5. Section 6 provides a brief conclusion.

2 Growth accounting with intangible capital

The framework of Corrado *et al.* (2005, 2009) for how intangibles can be incorporated into the national accounts and productivity accounts will be used in this paper.

When intangible expenditures are classified as investment, the gross domestic product (GDP) identity is expanded to include investment in intangible capital on the output side and the flow of services from intangible capital on the income side:

$$\begin{aligned} P^Y(t)Y(t) &= P^C(t)C(t) + P^I(t)I(t) + P^N(t)N(t) + P^G(t)G(t) + P^X(t)X(t) - P^M(t)M(t) \\ &= P^L(t)L(t) + P^K(t)K(t) + P^R(t)R(t) \end{aligned} \quad (1)$$

Y denotes aggregate output (or gross domestic product in constant dollars), which is the sum of the components on the output side: consumption (*C*), investment in tangible assets (*I*), investment in intangibles (*N*), government expenditures (G), exports (X) and imports (M). Their

2. Belhocine (2009) used a type of Tobin's Q to derive an alternative estimate of intangible capital in Canada.
3. Van Rooijen-Horsten *et al.* (2008) made a similar argument in favour of the use of purchases of intangibles as estimates of intangible investment.

corresponding prices are denoted by P^Y, P^C, P^I, P^N, P^G, P^X and P^M. The aggregate output is produced by using three inputs: labour input (*L*), tangible capital stock (*K*), and intangible capital stock (*N*). P^L is the price of labour input; P^K is the user cost of tangible capital; and, P^R is the user cost of intangible capital.

Corrado *et al.* (2005, 2009) also extend the Solow-Jorgenson growth-accounting framework to include investment in intangibles. The extended growth-accounting equation can be written as:

$$\Delta \ln Y = \bar{s}_c \Delta \ln C + \bar{s}_I \Delta \ln I + \bar{s}_N \Delta \ln N = \bar{s}_L \Delta \ln L + \bar{s}_K \Delta \ln K + \bar{s}_R \Delta \ln R + \Delta \ln A, \quad (2)$$

where $\bar{s}$ denotes average shares of inputs and outputs in nominal gross domestic product and where $\Delta \ln$ denotes the log difference between two periods. The growth rate of output is equal to share-weighted growth rates of inputs plus multifactor productivity growth.

The growth-accounting equation (2) can be written to examine the sources of labour productivity growth, defined as growth in output per hour worked. The sources of labour productivity growth can be expressed as:

$$\Delta \ln(Y/H) = \bar{s}_k \Delta \ln(K/H) + \bar{s}_R \Delta \ln(R/H) + \bar{s}_L \Delta \ln(L/H) + \Delta \ln A, \quad (3)$$

where *H* denotes hours worked. Equation (3) divides the growth in labour productivity into four components. The first two terms are the contribution of capital deepening resulting from tangibles and intangibles, respectively. The third term is the contribution of shifts in labour composition (e.g., towards more educated and more experienced workers). The fourth term is multifactor productivity growth, which is often associated with technological change, organizational change, or economies of scale.

When intangibles are included as investments as in Equation (1), this is expected to affect the national accounts and productivity accounts in several ways. First, the share of labour income in GDP is expected to decline, while the share of capital income is expected to increase as a result of the expanded capital base. Second, the growth of output is expected to be higher as investment in intangibles often increases at a higher rate than do consumption and investment in tangible capital. Third, residual multifactor productivity growth tends to be lower when intangibles are included as investment (Corrado *et al.* 2009; van Ark *et al.* 2008).[4]

3 Measurement of intangible investment and capital

This section outlines the construction of intangible-investment and capital-stock estimates. It follows the work of Corrado *et al.* (2005, 2009) for the United States and classifies intangibles into three main categories: (1) computerized information; (2) innovative property; and (3) economic competencies. The intangible estimates presented here build upon the work of Baldwin *et al.* (2009).

Computerized information reflects the knowledge embedded in computer software and computerized databases. One major type of computerized information─software expenditures─has been capitalized in the National Accounts.

The innovative-property category of intangibles includes scientific R&D expenditures as defined in the *Frascati Manual 2002* (Organization for Economic Cooperation (OECD) 2002). It also includes non-scientific R&D. This category is closely related to total science expenditures for the purpose of innovation outlined in Baldwin *et al.* (2009).

4. This does not have to be the case. Van Rooijen-Horsten *et al.* (2008) found that the residual multifactor productivity growth did not change when intangibles were capitalized in the Dutch commercial sector for the 1996-to-2000 period.

Economic competencies are the largest category of intangibles and include brand equity (for example, investment to retain or gain market share and investment in brand names), firm-specific human capital (employer-sponsored worker training), and organizational capital (or organizational changes and changes in workplace practices).

The data sources and methods used to estimate investment and capital stock for each type of intangible are presented in the Appendix. The main data sources include the detailed input-output tables and microdata from business surveys and household surveys. A distinguishing feature of the method followed in this paper is the use of the actual purchases of intangibles as estimates of intangible investment. As intangibles are often produced outside of main producing industries and imported from abroad, the actual purchase of intangibles represents a more accurate and coherent set estimates of intangible investment.

3.1 Nominal intangible investment

The time-series data on intangible investment have been constructed for the Canadian business sector covering the 1976-to-2008 period. Table 1 presents estimates of business investment in intangibles for years 1976, 1990, 2000, and 2008. Estimated business investment in intangibles increased over this period and was about $150 billion, or about 66% of tangible investment in the business sector in 2008. Total investment in intangibles grew more rapidly than investment in tangibles over time. The ratio of intangible investment to tangible investment increased from 0.23 in 1976 to 0.66 in 2008.

Table 1
Estimates of business investment in intangibles in the Canadian business sector

Categories	1976	1990	2000	2008
	millions of dollars			
Total intangible business investment	6,953	40,274	96,807	150,660
Computerized information	297	3,962	9,419	16,654
Innovative property	2,775	12,828	32,477	47,003
Scientific and engineering research and development	755	5,169	12,395	15,980
Mineral exploration and evaluation	431	1,391	7,290	11,840
Development costs in financial industry	251	1,267	2,683	3,548
New architecture and engineering design	1,052	4,304	8,784	13,101
Own-account other science and engineering services	194	321	331	662
Purchased other science and engineering services	91	376	994	1,871
Economic competencies	3,880	23,484	54,910	87,004
Advertising	1,650	7,240	12,934	17,070
Firm-specific human capital	279	1,722	2,842	3,932
Purchased organizational capital	505	4,600	23,815	40,995
Own-account organizational capital	1,447	9,923	15,319	25,006
	ratio			
Addendum				
Ratio of all intangibles to System of National Accounts tangibles[1]	0.23	0.43	0.66	0.66
	percent			
Share of intangibles capitalized in the System of National Accounts	10.50	13.30	17.30	18.90
	ratio			
Business sector output, ratio of existing to adjusted for intangibles	0.96	0.93	0.91	0.90

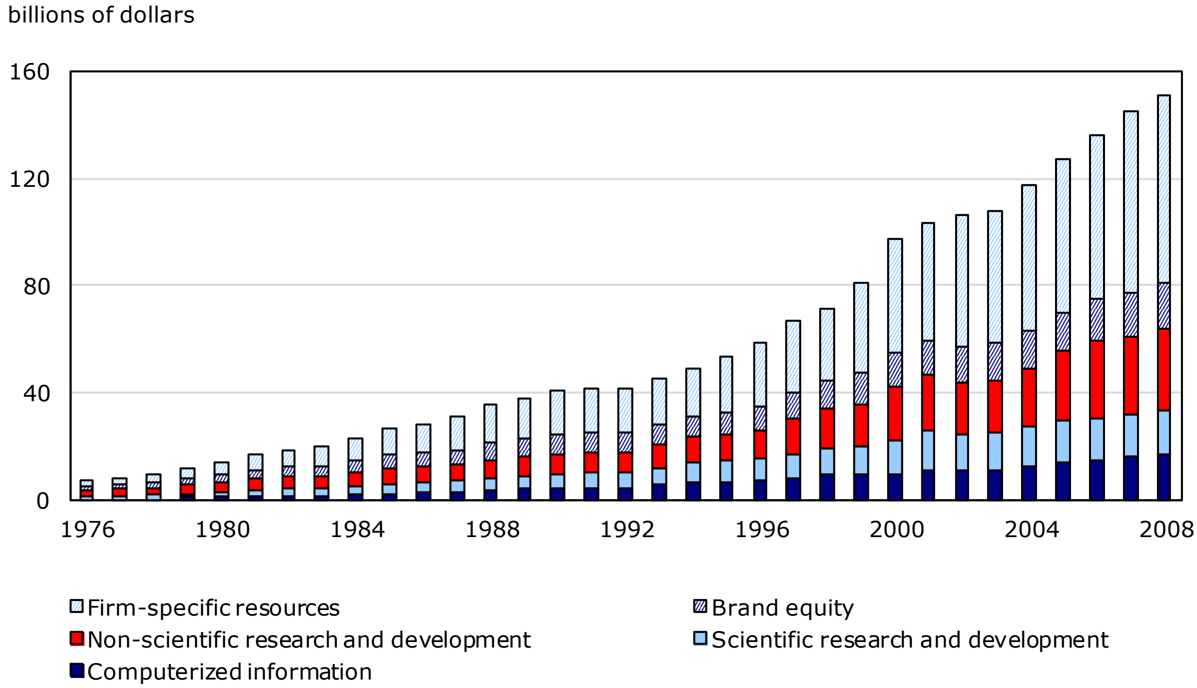
1. System of National Accounts (SNA) tangibles excluding investment in mineral exploration and computer software. The share of intangibles capitalized in the System of National Accounts is the ratio of investment in mineral exploration and computer software that has been capitalized in the SNA to all intangible investments.

Source: Statistics Canada, authors' calculations.

Of all intangible categories, only software investment and mineral exploration have been capitalized in the Canadian System of National Accounts (CSNA). However, the investment in those two categories is only a small fraction of total intangible investment. In 2008, intangibles capitalized in the CSNA accounted for 19% of total intangible investment.

The largest component of intangible investment is economic competencies, as shown in Table 1 and Chart 1. The total investment in economic competencies was $87 billion in 2008; this investment accounted for 60% of overall intangible investment. The second-largest component was innovative property. The investment in that category was $47 billion in 2008 and accounted for about 30% of overall intangible investment. Business investment in R&D accounted for about one-third of the total investment in innovative property. Investment in computerized information was the third-largest component. In 2008, Canadian businesses invested about $17 billion in software, about 10% of total intangible investment.

