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Abstract

It is widely recognized that Canada lags the United States (U.S.) in labour productivity level and the gap increased significantly since 1996, especially in the manufacturing sector. Lower capital intensity in Canada contributes to the productivity gap directly and indirectly. This paper examines the sources of the intensity gaps for total capital [including structures and machinery and equipment (M&E)], M&E capital and ICT (information and communications technology) capital between Canada and the U.S. A Bennet-type decomposition of the aggregate Canada-U.S. capital intensity gap suggests that the elimination of the differences in industrial structure between the two countries would have actually increased the capital intensity gap for total and M&E capital. On the other hand, the industrial structure accounted for a small part of the ICT capital intensity gap. This paper then creates a panel data set (18 years, 41 industries) to investigate key factors that might be responsible for the capital intensity gaps. The panel regression results suggest that differences in investment prices (including the real exchange rates), real wage rates, human capital, research and development, and business cycles all have a significant impact on the Canada-U.S. capital intensity gap.

Key words: capital intensity gap, M&E capital, ICT capital, real wage rate

Résumé

On sait que le Canada accuse un retard sur le plan de la productivité du travail par rapport aux États-Unis et que ce retard s'accentue sensiblement depuis 1996, surtout dans le secteur de la fabrication. La plus faible intensité de capital au Canada contribue directement et indirectement à l'écart de productivité. Les auteurs ont examiné les sources des écarts d'intensité pour l'ensemble du capital (y compris les structures et les machines et le matériel [M&M]), le capital pour les M&M et le capital pour les TIC (les technologies de l'information et des communications) entre le Canada et les États-Unis. Selon une décomposition de type Bennet de l'écart total au chapitre de l'intensité du capital entre le Canada et les États-Unis, il semble que l'abolition des différences relatives aux structures industrielles entre les deux pays aurait eu pour effet de creuser l'écart d'intensité du capital pour ce qui est du capital total et du capital pour les M&M. Par contre, la structure industrielle n'intervient que pour une petite part de l'écart d'intensité du capital pour les TIC. Les auteurs ont ensuite créé un ensemble de données longitudinales (18 ans, 41 industries) pour cerner les principaux facteurs qui pourraient être à l'origine des écarts d'intensité du capital. Les résultats de l'analyse de régression des données laissent supposer que les différences qui existent dans les prix des investissements (y compris les taux de change réels), les taux salariaux réels, le capital humain, la R-D et les cycles économiques sont des facteurs qui ont tous une incidence considérable sur l'écart d'intensité du capital entre le Canada et les États-Unis.

Mots clés : écart d'intensité du capital, capital pour les M&M, capital pour les TIC, taux salarial réel

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1. Introduction

It is widely recognized that Canada lags the U.S. in productivity performance. The most recent OECD estimates for the total economy (Table 1) show that Canada's GDP per capita and labour productivity (GDP per hour worked) were 79 percent and 76 percent of the U.S. level in 2004, respectively. In addition, Canada's labour productivity level (GDP per worker) gaps in both the total business sector[1] and the manufacturing sector have been increasing significantly since 1996 (Figure 1 and Figure 2). In the manufacturing sector, the battleground for fierce international competition, the increase in the Canada-U.S. productivity level gap was more dramatic from around 12 percent in 1987 to more than 40 percent in 2004. Past researches indicate that the Canada-U.S. labour productivity level gap is persistent, widening and pervasive across industries (for example, Rao, Tang and Wang (2004)). Physical capital and total-factor productivity (TFP thereafter) are the two sources of labour productivity. Canadian industries have lower capital intensity (capital-labour ratio), especially M&E capital, relative to their U.S. counterparts (Table 2 and Table 3). Such a capital intensity gap contributes significantly to the labour productivity gap between the two countries, not only directly (Table 2) but also indirectly through the TFP channel .[2]

This paper attempts to explore why Canadian industries are less capital-intensive in production than their U.S. counterparts. The analysis is based on the economic theory of production with profit maximizing producers. According to the theory, capital intensity is mainly determined by the cost of capital relative to labour. When capital is more expensive relative to labour, a profit-maximizing firm would choose to use more labour and less capital in its production.