Chart 1
Nominal intangible investment in Canada

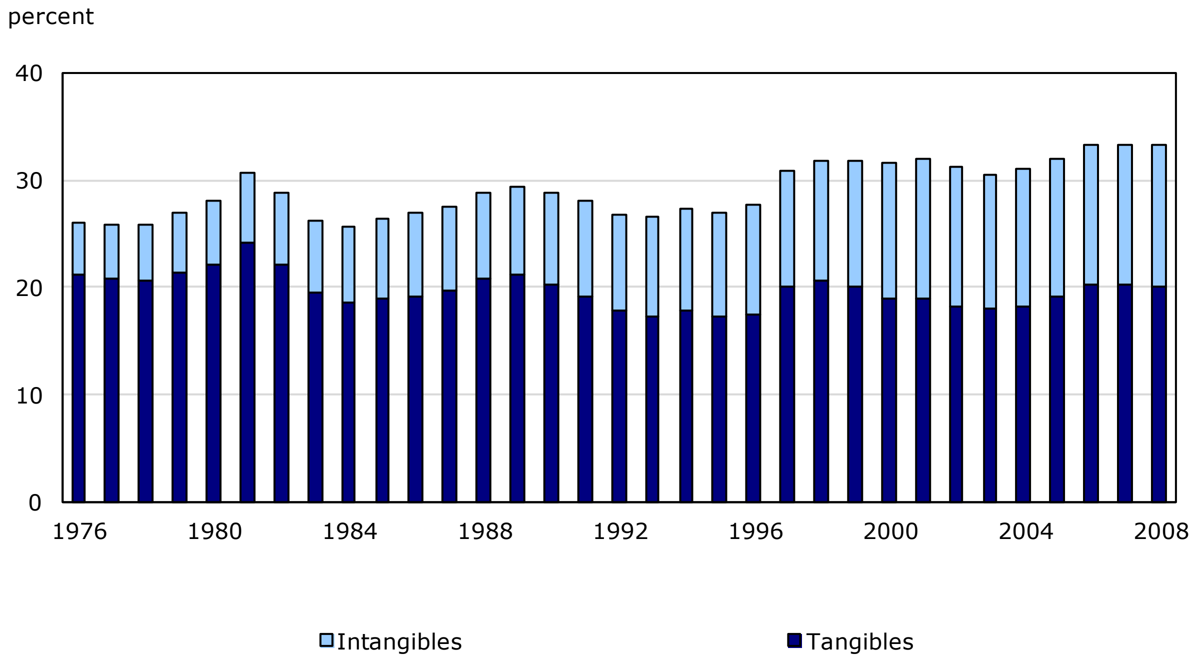


Note: Scientific research and development refers to scientific and engineering research and development in the innovation properties categories. Non-scientific research and development includes all other categories of innovative properties. Brand equity refers to advertising. Firm-specific resources consist of firm-specific human capital, and purchased and own-account organizational capital.
Source: Statistics Canada, authors' calculations.

Chart 2 shows nominal investment as a share of the unrevised GDP in the Canadian business sector.[5] The share of tangible investment in nominal GDP is flat, at about 20%, over the 1976-to-2008 period. When intangibles are included as investment, the ratio of investment to GDP increases from 26% to 33% over the 1976-to-2008 period.

5. The estimate of GDP is taken from that reported in the CSNA and does not include the adjustment to GDP required when new intangibles are capitalized.

Chart 2
Nominal investment in tangibles and intangibles as a percentage of unrevised gross domestic product, Canada



Source: Statistics Canada, authors' calculations.

Table 2 shows the investment in intangible capital as a percentage of the unrevised GDP in the Canadian business sector. The Canadian business sector invested 13.2% of GDP in intangible assets in 2008. The share increased for all types of intangible assets for the 1976-to-2008 period, except for own-account other product-development and science-related expenditures. Investment in that category was virtually unchanged over the period.

Table 2
Intangible investment as a percentage of gross domestic product in the Canadian business sector

Categories	1976	1990	2000	2008
		percent		
Total estimated intangible business investment	4.9	8.6	12.6	13.2
Computerized information	0.2	0.8	1.2	1.5
Innovative property	1.9	2.7	4.2	4.1
Scientific and engineering research and development	0.5	1.1	1.6	1.4
Mineral exploration and evaluation	0.3	0.3	0.9	1.0
Development costs in financial industry	0.2	0.3	0.3	0.3
New architecture and engineering design	0.7	0.9	1.1	1.1
Own-account other science and engineering services	0.1	0.1	0.0	0.1
Purchased other science and engineering services	0.1	0.1	0.1	0.2
Economic competencies	2.7	5.0	7.1	7.6
Advertising	1.2	1.6	1.7	1.5
Firm-specific human capital	0.2	0.4	0.4	0.3
Purchased organizational capital	0.4	1.0	3.1	3.6
Own-account organizational capital	1.0	2.1	2.0	2.2

Source: Statistics Canada, authors' calculations.

The ratio of intangible investment to GDP reported by Belhocine (2009) was 9.5% in 2000. The ratio of intangible investment to GDP reported here is 12.6% in that year. Some of the difference can be attributed to coverage. Belhocine (2009) focuses on the total economy, whereas this paper focuses on the business sector but, the most important difference is attributable to the data sources used for estimating intangibles. Belhocine (2009) relied on the output of intangible-producing industries (e.g., advertising-services and management-consulting-services industries) to estimate intangible investment in those areas. This paper uses the detailed input-output tables and microdata from business surveys and household surveys in order to derive the actual purchases of intangibles as estimates of intangible investment. As the intangibles are often produced outside of main producing industries and imported from abroad, the actual purchase of intangibles reported here provides a more comprehensive estimate of intangible investment. These results, for example, show that expenditures on advertising services totalled about four times the revenue of the advertising industry in 2006.

3.2 Real intangible investment and intangible capital stocks

The next step in calculating the contribution of intangibles to labour productivity growth requires the construction of real intangible investment and capital stocks. This section presents the methods for constructing such data and the estimates of real intangible investment and capital stocks.

3.2.1 Real intangible investment

Real investment in intangibles is calculated by dividing the nominal intangible investment by a price deflator for that investment. To calculate real investment, price deflators need to be constructed that can be used to deflate nominal investment.

Previous empirical studies have used two types of price deflators for intangible investment. The first type of deflator, makes use of the costs of inputs that serve to produce intangible assets, mainly wage costs plus material and capital costs. For example, the input costs or the wages of scientists and engineers are used to deflate nominal investment in R&D in some empirical studies on R&D capitalization. The second type of deflator, is the deflator of the output of those industries that are the main producers of intangible assets. For example, in the U.S. R&D Satellite Account, the U.S. Bureau of Economic Analysis (BEA) uses the output deflators of top R&D-intensive industries (BEA 2007). In converting nominal intangible investment to real investment, Corrado *et al.* (2009) used the output price deflators of the non-farm business sector in order to deflate nominal investment in intangible capital.

For this paper, the types of deflators used in Corrado *et al.* are adopted, in order to yield estimates for Canada that allow for comparison with the U.S. results in Corrado *et al.* The GDP deflators of the Canadian business sector are used to deflate all intangibles except mineral exploration and software investment. The price deflators for mineral exploration and software investment are obtained from the CSNA.

Appendix Table 9 presents the annual growth rates of real intangible investment. It also presents the growth rates of investments in two tangible assets: information and communication technologies (ICT) excluding software; and non-ICT excluding mineral exploration. Overall, real investments in intangible assets increased faster than investments in tangible assets in the Canadian business sector. Over the 1976-to-2008 period, real investment in intangible assets increased by an average rate of 6.4% per year in the Canadian business sector, while investment in tangible assets increased by 4.1% per year on average.

Software investment increased most rapidly, followed by purchased organizational capital. Over the 1976-to-2008 period, real software investment increased by 11.9% per year on average, and investment in organizational capital increased by 10.2% per year.

The rate of growth in investment in intangible assets declined after the bursting of the tech bubble of the early 2000s. The growth rate of real investment in intangible assets for the 2000-to-2008 period was 3.2% per year, which was less than half the growth rate (7.4% per year) for the 1976-to-2000 period. The decline occurred with respect to all intangible assets except own-account other science and development.

In contrast to the decline in the growth rate of intangible investment post 2000, the growth in tangible investment increased after 2000. The annual growth in tangible investment increased from 3.8% in the 1976-to-2000 period to 5.0% for the 2000-to-2008 period. The post-2000 increase in the growth of tangible investment is related to the resource boom and the increased investments being made in the mining sector. The increased rate of investment in tangibles may also be related to the appreciation of the Canadian dollar against foreign currencies, which has made investments purchased abroad cheaper.

3.2.2 Intangible capital

Obtaining intangible capital stocks starts with the estimates of real investment, *N(t)*. Intangible capital assets are assumed to follow geometric depreciation patterns. The capital stocks of intangibles are estimated by means of a perpetual inventory method (PIM):

$$R(t) = N(t) + (1-\delta)R(t-1), \tag{4}$$

Where *R(t)* is real intangible capital stock and δ is the depreciation rate.

There is little empirical evidence on the depreciation rates for intangibles. For this paper, the depreciation rates from Corrado *et al.* (2009) will be adopted for all intangibles except mineral exploration and software investment. The depreciation rates for those two intangibles are set equal to the rates used in the Multifactor Productivity Program of Statistics Canada (Statistics Canada 2007). The depreciation rates for other intangibles are based on limited previous empirical studies (Corrado *et al.* 2009). The last column of Appendix Table 8 shows the depreciation rates used for this paper. In general, depreciation rates for intangibles are much higher than those for tangibles.

The implementation of the perpetual inventory method for estimating intangible capital requires an estimate of initial capital stock. The initial capital stock of intangibles in period *0* is calculated by using

$$R(0) = N(0)/(\delta + g), \tag{5}$$

where *g* is set equal to the average annual growth rate of intangible investment for the first three years: 1977, 1978, and 1979.

Appendix Table 10 presents the annual growth rates of intangible and tangible capital stocks in the Canadian business sector. The trend in the growth of intangible and tangible capital stocks mirrors the trend in the growth of intangible and tangible investment. Overall, the stock of intangible capital increased much faster than the stock of tangible assets, with the software capital stock and purchased organizational capital stock being the two fastest-growing intangible capital assets.