There are many factors directly affecting the user cost of capital, including real interest rate, real exchange rate, and taxes. This means that these factors influence investment decisions and may play an important role in the Canada-U.S. capital intensity gap. Higher real interest rate may discourage investment due to higher borrowing cost, while cheaper Canadian dollar (relative to the U.S. dollar) may reduce M&E investment in Canada because a significant proportion of M&E in Canada is imported[3]. Canada-U.S. differences in tax rates on investment[4] could also impact the capital intensity gap.

In addition, technology is often embodied in new physical capital (especially in M&E capital). An effective use of new capital also requires highly skilled labour.[5] Canada-U.S. differences in

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[1] The term "business sector" used in this paper is defined as NAICS-based all industries excluding education service (NAICS 61), health service (NAICS 62) and public administration (NAICS 91).

[2] Rao, Tang and Wang (2006) find that the Canada-U.S. M&E capital intensity gap is the major contributor to the Canada-U.S. TFP level gap.

[3] The impact of Canada-U.S. bilateral exchange rate on relative capital investment cost between the two countries is implicitly included in the relative investment price. It assumes a full pass through between the changes in exchange rate and investment price.

[4] Mintz (2001) shows that the effective tax rate on capital investment is much higher in Canada than in the U.S. and this discourages capital investment in Canada. Clark (1993) identifies that tax changes were an important determinant of business investment in the U.S. during 1953-1992.

[5] For evidences on the capital-skills complementarity, see Flug and Hercowitz (2000), Duffy et al. (2004), Papageorgiou and Chmelarova (2005), and Krusell et al (2000). For evidences on the capital-R&D complementarity, see Bernstein and Nadiri (1984), Lach and Schankerman (1989), Lach and Rob (1996), Nickell and Nicolitsas (1996), Baussola (2000) and Chiao (2001).

industrial structure and firm size[6] could also be the contributing factors to the capital intensity gap. Furthermore, in the short-run, investment is also affected by business cycle[7].

This paper addresses the following five specific research questions:

- *How much of the Canada-U.S. capital intensity gap can be explained by the differences in the industrial structure in the two countries?*
- *Do investment prices and labour costs play an important role in explaining the Canada-U.S. capital intensity gap?*
- *Does a higher real interest rate discourage capital investment in Canada and hence increase the Canada-U.S. capital intensity gap?*
- *Are physical capital and human capital complements?*
- *Do R&D activities stimulate or discourage the use of physical capital?*

This paper first uses a Bennet-type decomposition to examine whether the Canada-U.S. capital intensity gap at the business sector level can be explained by differences in industrial structure between the two countries. It is found that in 2004 the Canada-U.S. total capital intensity gap would be about 13 percentage points wider and the M&E capital intensity gap would increase by about 10 percentage points in the business sector if the two countries had the same industrial structure.[8] Thus, in terms of capital deepening, the industrial structure was actually more favourable to Canada than to the U.S.

All other questions are addressed through panel regressions. The empirical analysis shows that the real wage rate gap is the dominant source of the total and M&E capital intensity gaps between Canada and the U.S. As the data on investment price levels are not readily available, this paper uses investment price indices instead, which only allows us to capture the impact of investment price trends on changes in the capital intensity gap over time. The result indicates that a higher investment price in Canada relative to the U.S. will lead to a lower capital intensity in Canada relative to the U.S. Physical capital and human capital are found to be complements. The skills gap is an important contributor to the ICT[9] and M&E capital intensity gaps. Physical capital and R&D are also found to be complements, but the contribution of the R&D gap to the capital intensity gaps is quite small.

The rest of the paper is organized as follows. Section 2 provides an overview on the Canada-U.S. capital intensity gap at both the aggregate and industry levels. Section 3 investigates the impact of the difference in industrial structure on the capital intensity gap using a Bennet-type decomposition method. Section 4 discusses what factors might have an impact on capital

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[6] Sharpe (2005) argues that the industry structure difference between Canada and the U.S. and a relatively smaller firm size in Canada contributed significantly to the information and communications technology (ICT) investment per worker gap between the two countries. This paper investigates the impact of the industry structure differences on the Canada-U.S. capital intensity gap using a Bennet-type decomposition for the three types of capital: total, M&E and ICT. It is unable to quantify the impact of the firm size differences on the capital intensity gap because of lack of data.

[7] Clark (1993) finds that output changes were the most important short-run determinant of business investment in the U.S. during 1953-1992.

[8] Total capital in this paper consists of M&E and structures capital.

[9] ICT capital has three types of assets: computers, communication equipment and software.

investment. The regression model and the estimation results using a panel data set are presented in Section 5. Section 6 concludes.

2. Recent trends in the Canada-U.S. capital intensity gap

This section provides a brief overview of trends in the Canada-U.S. capital intensity level gaps for total capital, M&E capital and ICT capital. Capital intensity is defined in this paper as non-residential capital stock per worker.[10] The value of capital stock for Canada is converted into U.S. dollars using total investment PPPs (for total capital) and M&E investment PPPs (for M&E and ICT capital) from Rao, Tang and Wang (2004).

Notice that the labour input used in this paper to measure capital intensity is number of workers instead of hours worked. Number of workers may be better than hours worked when capital intensities are aimed to measure how much capital can be used per worker when he or she is at work since more hours worked per worker does not imply that less capital is available to a worker.[11]

Canada-U.S. capital intensity ratios for total, M&E and ICT capital for the total business sector are presented in Table 2. Total capital intensity in the Canadian business sector was 89 percent of the U.S. level in 2004, down from 99 percent in 1995. The capital intensity gap is much bigger in terms of M&E and ICT capital. The M&E capital intensity for the business sector in Canada was only 56 percent of the U.S. level in 2004, dropped from 60 percent in 1995. For ICT capital, the relative intensity was 0.51 in 1995 and 0.45 in 2003. Figure 3 depicts Canada-U.S. relative capital intensity trends in the total business sector for total capital, M&E capital and ICT capital for the period of 1987 to 2004. All three capital intensity gaps are trended down prior to 1995 and increases there after. These figures suggest that all three measures of Canada-U.S. capital intensity gap in the total business sector have been widening since late 1990s.

The Canada-U.S. capital intensity gap is pervasive across industries. Table 3 presents the Canada-U.S. gap for total capital for 32 NAICS based industries. Only three Canadian industries (Mining, Wood and Paper) have persistently higher total capital intensity than their U.S. counterparts. In addition, two other Canadian industries (Utility and Petroleum & Coal manufacturing) have more or less the same total capital intensity as their U.S. counterparts. Note that all of them are resource-based industries. In contrast, in high-tech manufacturing industries (such as Machinery, Computer & Electronic, and Electrical Equipments), trade industries, and some business services industries (Professional and Administrative services), total capital intensity in Canada is much lower than in the U.S. For example, in 2004, total capital intensity in Machinery and Computer & Electronic industries in Canada was only 21 percent and 28 percent, respectively, of the corresponding U.S. levels. In 15 of 32 industries, Canadian capital

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[10] Non-residential capital stock and employment data are from Statistics Canada and the U.S. Bureau of Economic Analysis. Some compilation has been done based on the source data for comparison purpose.

[11] Capital intensity is still under-estimated when using number of workers due to the fact that not all workers work at the same time (e.g., an assembly manufacturing with three shifts). Such "bias" may not be a problem for country comparisons at the industry level if the industry operation in the two countries is similar.

intensity was less than 50 percent of the U.S. levels in 2004, and 25 Canadian industries experienced a widening of the capital intensity gap since 1995.

The situation is similar but more acute for M&E and ICT capital. As shown in Table 4, Paper and Wood industries are the only two industries in which Canada has persistently higher M&E capital intensity than the U.S. Even so, the Canada's advantage in these two industries has been dropping dramatically since 1995. In all other industries, Canada's M&E capital intensities are not even close to the corresponding U.S. levels. In 2004, Canada's M&E capital intensities were less than 50 percent of the U.S. levels in 20 industries and less than 20 percent of the U.S. levels in five industries including Machinery, Computer & Electronic and Wholesale Trade. The M&E capital intensity gap has widened in 19 industries since 1995. For ICT capital, there is no industry in which Canada has persistently a higher ICT capital intensity than the U.S. In 2003, the Canadian industry with the highest ICT capital intensity relative to the U.S. was Other Private Services (0.81), followed by Utility (0.73). In eight industries Canada's ICT capital intensity was less than 20 percent of the U.S. level.