The growth of intangible capital stock decelerated after 2000 while the growth of tangible capital stock accelerated. The growth of intangible capital stock decelerated for almost all types of intangible assets.

3.3 The user cost of intangible capital

An estimate of the user cost of intangible capital is required in order to implement the growth-accounting framework and examine the contribution of intangibles to labour productivity growth. The user cost of capital measures the flow of services from intangible capital. It can be estimated by means of the user-cost-of-capital formula derived by Jorgenson (1963), Hall and Jorgenson (1967), and Griliches and Jorgenson (1966).

The user cost of capital can be thought of as the price that a well-functioning market would produce for an asset that is being rented out by an owner to a user of that asset. That price would comprise a term reflecting the opportunity cost of capital (r_t) (either financing costs or the opportunity cost of using capital), a term reflecting the depreciation of the asset (δ), and a term reflecting capital gains or losses from holding the asset (reflecting changes in the market price of an asset, $P_t^I - P_{t-1}^I$). Christensen and Jorgenson (1969) extended the user-cost-of-capital formula in order to take into account taxes. The user cost of capital P_{kt}^K for the *k*th capital asset type in period *t* is

$$P_{kt}^K = \left[\frac{1-\mu_t z_{kt}}{1-\mu_t}\right]\left[P_{kt-1}^I r_t + P_{kt}^I \delta_k - P_{kt-1}^I \pi_t\right], \qquad (6)$$

where: μ_t is the corporate income tax rate; z_{kt} is the present value of depreciation deductions for tax purposes on a dollar's investment in asset type k over the lifetime of the investment; P^K is the user cost of capital; P^I is the market price of an investment asset; and

$$\pi_t = \frac{(P_{kt}^I - P_{kt-1}^I)}{P_{kt-1}^I}$$

is the expected capital gains.

Except for the nominal rate of return on capital (r_t), each term on the right-hand side can be calculated for each intangible asset. Two main alternatives have been used for estimating the nominal rate of return on capital and the user cost of capital for intangible assets: endogenous rates of return calculated from capital income; and exogenous rates of returns chosen from observed market rates such as a government bond rate, a corporate debt rate, or a weighted average of corporate debt and corporate equity rates. For example, Corrado *et al.* (2009) and Marrano *et al.* (2009) used endogenous rates of return to calculate the user cost of intangible capital for the United States and the United Kingdom. Van Rooijen-Horsten *et al.* (2008) used exogenous rates of returns for the Netherlands. Barnes and McClure (2009) and Barnes (2010) used an endogenous rate of return with an exogenous floor rate of return. Diewert (2005) and Baldwin and Gu (2007) compared alternative measures of the user cost of capital.

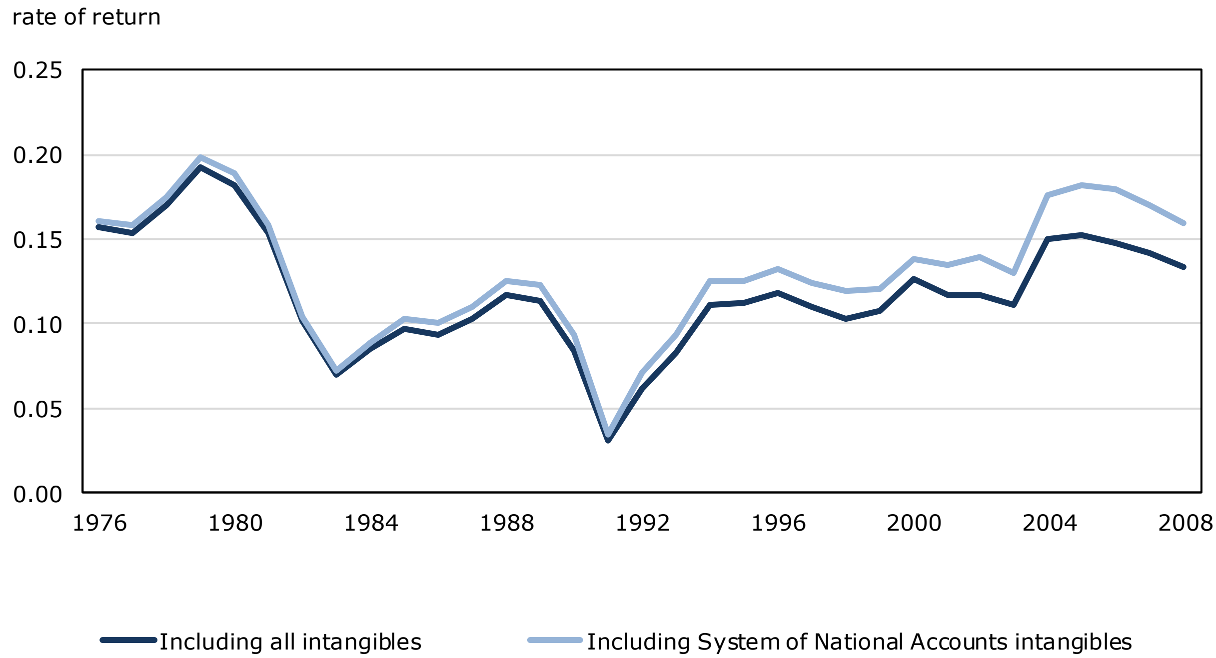
For this paper, the endogenous rates of return for estimating the user cost of intangible assets are used for purposes of a comparison with the results from the United States discussed in Corrado *et al*. (2009). The endogenous rate of return is solved by using the equation which provides that the sum of capital costs across all capital assets is equal to total capital income:

$$\Pi(t) = \sum_k P_k^K(t) K_k(t) + \sum_k P_k^R(t) R_k(t), \qquad (7)$$

where: $\Pi(t)$ is total capital income; K_k is the stock of the k^{th} tangible capital; R_k is the stock of k^{th} intangible capital; and P_k^K and P_k^R are the user cost of the tangible assets and the user cost of the intangible assets, respectively.

Chart 3 shows the endogenous rate of return for the business sector when all intangibles are treated as investment. For a comparison, this chart also shows the endogenous rate of return when only software and mineral exploration (which are already capitalized in the national accounts) are included as investment. The capitalization of all intangibles tends to lower the endogenous rate of return, but the difference is small before the mid-1990s. After the mid-1990s, the difference is slightly larger: it averaged about 2 percentage points for the 1995-to-2005 period—12% versus 14%. Corrado *et al.* (2009) and Barnes and McClure (2009) also found that the capitalization of intangibles has a small effect on the endogenous rate of return.

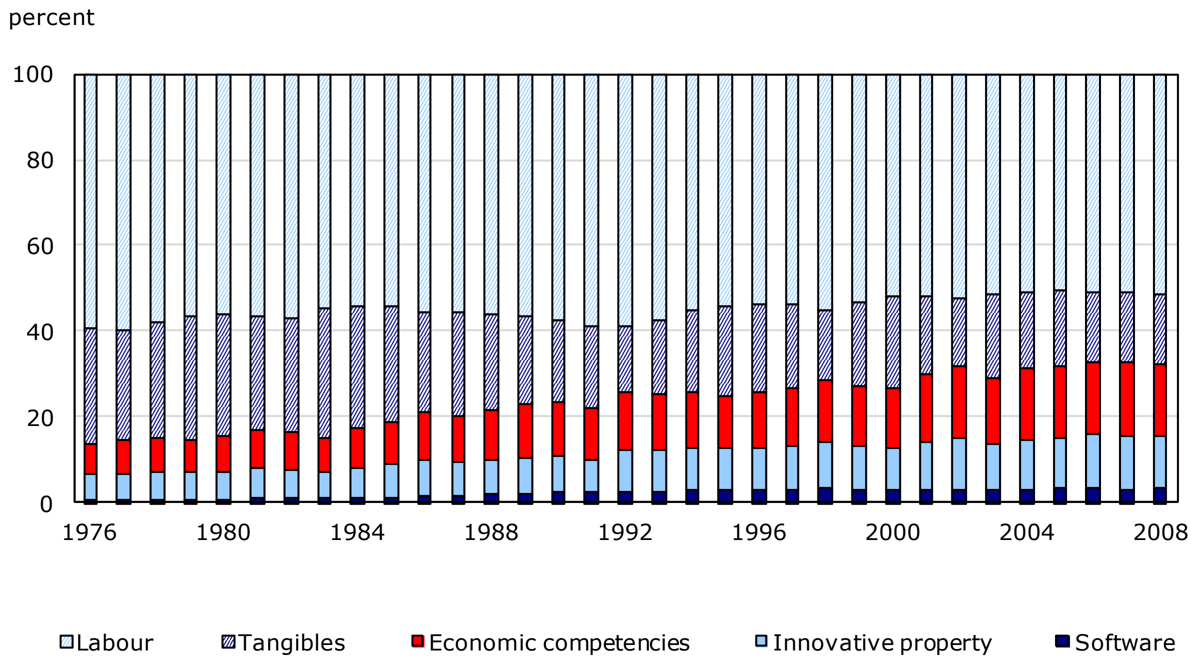
Chart 3
Endogenous rate of return in the business sector with all intangibles treated as investment, Canada



Source: Statistics Canada, authors' calculations.

The shares of income going to labour, tangible capital, and intangible capital are presented in Chart 4. The shares of labour and tangible capital in total GDP (adjusted to include intangible investments) declined over time while the income shares of intangibles increased over time. This reflects the increased importance of intangibles as a component of GDP. The share of labour in total income declined from 59.5% in 1976 to 51.4% in 2008—an 8-percentage-point decline over the period. The share of tangible capital declined from 26.8% in 1976 to 16.4% in 2008—a 10.4-percentage-point decline over the period. In contrast, the share of intangibles increased over time. The income share of economic competencies exhibited the largest increase followed by innovative property, and software.