3. The Canada-U.S. capital intensity gap at the aggregate level: The role of industrial structure

All other things remaining constant, differences in industrial structure between Canada and the U.S. could contribute to the aggregate capital intensity gap. This section employs a Bennet-type decomposition method to estimate the contribution of the differences in industrial structure to the business sector capital intensity gap.

Let K, L, and k be real capital stock, employment and capital intensity at the aggregate level. Capital intensity is defined as capital-to-labour ratio, i.e., $k \equiv K/L$. Suppose capital stock is additive across industry, so capital intensity at the aggregate level becomes weighted sum of industry capital intensities (k_i), using their employment share (l_i) as the weights, i.e.,

(1) $$k = \sum_i l_i k_i$$

After some algebra, the Canada-U.S. capital intensity gap at the aggregate level can be written as

(2) $$k^{US} - k^{CA} = \sum_i \frac{l_i^{US} + l_i^{CA}}{2}\left(k_i^{US} - k_i^{CA}\right) + \sum_i \frac{k_i^{US} + k_i^{CA}}{2}\left(l_i^{US} - l_i^{CA}\right)$$

This is a Bennet-type decomposition. The first term on the right hand side of (2) is the contribution of the Canada-U.S. capital intensity gap at the industry level, which is a weighted sum of the industry capital intensity gaps with the weights being the average of the two countries' employment shares. The second term is the contribution of the difference in industrial structure between the two countries, which is a weighted sum of the differences in employment shares, with the weights being the average industry capital intensities of the two countries. Thus, equation (2) decomposes the Canada-U.S. capital intensity gap into two effects: the *intensity effect* and the *structure effect*. The *intensity effect* captures the contribution of the differences in industrial capital intensity with industrial structure controlled, and the *structure effect* captures the contribution of the differences in industrial structure with industrial capital intensity controlled.

This paper uses the formula (2) to examine the Canada-U.S. total, M&E and ICT capital intensity gaps in manufacturing and the total business sector. The results are presented in Table 7. As shown in the table, the industrial structure differences have contributed negatively to the Canada-U.S. total and M&E capital intensity gaps in the business sector. In other words, Canada-U.S. total and M&E capital intensity gaps would be larger if Canada had the same industrial structure as the U.S. in terms of employment. In this case, in 2004, the total capital intensity gap in the business sector would increase by12.8 percentage points and the M&E capital intensity gap would increase by 6.9 percentage points. The contribution of the industrial structure differences for employment to the total and M&E capital intensity gaps at the aggregate manufacturing sector was large during late 1980s and early 1990s, but has trended down dramatically since 1995. In 2004, the contribution of industrial structure differences to the Canada-U.S. M&E gap in the manufacturing sector was actually positive (0.2 percentage points), although very small. The results are similar to the findings by Rodriguez (2006) that shows that the industrial structure differences did not contribute significantly to the Canada-U.S. gap in M&E investment-to-GDP ratio.

The reason for the negative contribution of the industrial structure differences to the total and M&E capital intensity gaps between Canada and the U.S. is that those industries with higher employment shares in Canada than in the U.S. are, on average, more capital intensive than all other industries. For example, in 2004, the total capital intensity in mining and utilities industries is much higher than in all other industries in both Canada and the U.S. (see Table 5) and their employment shares in the business sector are quite higher in Canada than in the U.S. (see Table 6). As a result, almost all of the industrial structure effect comes from these two industries. Without the contribution to the industrial structure effect from the two industries, the contribution of the industrial structure differences to the Canada-U.S. total capital intensity gap would be only –0.5 percentage points instead of –12.8 percentage points.

The results for the ICT capital intensity gap are somewhat different. The results in Table 7 show that Canada has lower ICT capital intensity relative to the U.S. partly because of the industrial structure differences in the two countries. The contribution of industrial structure differences to the business sector ICT capital intensity gap was 13.7 percentage points in 1987 and trended down to 0.1 percentage points in 2003. For the manufacturing sector, the contribution was 4.9 percentage points in 1987 and increased to 9.8 percentage points in 2003.