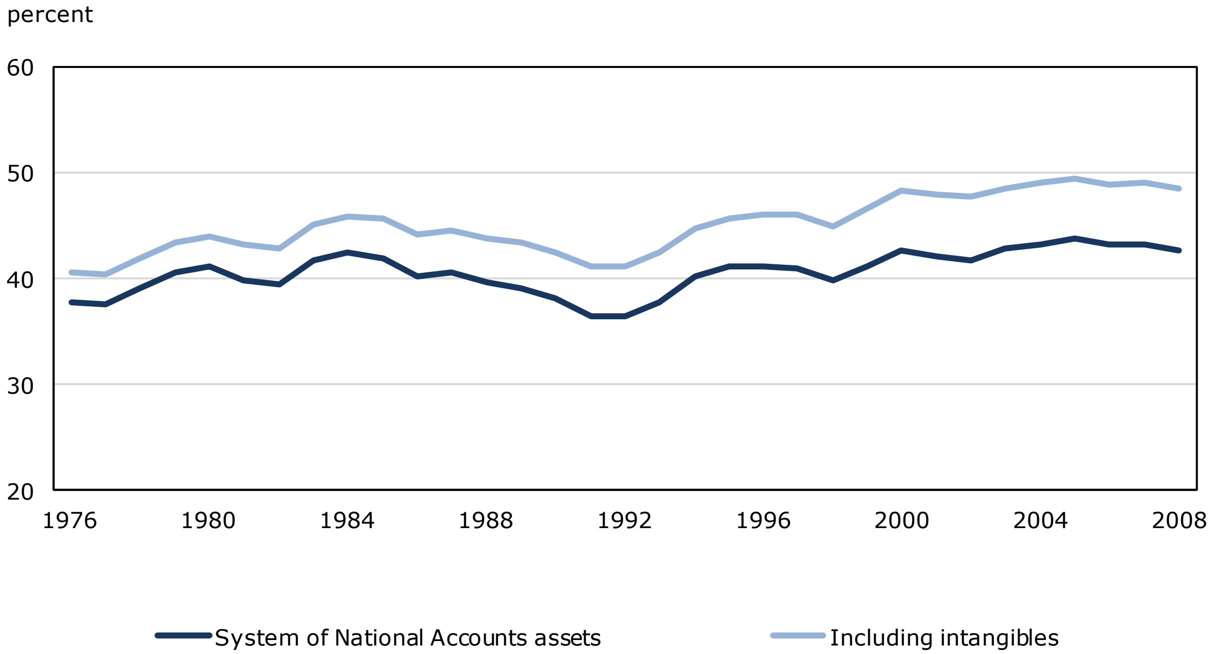
Chart 4
Share of tangibles, intangibles, and labour in gross domestic product, Canada



Source: Statistics Canada, authors' calculations.

Chart 5 shows that the income shares of capital increased while income shares of labour declined when intangibles were included as investment. Similar results are found in all other countries and are attributable to the expanded capital base (van Ark *et al.* 2009).

Chart 5
Share of capital in gross domestic product (with and without intangibles), Canada



Source: Statistics Canada, authors' calculations.

4 Intangible capital and labour productivity growth

In this section, the growth-accounting equation (3) is used to decompose labour productivity growth into the following: a part from capital deepening arising from tangibles and intangibles; a part from increases in skill levels of workers (referred to here as *change in labour composition*); and a part from all other sources—what is referred to as *multifactor productivity growth*. The results for Canada are presented, and then compared to the results for the United States from Corrado *et al.* (2009). As data on R&D expenditures are available for the Canadian and U.S. business sectors, a similar method will be used to construct R&D capital stock and examine its contribution to labour productivity growth in the two countries. A number of recent studies in Canada have focused on the quality of a particular type of intangible─management capital as a possible cause of Canada's weak productivity performance (Martin and Milway 2005; Sharpe 2010). Consequently, the last part of the section examines the correlation between the quality of management capital and multifactor productivity growth in Canadian industries.

4.1 The results for Canada

Table 3 presents the results from the decomposition of labour productivity growth in the Canadian business sector for the 1976-to-2008 period. The top panel presents the decomposition results when only investment from the CSNA is included─this investment consists of tangibles and two types of intangibles (software and mineral exploration). The results are taken from the Multifactor Productivity Program of Statistics Canada (CANSIM table 383-0021). The bottom panel shows results when all intangibles are included as investment. A comparison of the two panels shows the effect on labour productivity growth and on its main sources of including all new intangibles. A number of conclusions can be drawn from this comparison.

Table 3
Decomposition of labour productivity growth in the Canadian business sector

Components	1976 to 2000	2000 to 2008	2000 to 20008 less 1976 to 2000
		percent	
Including System of National Accounts intangibles			
Labour productivity growth	1.5	0.7	-0.8
Contributions of			
Capital deepening	1.0	1.1	0.1
Labour composition	0.4	0.3	-0.1
Multifactor productivity growth	0.1	-0.6	-0.8
Including all intangibles			
Labour productivity growth	1.7	0.8	-1.0
Contributions of			
Capital deepening	1.3	1.4	0.1
Tangible	0.8	0.8	0.0
ICT[1] excluding software	0.3	0.3	-0.1
Non-ICT[1] excluding mineral exploration	0.4	0.5	0.1
Intangible	0.5	0.6	0.0
Computerized information	0.1	0.1	0.0
Innovative property	0.2	0.2	0.0
Economic competencies	0.3	0.2	0.0
Labour composition	0.4	0.3	-0.1
Multifactor productivity growth	0.1	-0.8	-0.9

1. ICT refers to Information and Communications Technology.
Source: Statistics Canada, authors' calculations.

First, the capitalization of intangibles increases the growth in real GDP and in labour productivity in the Canadian business sector in both the 1976-to-2000 and the 2000-to-2008 periods. The increase was larger in the 1976-to-2000 period than in the period after 2000. This is the result of a more rapid increase in intangible investment in the 1976-to-2000 period. The results show that labour productivity growth and GDP growth are 0.2-percentage-points higher when new intangibles (that is, those intangibles other than software and mineral exploration) are included as investment over the 1976-to-2000 period. For the 2000-to-2008 period, the labour productivity growth is 0.1-percentage-points higher.

Second, the capitalization of intangibles increases the contribution of capital deepening to labour productivity growth. For the 1976-to-2000 period, the effect of capital deepening increased from 1.1 percentage points to 1.3 percentage points per year. For the 2000-to-2008 period, it increased from 1.1 percentage points to 1.4 percentage points per year.

Third, multifactor productivity growth exhibited little change over the 1976-to-2000 period when all intangible capital was included. During the 2000-to-2008 period, multifactor productivity growth declined, from -0.6% per year to -0.8% per year.

Fourth, the well-documented decline in labour productivity growth after 2000 became more pronounced when all intangibles were included as investment (Baldwin and Gu 2009). The labour productivity growth declined from 1.7% per year in the 1976-to-2000 period to 0.8% per year post 2000—a 1.0-percentage-point decline between the two periods. This decline was larger than the 0.8-percentage-point drop in labour productivity growth estimated without new intangibles.

Fifth, the sources of decline in labour productivity growth after 2000 remain unchanged when all intangibles are included. The decline in multifactor productivity growth after 2000 continues to be the main source of the decline in labour productivity growth in the Canadian business sector.

When the contribution of capital deepening is divided between tangibles and intangibles, intangible capital is found to make a significant contribution to labour productivity growth, accounting for about 40% of the total capital deepening effects in both the 1976-to-2000 and the 2000-to-2008 periods. Of the three main categories of intangible capital, innovative property and economic competencies each contributed roughly 0.2 percentage points to 0.3 percentage points to annual labour productivity growth in the Canadian business sector. Investment in computerized information contributed 0.1 percentage points to annual labour productivity growth.

4.2 A Canada−United States comparison of intangible capital and labour productivity growth

This section presents a comparison of the results for Canada with those for the United States from Corrado *et al.* (2009). Intangibles related to other own-account and purchased science and engineering are excluded from the Canadian estimates, as those intangibles are not included in the U.S. data from Corrado *et al.* (2009).

Table 4 compares intangible investment in the business sector in Canada and the United States. The share of intangible investment in GDP for the United States is estimated by dividing business investment in intangibles from Corrado *et al*. (2009) by the business-sector GDP from the U.S. Bureau of Labor Statistics (BLS) productivity programs. Total business investment in intangibles is slightly lower in Canada than in the United States. In the United States, the business sector invested 15.6% of conventionally measured GDP in intangible assets for the years 2000 to 2003. In Canada, the business sector invested 12.6% of GDP in intangible assets for those years.

Table 4
Intangible investment as a percent age of gross domestic product in the business sector, Canada and the United States

Categories	1980 to 1989	1990 to 1999	2000 to 2003
		percent	
Canada			
Total intangible	7.1	9.7	12.6
Computerized information	0.5	1.1	1.3
Scientific research and development	1.0	1.4	1.7
Non-scientific research and development	1.5	1.8	2.3
Brand equity	1.4	1.5	1.6
Firm-specific resources	2.7	3.9	5.7
United States			
Total intangible	11.3	13.5	15.6
Computerized information	0.8	1.5	2.2
Scientific research and development	3.4	2.8	2.9
Non-scientific research and development	1.9	2.6	3.0
Brand equity	1.8	1.9	2.0
Firm-specific resources	3.5	4.6	5.4

Note: The ratios of intangible investment to gross domestic product for the United States are estimated by dividing intangible investments from Corrado et al. (2009) into the business-sector gross domestic product from the Bureau of Labor Statistics.
Source: Statistics Canada, authors' calculations.

The table also shows differences in business investment between Canada and the United States; these differences have been well documented. The business investment in R&D was lower in Canada than in the United States during this period. The business investment in software was also lower in Canada (Rao *et al.* 2005).

In contrast, business investment in non-scientific R&D was similar in the two countries. This is consistent with the evidence in Beckstead and Gellatly (2006), which shows that the share of scientists and engineers in total employment was similar in Canada and the United States.

Business investment in brand equity and firm-specific resources (including workplace training and organizational capital) was similar in the two countries. Martin and Milway (2005) and OECD (2006) report that Canadian firms have a lower share of highly-educated managers than do U.S. firms. When investments in organizational capital or management capital are measured by means of the methodology followed by Corrado *et al.*, the results show that there was little difference in the investment in management capital between Canada and the United States. While the share of managers with advanced education was lower in Canada, the share of all managers (measured as their compensation share in total GDP) was similar in the two countries.

Table 5 presents the sources of labour productivity growth in the business sector for Canada and the United States for the periods from the mid-1970s to 1995 and from 1995 to 2003. There are a number of similarities and differences in the sources of aggregate labour productivity growth between Canada and the United States. The most important source of labour productivity growth is capital deepening for both Canada and the United States. For the 1995-to-2003 period, capital deepening from intangibles and tangibles contributed 1.4 percentage points, or about 70%, of labour productivity growth in Canada. For the United States, capital deepening contributed 1.7 percentage points, or about 60%, of labour productivity growth.