4. The determinants of the Canada-U.S. capital intensity gap

The standard production theory suggests that capital intensity is negatively correlated with the price ratio of capital-to-labour. Producers would use more capital if its price becomes cheaper relative to labour cost. In addition, due to the embodiment of technologies in new capital, especially in new M&E and ICT capital, skilled workers and R&D activities are complements to physical capital.

4.1. Cost of capital services

Calculating the cost of capital services is quite complicated. Feldstein and Flemming (1971) decompose the user cost of capital into three components: the price of capital goods, tax variables and the interest rate. As shown in Jorgenson and Yun (1991), the user cost of capital services is proportional to the price of new investment goods, and is affected by the real interest rate, the depreciation rate and tax related factors such as corporate income taxes, investment tax credits and capital consumption allowances.

The price of new investments is the major determinant of capital cost. It implicitly includes the impact of exchange rates through price changes in imported capital goods and the impact of investment tax incentives[12]. It has been shown that the price of investment goods has a significant impact on capital formation. For example, the estimated long-run price elasticity of M&E capital is –0.9 in Schaller (2005).

A higher level of taxation imposed on capital investment in Canada than in the U.S. might be an important reason for the Canada-U.S. capital intensity gap, because a higher tax rate on capital will reduce the real return to capital and hence discourages capital investment. As shown in Table 8, the effective tax rates on capital are considerably higher in Canada relative to the U.S. for most industries and at the aggregate level, which implies that, as claimed by Chen and Mintz (2003a), Canada's ability to attract more investment and adopt new technology is impeded by its tax system.

The real interest rate indicates the opportunity cost of capital investment. Higher opportunity cost in Canada may discourage capital investment in Canada, compared to the U.S. Figure 4 shows that the real interest rate was higher in Canada than in the U.S. in most years during the period of 1987 to 2003, which could have partly contributed to the Canada-U.S. capital intensity gap.

4.2. Cost of labour

Under the assumption that capital and labour are substitutable, producers would use more labour if it becomes cheaper relative to capital, leading to lower capital intensity. This paper uses the real wage rate to measure the labour cost. As shown in Table 2, in 2003, the real wage rate in Canada was 73 percent of the U.S. level for the total business sector, and the gap persisted during the sample period. Table 10 shows that the real wage gap is pervasive across all industries except in three industries: Agriculture, Construction, and Wood Manufacturing.

4.3. Skills

The capital-skill complementarity hypothesis has been well discussed and documented in the literature since Grilliches (1969). The hypothesis suggests that capital and skilled labour are more complementary than are capital and unskilled labour. Many empirical evidences support the hypothesis (Flug and Hercowitz (2000), Duffy et al. (2004), Papageorgiou and Chmelarova

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[12] Goolsbee (1998) shows that much of the benefit of investment tax incentives does not go to investing firms but rather to capital suppliers through higher prices.

(2005), and Krusell et al (2000)). On the other hand, Goldin and Katz (1998) suggest that the capital-skill complementarity may be just a transitory phenomenon.

New technologies are usually skill-biased and many of them are embodied in new M&E capital. Hence the use of new capital involves technology adoption and raises demand for skills. The increase in skill or education premium in many countries is considered to be a result of the skill upgrading process due to the adoption of skill-biased technology. This implies that skills are important for the use of new capital, and hence encourage capital investment. Krusell et al (2000) find that the capital-skill complementarity is the main source of the skill premium.

Measuring skill levels is not easy. This paper follows the tradition in the literature (see Duffy et al. (2004)) and uses educational attainment to differentiate between skilled and unskilled workers. More specifically, it uses the share of workers with university degree in total hours to indicate skills levels by industry in both Canada and the U.S. As shown in Table 2 and Table 10, Canadian industries use less skilled workers than their U.S. counterparts. The Canada-U.S. skill gap was about 32 percent for the total business sector in 2000, and the gap is persistent and pervasive across industries.

4.4. R&D activities

The causal link between innovation and M&E investment has been investigated since Schumpeter (1939). Successful innovations will derive physical investment subsequently because (1) knowledge generated by R&D activities will be used in producing new capital as emphasized in new growth theory (see Romer (1990) and Grossman and Helpman (1991)); (2) the implementation of R&D output requires more capital investment; and (3) R&D activities can improve firms' ability to adopt new technologies and use new capital more efficiently. Many empirical studies suggest that there is a link between R&D and physical capital. For example, Bernstein and Nadiri (1984) find that physical capital and R&D capital are complements; Lach and Schankerman (1989), Lach and Rob (1996), Nickell and Nicolitsas (1996), Baussola (2000) and Chiao (2001) demonstrate that R&D induces investment in physical capital.

This paper will investigate the impact of the R&D intensity (defined as R&D expenditure as a share of GDP) gap on the capital intensity gap between Canada and the U.S. As shown in Table 2 and Table 10, the R&D intensity gap between Canada and the U.S. is large, persistent and pervasive across industries.

4.5. Capacity utilization

Output and factor inputs fluctuate due to business cycle. Capacity utilization is pro-cyclical but adjusts less frequently than labour input (see Nakajima (2005) and Baxter and King (1991)). This implies that capital intensity is counter-cyclical. To capture the cyclical effect, this paper uses a percentage deviation of industry value-added from trend as an explanatory variable in the regression model.

5. Regression results

This section uses a panel dataset to explore the possible impact of the factors discussed in the previous section on the Canada-U.S. capital intensity gap. The panel dataset is mainly based on the information from Statistics Canada and the U.S. Bureau of Economic Analysis. Other data sources include Dale Jorgenson of Harvard University for the share of hours worked by workers with university degree and above in total hours worked in the U.S. industries, the U.S. National Science Foundation and the U.S. Agriculture Department for the data on the U.S. R&D spending, and the OECD outlook for the short-term nominal interest rates for both Canada and the U.S. The dataset covers the period of 1987 to 2004 and includes 41 industries.

The regression model used for our analysis is:

(3)

$$\ln(k_{i,t}^{s}) = \sum_{l_1=0}^{L_1} \beta_1^{l_1} \ln(invp_{i,t-l_1}^{s}) + \sum_{l_2=0}^{L_2} \beta_2^{l_2} \ln(wage_{i,t-l_2}) + \sum_{l_3=0}^{L_3} \beta_3^{l_3} \ln(skill_{i,t-l_3}) + \sum_{l_4=0}^{L_4} \beta_4^{l_4} \ln(RD_{i,t-l_4}) + \sum_{l_5=0}^{L_5} \beta_5^{l_5} rin_{t-l_5} + \beta_6 capa_{i,t} + \alpha \text{ (or } \sum_{j=1}^{9} \delta_j D_{i,j}) + \varepsilon_{i,t}$$

The dependent variable (k) is the Canada-U.S. relative capital intensity. The superscript (s) refers to total, M&E, or ICT capital, and the subscripts (i and t) represent industry and time, respectively. L is the number of years of lagging for different variables.

The six explanatory variables are: the Canada-U.S. relative investment price index ($invp$); the Canada-U.S. relative real wage rate ($wage$); the Canada-U.S. relative skills ($skill$); the Canada-U.S. relative R&D intensity (RD); the Canada-U.S. difference in the short-term real interest rates (rin); and the Canada-U.S. difference in capacity utilization ($capa$)[13]. The implicit price index of investment is used as the investment price index. The real wage rate is defined as total labour compensation per worker, deflated using GDP deflator. The Canadian real wage rate is converted into US dollar using the aggregate GDP PPP. This paper uses education attainment to proxy skills. Skills variable used in this paper is the share of hours worked by workers with university degree and above in total hours worked. R&D intensity is defined as R&D spending to industry value-added ratio. The short-term real interest rate is equal to the short-term nominal interest rate minus inflation rate estimated using Consumer Price Index (CPI). The capacity utilization is proxied using the percentage deviation of industry value-added from its trend. This paper decomposes industry value-added into two parts (trend and cycle) using Hodrick-Prescott (HP) filter[14]. All industries are grouped into nine groups and one dummy variable is used for each group[15]. The nine industry groups are: primary (NAICS 11-21), construction (NAICS 23),

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[13] Canada-U.S. difference in tax rate on investment is not used as an explanatory variable in the model simply due to lack of data. However, as discussed earlier in the paper, part of the impact of tax on investment is implicitly included in the investment price.

[14] See Appendix for definitions of all variables and data sources.