Table 5
Sources of labour productivity growth in the business sector, Canada and the United States

Components	Canada		United States		Canada minus United States	
	1976 to 1995	1995 to 2003	1973 to 1995	1995 to 2003	mid-1970s to 1995 [1]	1995 to 2003
			percentage points			
Labour productivity growth	1.5	2.1	1.6	2.8	-0.2	-0.7
Capital deepening	1.2	1.4	1.0	1.7	0.2	-0.3
Tangibles	0.8	0.7	0.6	0.9	0.3	-0.1
ICT[2] equipment	0.3	0.4	0.3	0.6	0.0	-0.2
Other	0.5	0.3	0.3	0.2	0.3	0.0
Intangibles	0.4	0.6	0.4	0.8	0.0	-0.2
Software	0.1	0.1	0.1	0.3	0.0	-0.2
Other	0.3	0.6	0.3	0.6	0.0	0.0
Labour composition	0.4	0.3	0.3	0.3	0.1	0.0
Multifactor productivity growth	-0.1	0.4	0.4	1.1	-0.5	-0.7

1. The period covers 1976 to 1995 for Canada and 1973 to 1995 for the United States. The results for the United States are from Corrado et al. (2009). The numbers may not add up as a result of rounding.
2. ICT refers to Information and Communications Technology.
Source: Statistics Canada, authors' calculations.

Multifactor productivity growth contributed positively to labour productivity growth in both countries after 1995. However, multifactor productivity growth was a much more important source of labour productivity growth in the United States than in Canada. For the 1995-to-2003 period, multifactor productivity growth accounted for 0.4 percentage points, or about 20%, of labour productivity growth in Canada. Multifactor productivity growth in the United States was more than twice that in Canada: it contributed 1.1 percentage points, or 40%, of labour productivity growth in the United States.

The contribution of labour composition and worker skills to aggregate labour productivity growth was slightly higher in Canada than in the United States over the period from the mid-1970s to

1995. After 1995, the contribution of labour composition and worker skills to labour productivity growth was similar in the two countries.

The last two columns of Table 5 present the sources of differences in labour productivity growth between Canada and the United States. For the period before 1995, the labour productivity growth was about 0.2-percentage-points lower in Canada than in the United States. The lower labour productivity growth in Canada for that period was due to lower multifactor productivity growth. The contribution of capital deepening was higher in Canada. After 1995, labour productivity growth was much slower in Canada than in the United States. The slower productivity growth found in Canada is due to slower multifactor productivity growth and lower investment in information technology (IT) equipment and software. Businesses in Canada invested less in IT equipment and software than their counterparts in the United States after 1995.

Those differences between Canada and the United States are well documented in previous empirical studies (Baldwin and Gu 2009). The new finding here relates to the difference in the role of intangible capital between the two countries. Intangible capital other than software makes a similar contribution to labour productivity growth in the two countries. The main difference between the two countries relates to software investment. Businesses in Canada invested less in software capital; this reduced Canada’s labour productivity growth relative to that of the United States by 0.2 percentage points per year for the 1995-to-2003 period.

Appendix Table 11 presents the contributions of individual intangible assets to labour productivity growth for Canada and the United States. The overall contribution of intangible capital to labour productivity growth was similar in the two countries for the period from the mid-1970s to 1995. After 1995, the contribution of intangibles was lower in Canada than in the United States. This was due to the lower contribution of software capital in Canada over that period. The contribution of firm-specific resources (arising from organization development and management capital) was similar in the two countries. The contribution of innovative property was also similar in the two countries. This reflects the well-documented empirical evidence that the share of scientists and engineers whose work involved innovation was similar in the two countries (Beckstead and Gellatly 2006).

4.3 A Canada−United States comparison of research-and-development capital and labour productivity growth

This section uses a similar method to construct a measure of R&D capital and to examine the contribution of R&D capital to labour productivity growth in the Canadian and U.S. business sectors. Business expenditures on R&D as a share of GDP are lower in Canada than in the United States and many other OECD countries (OECD 2006). Canada’s relatively lower R&D intensity in the business sector reflects mainly the lower R&D intensity at the industry level (e.g., services sector and motor vehicles) (ab Iorwerth 2005). The lower R&D intensity in Canada is often cited as another possible explanation for Canada’s lower labour productivity growth. This section focuses on R&D intangible capital. It constructs R&D capital for Canada and the United States and examines its contribution to the productivity growth difference between Canada and the United States.

Intramural business expenditures on R&D are used for the comparison. The R&D expenditures data for Canada are the same as those used in the previous section on intangibles. The data for the United States are obtained from the OECD.

In order to examine the contribution of R&D to productivity growth, R&D investments need to be accumulated for deriving an estimate of R&D capital stock. Until now, the GDP deflator of the business sector has been used to deflate nominal R&D investment, and R&D capital is assumed to follow a geometric depreciation pattern, with the rate of depreciation equal to 20%.

Those choices are made so as to compare the Canadian results with the results for the United States from Corrado *et al*. (2009).

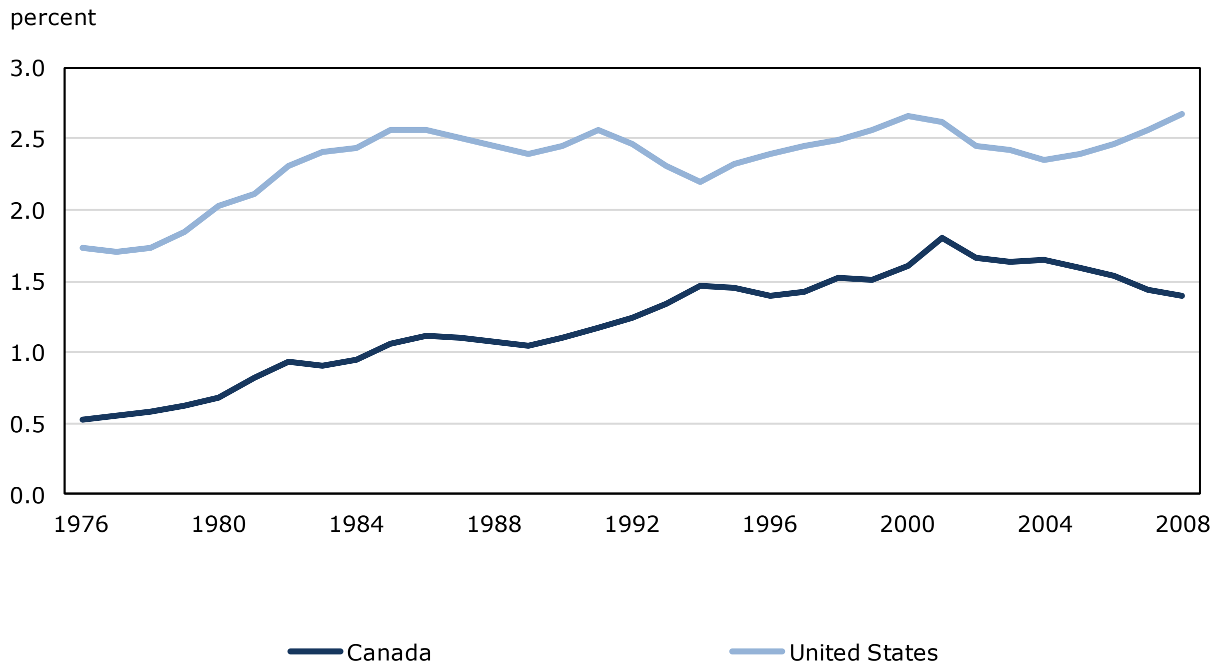
In this section, the depreciation rates and price deflator adopted in the R&D satellite accounts are used. The R&D depreciation rate is set equal to 0.16, a rate that is used in the U.S. BEA R&D satellite accounts. The price deflator of R&D investment is set equal to the price deflator of the outputs in those industries that produce R&D. The index is constructed as a Tornqvist-weighted combination of output prices of the nine R&D-intensive industries in Canada, where the weights are each industry's share of R&D expenditures.[6]

To calculate the user cost of capital for R&D capital, the user-cost-of-capital formulation that ignores tax parameters is used, since the tax parameters for the United States are not readily available. For Canada, the endogenous rate-of-return method for calculating the user cost of capital is employed. For the United States, the exogenous rate-of-return specification is used, and the exogenous rate of return is set equal to the endogenous rate of return in Canada.[7] Baldwin *et al.* 2008 found that the endogenous rates of return are similar in Canada and the United States.

Chart 6 shows the well-documented difference in business R&D investment between Canada and the United States as a share of GDP. The R&D intensity was lower in Canada than in the United States over the 1976-to-2008 period. R&D intensity differences between the two countries narrowed over time between 1976 and 2000. After 2000, the differences widened. In 2008, R&D intensity in Canada was 1.4%, which was about the half that in the United States.

6. Those nine R&D-intensive industries are "Pharmaceutical and medicine manufacturing," "Other chemicals," "Computer and peripheral equipment manufacturing," "Electronic product manufacturing," "Motor vehicle parts manufacturing," "Aerospace product and parts manufacturing," "All other transportation equipment," "Information and cultural industries," and "Other professional, scientific, and technical services."
7. The exogenous rate-of-return method for estimating the user cost of R&D capital is chosen for the U.S. as a result of data constraints. Implementing the endogenous rate-of-return method requires consistent time-series data on investment and capital stock for the U.S. for the 1976-to-2008 period; these are not available.

Chart 6
Intensity of research and development in the business sector, Canada and the United States (percentage of GDP)



Source: Statistics Canada, authors' calculations.

Table 6 presents the contribution of R&D capital to labour productivity growth in the Canadian and U.S. business sectors. The sources of labour productivity growth without R&D capital are also presented for comparison. Those data without R&D investment are obtained from the BLS for the United States and from the Multifactor Productivity Program of Statistics Canada for Canada. A number of conclusions can be drawn from the table.