[15] The regression model (3) will be estimated separately using common intercept and industry dummies. As a period SUR is used to estimate the model because the residuals of the model are seemly period related. Technically the cross-sectional fixed effects cannot be used when the period SUR is employed. This paper groups together the industries with similar characteristics and use group dummies to control for the impact of the inter-group characteristic differences.

resource-based manufacturing (NAICS 311, 312, 321, 322, 324, 326-332), labour-intensive manufacturing (NAICS 313-316, 337, 339), high-tech manufacturing (NAICS 323, 325, 333-336), trade (NAICS 41-45), utility, transportation and warehousing (NAICS 22, 48,49), information, FIRE and business services (NAICS 51-56), and other services (NAICS 71-81). The group dummy ($D_{i,j}$) equals one if $i \in j$ and zero otherwise.

The model (3) is estimated using Period SUR weighted least squares with panel-corrected standard errors (PCSE) due to period heteroskedasticity and serial correlation[16]. The estimation results are presented in Table 11. Signs of the estimated coefficients are consistent with prior expectations and the findings of previous literature in the subject.

Two sets of estimation results are presented in Table 11. The first set corresponds to the model with common intercept specification, and the second allows intercept to vary across industries by introducing industry dummies.

The impact of the Canada-U.S. relative investment price on the relative capital intensity is negative and statistically significant. Investment price impacts capital with lags and the length of lag depends on the type of capital. Usually M&E investment reacts more quickly than the investment in structures. The results show that the total capital intensity gap is affected by the total investment prices of past three years, which implies that full adjustment of total investment may take as long as three years. On the other hand, the results imply that M&E investment might take only one year and ICT investment could take less than a year. Note that the relative investment price is indexed, so it can only explain the trend in the capital intensity gap.

The impact of the relative real wage rate on total and M&E capital is positive and statistically significant.[17] Note that this paper does not find a lagged impact of the relative real wage rate on the capital intensity gap, implying that labour input adjusts faster than capital input. The elasticities of the capital intensity gap with respect to the relative real wage rate are 0.46 and 0.31 for total and M&E, respectively, implying a significant real wage effect on the capital gaps. For example, in 2004, Canada's real wage rate in the business sector was 30 percent lower than the U.S. rate, which would result in a 15-percent-gap for total capital intensity and a 10-percent-gap for M&E capital intensity, given all others equal. On the other hand, the regression results show that the relative real wage rate does not have a significant impact on the ICT capital intensity gap. A possible reason may be that ICT capital is more skill-biased than non-ICT capital and hence less substitutable to labour.

The skills variable is found to have a positive and significant impact on the M&E and ICT capital intensity gaps. The elasticities of the capital intensity gap with respect to the skills are

[16] The associated covariance structures of period SUR allow for arbitrary period serial correlation and period heteroskedasticity between the residuals for a given cross-section, but restricted residuals in different cross-sections to be uncorrelated. The advantage of this estimation method is that it can take care of period heteroskedasticity and serial correlation without using the lagged dependent variable. A potential drawback of this method is that it may lead to overconfidence. However, the use of panel-corrected standard errors (PCSE) can overcome the potential problem of overconfidence (see Beck and Katz (1995)).

[17] The regression results on the impact of the investment prices and the real wage rate are consistent with the findings in our earlier paper (Rao, Tang and Wang, 2003), where the Canada-U.S. total capital intensity gap is regressed only on the ratio of Canada's rental price of capital to the U.S. price.

0.08 and 0.09 for M&E and ICT capital, respectively, implying that the skills gap is an important source of the M&E and ICT capital intensity gaps. For example, in 2000, the skills gap in the business sector was 32 percent, which would lead to a 3-percent-gap for M&E capital intensity and a 4-percent-gap for ICT capital intensity, given all others equal. On the other hand, the skills variable does not have a significant impact on the total capital intensity. Given that about 75 percent of total capital is structure capital in Canada and about 60 percent of total capital is structure capital in the U.S., the results imply that M&E capital (including ICT capital) is skill-biased but structure capital is not. Also note that the coefficient of the skills is larger for ICT capital than for M&E capital, which is consistent to the fact that ICT capital is more skill-biased than non-ICT M&E capital.