Table 6
Contributions of research and development to labour productivity growth in the business sector, Canada and the United States

Components	Canada		United States		Canada minus United States	
	1976 to 2000	2000 to 2008	1976 to 2000	2000 to 2008	1976 to 2000	2000 to 2008
	percentage points					
Excluding research-and-development capital						
Labour productivity growth	1.5	0.7	1.7	2.6	-0.3	-1.8
Contributions of						
Capital deepening	1.0	1.1	0.7	1.0	0.2	0.1
ICT[1] including software	0.5	0.4	0.6	0.6	-0.1	-0.2
Non-ICT[1]	0.5	0.7	0.2	0.4	0.3	0.4
Labour composition	0.4	0.3	0.3	0.2	0.1	0.1
Multifactor productivity growth	0.1	-0.6	0.7	1.4	-0.6	-2.0
Including research-and-development capital						
Labour productivity growth	1.6	0.8	1.8	2.6	-0.3	-1.9
Contributions of						
Capital deepening	1.0	1.2	0.9	1.2	0.1	0.0
ICT[1] including software	0.4	0.3	0.5	0.6	-0.1	-0.2
Non-ICT[1]	0.5	0.7	0.2	0.4	0.3	0.3
Research-and-development capital	0.1	0.1	0.2	0.3	-0.1	-0.2
Labour composition	0.4	0.3	0.3	0.2	0.1	0.1
Multifactor productivity growth	0.2	-0.7	0.7	1.2	-0.5	-1.9

1. ICT refers to Information and Communications Technology.
Source: Statistics Canada, authors' calculations.

Firstly, when R&D expenditures are included as investment, real GDP growth and labour productivity growth increased by 0.1 percentage points per year in both Canada and the United States.

Secondly, R&D capital made a small contribution to labour productivity growth for both Canada and the United States. The contribution of R&D capital to labour productivity growth was lower in Canada than in the United States. R&D capital accounted for 0.1 percentage points of labour productivity growth in Canada for the 1976-to-2000 and 2000-to-2008 periods. For the United States, R&D contributed 0.2 percentage points to labour productivity growth in the 1976-to-2000 period and 0.3 percentage points in the 2000-to-2008 period.

Thirdly, when R&D expenditures are included as investment, the sources of Canada's slower labour productivity growth in the 2000-to-2008 period compared to its historical performance and to that of the United States, remain unchanged. There are three reasons for this. First, the decline in labour productivity growth in Canada after 2000 can be traced to slower multifactor productivity growth. The effect of fixed capital and R&D capital deepening did not decline after 2000. Second, Canada's slower labour productivity growth after 2000, compared with that of the United States, was due mainly to Canada's slower multifactor productivity growth. Lower investments in ICT and R&D also contributed to Canada's slower labour productivity growth. However, the Canadian business sector invested more than did the U.S. business sector in non-ICT capital; this raised Canada's relative labour productivity growth. The overall effect of capital deepening from ICT capital, non-ICT capital, and R&D capital was similar between Canada and the United States after 2000.

The contribution of R&D capital to labour productivity growth in the United States set out in Table 6 is about 0.1-percentage-points higher than the contribution obtained from Table 5 in Corrado *et al.* (2009). The difference reflects the choice of depreciation rates and price deflators for R&D investment. Corrado *et al.* assume that the depreciation rate for R&D is 20% and that the price deflator for R&D investment is the GDP deflator of the business sector. In this paper, a lower depreciation rate of 15% for R&D capital is assumed, and the R&D investment price deflator is set equal to the price index of output of R&D-intensive industries. The lower depreciation rate adopted here raises the stock of R&D capital. As the price index of the output of R&D-intensive industries grew at a slower rate than the price index of the business-sector output, the R&D price index adopted here will increase the growth rate of R&D investment and R&D capital stock. Overall, the assumptions adopted here increased the contribution of R&D capital to labour productivity growth by about 0.1 percentage points per year over the period from 1976 to 2008. The assumptions also increased the contribution of R&D capital to labour productivity growth in Canada. However, the increase was less than 0.1 percentage points.

5 Management capital and labour productivity growth

The evidence presented in this paper shows that the contribution of intangibles to labour productivity growth is only slightly lower in Canada than in the United States. The difference in intangible capital is not a main factor behind the differences in labour productivity growth in the two countries.

The evidence also shows that there is little difference in management capital and its contribution to labour productivity growth between the two countries. However, a number of recent studies have focused on the quality of management capital as a potential explanation for Canada's lower productivity growth. Managers in Canada tend to have relatively lower educational attainment overall, in business education specifically, than their U.S. counterparts. Only 31% of managers in Canada hold a university degree versus 50% of managers in the United States (Martin and Milway 2005; OECD 2006). Martin and Milway (2005) argued that, the more educated managers are, the more likely they are to think innovatively and strategically and to operate more effectively. A survey of CEOs of growing R&D-intensive firms identified a dearth of sales, marketing, and management skills as a major weakness for their firms and the Canadian economy as a whole (OECD 2006).

This section examines the relationship between the quality of management capital and productivity growth across industries. If the talent of management matters for productivity growth, the industries with higher shares of managers who have a higher educational level (bachelor's degree or higher degree) would have the largest gains in multifactor productivity growth in two periods (the pre-2000 and post-2000 periods).

For this purpose, a cross-sectional regression that relates the change in multifactor productivity growth over two periods to the share of managers with educational attainment at the bachelor level or higher in total hours of all managers at the end of the first period is estimated:

$$\Delta \ln A_i^2 - \Delta \ln A_i^1 = \alpha + \beta M_i + \varepsilon_i , \qquad (8)$$

where the dependent variable is the change in multifactor productivity growth between two periods (1988-to-2000 and 2000-to-2008) in industry i. The control variables M include the share of mangers with a bachelor's degree or higher degree in the hours worked of all managers in industry i, and the share of managers in total hours worked of all individuals. This "difference-in-difference" specification has been used to examine the link between investment in information and in communication technologies and productivity growth (Oliner *et al.* 2007 and Stiroh 2002 for the United States; Gu and Wang 2004 for Canada).

The share of managers with a bachelor's degree or higher degree represents the share in year 2000, the year just before the period of decline in multifactor productivity growth. A positive coefficient β suggests that increases in the education qualification of management contribute to multifactor productivity growth. In other words, industries with a higher share of university-educated managers tend to experience less of a decline in multifactor productivity growth after 2000.

Table 7 presents the results from estimating equation (8) on the basis of a sample of Canadian industries at the North American Industry Classification System (NAICS) *p*-level of industry aggregation. The estimation results are obtained from a weighted least squares regression. The weights are nominal value added for the regression on value-added based multifactor productivity, and nominal gross output for the regression on gross-output based multifactor productivity. The equation is also estimated using an un-weighted regressions and results are similar. Data on multifactor productivity growth are obtained from the Multifactor Productivity Program of Statistics Canada. The data on shares of managers in labour income are obtained from the 2001 Census of Canada.[8]

Table 7
Results from regression relating changes in multifactor productivity growth to the education level of managers

	Value added				Gross output			
	Model 1		Model 2		Model 3		Model 4	
Dependent variables	**coefficient**	**standard error**	**coefficient**	**standard error**	**coefficient**	**standard error**	**coefficient**	**standard error**
Share of managers in hours	10.33 **	3.85	8.20	4.30	4.63 *	1.76	3.80	2.07
Share of managers with bachelor's degree or higher degree	...	...	-5.48	4.41	...	...	-2.81	2.36
Constant	-1.98 *	0.86	0.11	1.33	-0.86 *	0.35	0.16	0.70

	Value added		Gross output	
	Model 1	Model 2	Model 3	Model 4
Diagnostic statistics				
Number of observations	85	85	85	85
R-squared	0.04	0.09	0.03	0.09

* p<0.05
** p<0.01
Note: The change in multifactor productivity growth is the difference between the 2000-to-2006 period and the 1988-to-2000 period.
Source: Statistics Canada, authors' calculations.

The results are similar whether multifactor productivity growth based on gross output or multifactor productivity growth based on value added is used. The results show that the coefficient on the share of university-educated managers is not statistically significant. There is no evidence that an increase in the educational level of managers is positively associated with higher multifactor productivity growth. However, the coefficient on the share of managers in total hours worked is positive and statistically significant. This suggests that the industries with a higher share of managers in 2000 experienced less of a decline in multifactor productivity growth after 2000.

8. The data used in this paper show that managers with a bachelor's degree or higher degree accounted for 30% of the total hours worked by all managers and for 40% of the total labour income of all managers in the Canadian business sector. These results are consistent with those reported by Martin and Milway (2005).

6 Conclusion

This paper constructed a measure of intangible capital and examined the contribution of intangible capital to labour productivity growth in the Canadian business sector. The results were then compared with the results for the U.S. business sector.

Investment in intangibles was an estimated $150 billion in the Canadian business sector in 2008. This was about 66% of the level of all tangible capital investment. Total investment in intangible assets grew more rapidly than investment in tangibles over time. The ratio of intangible investment to tangible investment increased from 0.23 in 1976 to 0.66 in 2008. The largest component of intangible investment is economic competencies; this is followed by innovative property and software investment. R&D expenditures made up only a small portion of total intangible investment.

Intangible capital made a significant contribution to labour productivity growth, accounting for about 40% of the total capital-deepening effects in both the 1976-to-2000 and the 2000-to-2008 periods. Investment in innovative property and investment in economic competencies each contributed about 0.2 percentage points to 0.3 percentage points to annual labour productivity growth in the business sector. Investment in computerized information contributed 0.1 percentage points to annual labour productivity growth.

There was some decline in the growth of intangibles after 2000 in the Canadian business sector, but this decline was not a main factor behind the decline in labour productivity growth. The main source of the decline in labour productivity growth in Canada after 2000 remains the decline in multifactor productivity growth (for a possible explanation, see Baldwin *et al.* 2011).

The lower educational level of Canadian managers compared to their U.S. counterparts has been suggested as a main factor in Canada's lower multifactor productivity growth. The evidence shows that management plays a significant role in multifactor productivity growth. However, there is no empirical evidence that an increase in the educational level of managers is associated with higher multifactor productivity growth.

The research for Canada, the United States, and other countries all points to the importance of intangibles for economic growth and productivity growth in advanced countries. However, the measurement of intangibles presents formidable challenges. Some of those challenges are the same as those related to the capitalization of R&D, such as the choice of depreciation rates and investment price deflators. However, the measurement of intangibles poses additional challenges, chief among them being incomplete or imperfect data on business expenditures with respect to those intangible assets (e.g., training and firm-specific human capital, and management capital).

7 Appendix

7.1 Data sources and measurement of intangible investment

In this Appendix, the data sources and methods used to estimate investment and capital stock for each type of intangible are presented. Table 8 presents a summary of the data sources and methods.

Computerized information

The first category of intangibles, investment in computerized information is composed largely of computer software. Expenditures on computer software have been capitalized as investment in the National Accounts of Canada and are already included in gross domestic product (GDP) (Jackson 2002). Computer software included in the National Accounts consists of three types: pre-packaged software, custom software, and own-account software. Own-account software includes all in-house software development, whether for software to be used exclusively for internal company operations or for software to be marketed outside the company, such as a software program for widespread distribution developed by a firm. The National Accounts estimates of software investment for the business sector are used in this paper.[9]

Innovative property

The second category of intangibles is innovative property. Corrado *et al.* (2005, 2009) broadened the scope of innovative property beyond research and development (R&D) activities to include the development of new products and new scientific activities in a number of other industries (e.g., mining, finance, arts and entertainment, and architectural and engineering designs). These authors included six types of innovative property—scientific R&D, mineral exploration, copyright, and licence costs (i.e., the costs involved in developing new motion-picture films and other forms of entertainment and artistic originals), costs relating to the development of new products in the financial industry, new architectural and engineering designs, and R&D in social sciences and humanities.

The development of new products and new scientific activities that are not captured by R&D expenditures also takes place in industries other than finance, information and culture, and architectural and engineering designs; these are outlined in Corrado *et al.* (2005, 2009). In order to capture those innovative and scientific activities, the list of innovation property is extended to include two additional types of innovative property as in Baldwin *et al.* (2009): other own-account science and engineering expenditures; and other purchased science and engineering expenditures.

Science and engineering R&D

This category includes business expenditures on R&D. It also includes mining R&D (the development of new exploration techniques and associated research). In Canada, mining R&D is included in business expenditures on R&D. The data on business expenditures relating to R&D are obtained from the Science, Innovation and Electronic Information Division of Statistics Canada (CANSIM table 358-0001). These expenditures include the wages and salaries of scientists, purchased services, and capital expenditures for land, buildings, and machinery and equipment.

The business expenditure on R&D is adjusted before it is included as investment. First, capital expenditures for structures and equipment used to produce R&D are subtracted from total R&D expenditures. Those expenditures are included in the stock of fixed capital. Second, an estimate

9. The data on software investment is downloaded from CANSIM table 380-0026.

of the cost of capital used for R&D is added to the current R&D expenditures. The costs of using equipment and structures include the consumption of fixed capital and may include a return to the R&D capital.[10] Third, R&D imports are added to business expenditures on R&D, while R&D exports are subtracted from business expenditures on R&D.

Statistics Canada (2008) has published an R&D Satellite Account that provides an estimate of R&D investment with respect to the business sector for the 1997-to-2004 period. The R&D investment estimates in the satellite accounts are obtained from making those adjustments to the data on business expenditures on R&D.

For the purpose of this paper, the business expenditures on R&D are used as an estimate of R&D investment. There are a number of reasons for this choice. First, this paper covers a longer period than the period covered in the R&D Satellite Account. While the Satellite Account provides estimates for the 1997-to-2004 period, this paper covers the 1976-to-2008 period.

Second, the first two adjustments to R&D expenditures are often offsetting, and the overall impact on R&D investment estimates is negligible (Table 3 in Statistics Canada 2008). The adjusted R&D investment estimate is similar to the original estimates for business expenditures on R&D.

Third, the objective of this paper is to compare the results for Canada with the results for the United States. If R&D estimates from the satellite accounts are used, the results will not be comparable. The main difference is that business R&D investment for Canada in the Canadian R&D Satellite Account is based on the performance of R&D; it captures the amount of R&D that is performed by Canadian businesses. In contrast, R&D investment in the U.S. R&D Satellite Account is based on the funder of R&D. The U.S. R&D Satellite Account captures the amount of R&D funded by U.S. businesses. R&D performed by the business sector often exceeds R&D funded by the business sector, since R&D performed by the business sector is partially funded by the government.[11] As a result, the comparison of the business R&D investment from the satellite accounts of the two countries will bias results in favour of Canada.

There are additional differences between the methods for estimating R&D investment followed in the satellite accounts of the two countries. The estimates of the costs of capital that are included in R&D investment estimates in Canada and in the United States differ. The United States includes the consumption of fixed capital in R&D investment estimates, while Canada includes the consumption of fixed capital as well as a return to R&D capital in its estimate. Both Statistics Canada and the Bureau of Economic Analysis (BEA) eliminate a double counting of R&D expenditures contained in software investment in their R&D satellite accounts, since data on business expenditures on R&D in the two countries include the cost of developing software for resale. However, the method for eliminating the double count differs in the two countries. The BEA has removed that amount from the software investment estimate, retaining it in R&D investment. Statistics Canada has removed that amount from the R&D investment estimate and retained the amount in the software investment estimate.

As R&D investment estimates from the satellite accounts of the two countries are not entirely comparable, the data on business R&D expenditures for both Canada and the United States are used to compare R&D capital and its contribution to labour productivity growth in the two countries. This will also allow for a comparison of the Canadian results with the results for the

10. There is no consensus on whether a return to R&D capital should be included in total R&D investment. The BEA argues that the return to R&D capital is already captured in the returns in business income and that the cost of capital for R&D is the consumption of fixed capital (BEA 2006). Statistics Canada includes a return to R&D capital in the R&D investment estimates for its satellite account (Statistics Canada 2008).
11. The ratio of business-performed R&D to business-funded R&D for the United States was about 70% in 1981. This ratio declined over time as the share of business expenditure on R&D funded by the U.S. government declined. In 2008, the ratio of business-performed R&D to business-funded R&D was about 93%.

United States from Corrado *et al.* (2009), which use business expenditures on R&D from the U.S. National Science Foundation as their R&D investment estimate.

Mineral exploration

The expenditures that resource-based economies make on mineral exploration have characteristics that could also see them classified as intangible assets. These expenditures provide new information that is useful for production many years after they are incurred. Early-stage exploration expenditures are used to develop knowledge about where mineral resources are found and knowledge on the economic properties of the mineral or petroleum reserves. The expenditures on mineral exploration for a number of countries differ from the figures for mining R&D outlined in Corrado *et al.* (2005, 2009). The mining R&D is included in R&D investment estimates in Canada and in many other countries (e.g., Australia) (Barnes and McClure 2009).

Mineral exploration consists of all exploration, drilling, and geological and geophysical expenditures associated with the predevelopment stage of mineral and oil-and-gas extraction.

Mineral exploration has been capitalized in the Canadian System of National Accounts (CSNA) since 1997 as part of the revision to implement the recommendations set out in the *System of National Accounts 1993* (SNA 1993) (Inter-Secretariat Working Group on National Accounts 1993). The data on mineral exploration are taken from the Investment and Capital Stock estimates that feed into the National Accounts (Baldwin *et al.* 2009).

Costs relating to the development of new products in the financial services industry

The financial services industry as well as the information-sector industries—book publishers, motion picture producers, sound recording producers, and broadcasters—routinely research, develop, and introduce new products. However, there are no broad survey data on the resources they devote to these activities. Here, the Corrado *et al.* methodology (2005, 2009) is followed in order to estimate the costs of new-product development by the financial services industry as 20% of total intermediate purchases by that industry.[12] The data on the total intermediate purchases are taken from the input-output tables of Statistics Canada.[13]

New architectural and engineering designs

Corrado *et al.* (2005, 2009) estimate this intangible as half of total expenditures on architectural and engineering services by the business sector. In this paper, the Corrado *et al.* method is used in order to estimate this intangible as half of the expenditures on architectural, engineering, and related services (NAICS 5413).

The data on expenditures on architectural, engineering, and related services are available from the input-output tables of Statistics Canada for 1997 and subsequent years. For the pre-1997 period, the data are available only for the following industries: architectural services; engineering combined with other scientific services: and technical services. For years prior to 1997, earnings data from the Census of Population and the LFS are used to split the expenditures between architectural, engineering, and related services and other scientific and technical services.

12. The financial services industry includes Monetary Authorities (NAICS 521) and Credit Intermediation and related activities (NAICS 522).
13. The estimated costs of new-product development in the financial services industry may include R&D expenditures for that sector. Some R&D expenditures in the finance services sector may be double-counted in the costs of new-product development.

Other product-development and science-related expenditures

Corrado *et al.* (2005, 2009) also include as part of expenditures on innovative property, the costs of product development in the information sector (motion picture industry, radio and television, sound recording industry, and book publishing industry) and R&D expenditure in the social sciences and humanities. Baldwin *et al.* (2009) argued that the development of new products and new scientific activities—primarily in the area of applied engineering—also take place in other industries. The expenditures on those scientific activities are not captured in R&D statistics. In this paper, the other product-development and science-related expenditures are included under innovative property. Baldwin *et al.* (2009) distinguished between two types of science-related activities: own-account science and engineering services; and purchased science and engineering services.

Own-account science and engineering expenditures consist of wages and salaries of scientists and engineers in each year. This category is created from occupational data on scientists taken from the Census of Population and the LFS. The category consists of total labour compensation of all scientists minus the wage component that is already included in expenditures for R&D and software.

To avoid double-counting with other categories of intangibles, scientists and engineers in the following industries are excluded: financial services (NAICS 521); architectural, engineering, and related services (NAICS 5413); management, scientific, and technical consulting services (NAICS 5416); scientific research and development services (NAICS 5417); advertising and related services (NAICS 5418); and other professional, scientific, and technical services (NAICS 5419). The product-development costs and science-related expenditures in those industries are captured in other categories of intangible capital. For example, own-account science and engineering expenditures in the financial services industries are included in estimates of new-product development costs in the financial services industry.

It can be argued that a portion of these costs are current expenses rather than investment. For this paper, it is assumed that only 20% of those other own-account science and engineering expenditures (or labour compensation of scientists and engineers) are investment. The remaining 80% are classified as current expenses. The 20−80 split between investment and current expenses for expenditures on scientists and engineers is the same as the split for the value of managers' time between investment and current expenses.

The purchased-science-and-engineering expenditures are estimated as 50% of business expenditures on scientific R&D services (NAICS 5417) and as 50% of the expenditures in other professional, scientific, and technical services (NAICS 5419).[14] The 50%−50% split between investment and current expenses is the same as the split that Corrado *et al.* (2005, 2009) used for new architectural and engineering designs.

The data on total expenditures are not available for the individual four-digit NAICS industries (NAICS 5417 and 5419) used to estimate the expenditures on purchased science and engineering. They are available only for more aggregated industries. Once again, the labour compensation data from the censuses and the LFS are used to allocate the aggregate gross output data to those NAICS four-digit industries.

14. Other professional, scientific, and technical services (5419) include marketing research, photographic services, translation and interpretation services, veterinary services, and other professional, scientific, and technical services. It is assumed that 50% of total expenditures in that category are related to science and engineering activities.

Economic competencies

Corrado *et al.* (2005, 2009) define economic competencies as the value of brand names and other knowledge embedded in firm-specific human and structural resources. Corrado *et al.* include three types of assets in economic competencies: brand names, firm-specific human capital, and organizational structure.

Brand equity

Spending on brand equity is provided by expenditures on advertising and market research. Those expenditures provide firms with a reputation which, if extended beyond the present, has an impact on the value of the firm and should be considered an investment in intangibles. Such expenditures provide brand value that has long been recognized as a valuable intangible asset.

Expenditures on advertising are obtained from the input-output tables of Statistics Canada. Total expenditures on advertising services were much higher than the gross output of advertising and related services industries (NAICS 5418), since advertising services are often produced in industries other than advertising industries. In 2006, total expenditures on advertising services were about four times the gross output of the advertising industry. Previous studies that used the gross output of the advertising industries underestimated the total spending in that category.

Expenditures on market research are combined with the expenditures on other professional, scientific, and technical services in the input-output tables. That spending is included in other product-development and science-related expenditures. A separate time series for spending on market research was not available for Canada.

Like Corrado *et al.* (2005, 2009), this paper assumes that 60% of total advertising expenditures are for advertising that had long-lasting effects. These are included as investment. The remaining 40% of this type of expenditure are considered current expenses.

Firm-specific human capital

Corrado *et al.* (2005, 2009) estimated spending on firm-specific human capital from the costs of employer-provided workplace training. The costs of employer-provided training are obtained from the Workplace and Employee Survey (WES), conducted by Statistics Canada, for the years from 1999 to 2005. The WES is designed to represent the workplaces in Canada for odd years, as the sample is refreshed with birth units in order to maintain a representative sample of workplaces in those years (while this is not the case for even years). Business expenditures on workplace training are estimated at $30 billion per year for the odd years 1999, 2001, 2003, and 2005. The total spending obtained from the WES includes direct firm expenses (outlays on instructors, tuition reimbursements, and the like) and, in most cases, also includes the wage and salary costs of employee time spent in formal and informal training.[15]

Training expenditures for other years are extrapolated by using the labour compensation of scientists, engineers, and managers obtained from the Census of Population and the LFS. The extrapolation method is chosen, since previous studies show that training tends to be disproportionately taken by managers and professionals (Dostie and Montmarquette 2007). The ratio of training expenditures to labour compensation of managers and professionals is more or less constant across the years 1999, 2001, 2003, and 2005, for which data on training expenditures are available.

15. The estimate of the costs of workplace training for Canada used in this paper appears to be low compared with estimates for other countries. One possible explanation is that the reported costs of training in the WES do not fully reflect the cost of forgone earnings (O'Mahony 2010).

Organizational capital

Investment in this type of intangible, together with firm-specific human capital, is found to be an important co-investment associated with investment in information and communication technologies for boosting firms' productivity growth (Oliner *et al.* 2007; Gu and Gera 2004). Investments in organizational change and development have both own-account and purchased components.

Corrado *et al.* (2005, 2009) estimated the own-account component of organizational capital as 20% of the value of executive time by using BLS data on employment and wages for executive occupations. In this paper, a similar approach is followed, and own-account investment in organizational capital is estimated as 20% of the labour compensation of managers in the business sector.

The data on the labour compensation of managers are obtained from the occupation data included in the Census of Population and the LFS. The labour compensation of managers is estimated as the hours worked times the hourly labour compensation of managers. The total hours worked of managers for the 1976-to-2009 period are estimated from the LFS, and the hourly labour compensation is estimated from the Census of Population. The data on hours worked and labour compensation are benchmarked to the data in the CSNA.

The LFS provides data for workers based on the National Occupational Classification for Statistics (NOC-S) occupation classification for the period from 1987 onward. It also provides data for workers based on the Standard Occupation Classification (SOC) for the 1976-to-1998 period. The two series are linked to form a consistent time series on hours worked by managers (A0 to A39 as defined by the NOC-S) for the 1976-to-2008 period.

The Census of Population provides data on the hourly labour compensation of managers. The Census of Population classifies workers according to the National Occupational Classification (NOC) for the 2001 and 2006 census years and according to SOC-1991 for 1991 and 1996. The NOC and SOC-1991 employ a similar definition of managers. However, for the years 1981 and 1986, the Census of Population uses the SOC occupation classification and provides data on managers combined with administrators; this definition is broader than the manager occupation in NOC and SOC-1991. Those series are linked in order to form a consistent time series on the hourly compensation of managers.

Corrado *et al.* (2005, 2009) estimate the purchased component of organizational capital as the revenues of the management consulting services industry. This component of organizational capital for Canada is estimated as total expenditures on management consulting services. Separate expenditure estimates are not available for this category. Instead, the expenditure estimates are available for more aggregated categories. Once again the labour compensation data from the Census of Population and the LFS are used to allocate the aggregate expenditure estimates to that more detailed expenditure category.

Table 8
Data sources and assumptions used to construct investments and stocks of intangible assets

Type of intangible	Investment share	Depreciation rate
	ratio	**percent**
Computerized information		
Computer software[1]	1.0	33.0
Innovative property		
Scientific and engineering research and development[2]	1.0	20.0
Mineral exploration and evaluation[3]	1.0	13.4
Development costs in the financial services industry[4]	1.0	20.0
New architecture and engineering design[5]	1.0	20.0
Own-account other science and engineering services[6]	1.0	20.0
Purchased other science and engineering services[7]	1.0	20.0
Economic competencies		
Advertising[8]	0.6	60.0
Firm-specific human capital[9]	1.0	40.0
Organizational capital		
Purchased[10]	0.8	40.0
Own-account[11]	1.0	40.0

1. Main data source: System of national accounts.
2. Main data source: Statistics Canada research-and-development surveys.
3. Main data source: Investment capital expenditure surveys.
4. Main data source: 20% of all intermediate purchases by the finance industry.
5. Main data source: 50% of total expenditures on architectural, engineering, and related services. Input-output tables and household surveys.
6. Main data source: 20% of the compensation of scientists and engineers in industries other than the finance and business services industries, net of labour costs included in research-and-development expenditures. Input-output tables and household surveys.
7. Main data source: 50% of total expenditures on scientific research-and-development services. Input-output tables and household surveys.
8. Main data source: Total expenditures on advertising services. Input-output tables.
9. Main data source: Training costs, including direct firm expenses and wage-and-salary costs for employees. Workplace and employee surveys.
10. Main data source: Total expenditures on management consulting services. Input-output tables and household surveys.
11. Main data source: 20% of compensation of managers in the business sector. Household surveys.

Source: Corrado, Hulten and Sichel (2009).

Table 9
Annual growth rates of investment in tangibles and intangibles, Canada

Categories	1976 to 2008	1976 to 2000	2000 to 2008
		percent	
Tangible assets (excluding software and mining exploration)	4.1	3.8	5.0
ICT[1] (excluding software)	14.6	16.6	8.6
Non-ICT[1] (excluding mining exploration)	2.6	2.0	4.4
Intangible assets	6.4	7.4	3.2
Computerized information	11.9	12.9	8.9
Scientific and engineering research and development	6.0	7.9	0.4
Mineral exploration and evaluation	6.4	7.8	2.3
Development costs in financial industry	4.8	6.1	0.7
New architecture and engineering design	4.4	5.1	2.3
Own-account other science and engineering services	0.3	-1.6	5.9
Purchased other science and engineering services	7.7	8.6	4.8
Advertising	3.8	4.8	0.7
Firm-specific human capital	4.7	5.9	1.3
Purchased organizational capital	10.2	12.3	4.0
Own-account organizational capital	5.4	6.1	3.4

1. ICT refers to Information and Communications Technology.
Source: Statistics Canada, authors' calculations.

Table 10
Annual growth rates of capital stock of tangibles and intangibles in Canada

Categories	1976 to 2008	1976 to 2000	2000 to 2008
		percent	
Tangible assets (excluding software and mining exploration)	2.5	2.5	2.6
ICT[1] (excluding software)	11.8	12.8	8.7
Non-ICT[1] (excluding mining exploration)	2.2	2.2	2.4
Intangible assets	6.8	7.3	5.3
Computerized information	12.4	13.7	8.5
Scientific and engineering research and development	7.3	8.4	3.8
Mineral exploration and evaluation	8.1	8.1	8.2
Development costs in financial industry	5.9	6.8	3.1
New architecture and engineering design	4.4	4.8	3.4
Own-account other science and engineering services	0.0	-0.2	0.5
Purchased other science and engineering services	8.0	7.6	9.4
Advertising	4.0	5.0	1.1
Firm-specific human capital	5.2	6.4	1.8
Purchased organizational capital	10.8	11.9	7.5
Own-account organizational capital	5.9	6.7	3.3

1. ICT refers to Information and Communications Technology.
Source: Statistics Canada, authors' calculations.

Table 11
Differences in intangible capital deepening effect between Canada and the United States

Categories	Mid-1970 to 1995 [1]	1995 to 2003
	percent	
Canada		
Intangible capital deepening	0.4	0.7
Computerized information	0.1	0.1
Innovative property	0.1	0.2
Economic competencies	0.2	0.4
Brand equity	0.0	0.1
Firm-specific resources	0.2	0.4
United States		
Intangible capital deepening	0.4	0.8
Computerized information	0.1	0.3
Innovative property	0.1	0.2
Economic competencies	0.2	0.4
Brand equity	0.0	0.1
Firm-specific resources	0.1	0.3
Canada minus United States		
Intangible capital deepening	0.0	-0.1
Computerized information	0.0	-0.2
Innovative property	0.0	0.0
Economic competencies	0.0	0.1
Brand equity	0.0	0.0
Firm-specific resources	0.0	0.1

1. The period covers 1976 to 1995 for Canada and 1973 to 1995 for the United States.
Source: Statistics Canada, authors' calculations.

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