R&D and physical capital are found to be complement to each other. The coefficients on the R&D intensity gap variable are positive and statistically significant in all three capital gap equations. Note that the magnitude of the coefficient is the largest for ICT capital and the smallest for total capital among the three equations, which implies that R&D is more important for the use of ICT capital than the use of non-ICT capital.

Capital, skills and R&D are usually highly positively correlated so we need to clarify the direction of causation among these variables. However, causality is less an issue for total capital and M&E capital intensity gaps, because lagged skills and R&D intensity gaps are used in the two regressions. For ICT capital intensity gap, we test for the causality. The results show that both the skills and R&D intensity gaps Granger cause the ICT capital intensity gap, while the ICT capital intensity gap does not Granger cause the skills and R&D intensity gaps.

The coefficient on the real interest rate variable is negative in all three equations but only statistically significant in the equation for the total capital intensity gap. Even in the total capital intensity gap equation, the magnitude of the coefficient is quite small, suggesting that the impact of the real interest rate difference on the total capital intensity gap between Canada and the U.S. is very small. The small impact of the real interest rates may be caused by endogeneity of interest rate, as mentioned in ab Iorwerth and Danforth (2004) that central banks would raise interest rates to cool down economy and investment demand. Consequently, the impact of interest rates might be partly captures by investment prices and capacity utilization (used to control for the business cycle effect). Also, as the interest rates used in the regressions only have a time dimension, they might be capturing some of the time fixed effect.

The impact of the capacity utilization or business cycle variable is negative in all three equations, and is statistically significant in the M&E and ICT capital gap equations.

In all three capital gap equations, the industry effects are quite significant, especially for the M&E and ICT capital intensity gaps. The adjusted R-square increases from 0.20 to 0.54 for ICT capital intensity, from 0.28 to 0.47 for M&E capital intensity and from 0.44 to 0.45 for total capital intensity with the industry dummies, instead of a common intercept. These results imply that more industry-specific variables are needed to explain the Canada-U.S. M&E and ICT capital intensity gaps. For example, according to Sharpe (2005), Canada has more small firms than the U.S. and small firms on average invest less in ICT capital than medium- and large-sized firms. However, data on firm size by industry in the two countries are not available for this study.

6. Conclusions

This paper has examined the sources of the capital intensity gap between Canada and the U.S. It first undertakes a Bennet-type decomposition exercise to investigate the impact of the differences in industrial structure on the capital intensity gap between the two countries, and finds that a common industrial structure in the two countries actually would have increased the total and M&E capital intensity gaps in the business sector. However, the industrial structure difference accounted for a small portion of the ICT capital intensity gap.

It then uses a panel data set to investigate the factors that might have contributed to the capital intensity gaps. The panel regression results confirm that capital intensity is positively correlated with the real wage rate and negatively correlated with investment price. It finds that the increasing investment prices for total and M&E investments in Canada relative to the U.S. were responsible for a large part of the widening of gaps in total and M&E capital intensities. A notable finding of this paper is that the real wage gap is the dominant factor for the total and M&E capital intensity gaps between the two countries. The capital-skill and capital-R&D complementarities are confirmed by the regression results. The Canada-U.S. skills and R&D gaps played an important role in accounting for the capital intensity gap. The skills gap is found to be one of the most important sources of the ICT capital intensity gap, which is consistent with the more skills-biased nature of ICT capital.

Some important variables such as the effective tax rate on investment and firm size are not included in the analysis because of lack of data. The inclusion of these variables may shed more light on the sources of the Canada-U.S. capital intensity gap. We intent to re-visit these and other data issues in the near future.

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Appendix: Variable Definitions and Data Sources

Capital Intensity

Capital intensity is defined as capital stock per worker. The capital stock used is the private fixed non-residential geometric end-year net stock. Three types of capital intensities are used in the paper, i.e., total capital (M&E and structures) intensity, M&E capital intensity and ICT capital intensity. To calculate Canada-U.S. capital intensity level gap, capital stock in Canadian dollar for Canada is converted into US dollar using the Canada-U.S. bilateral total investment PPP values by industry for total capital stock and M&E investment PPP values by industry for M&E and ICT capital stock. All the PPP values are obtained from Rao, Tang and Wang (2004). All capital stock series are in chained-Fisher dollar and re-referenced to the year of 1999.

The Canadian data for total capital stock and M&E capital stock by industry are obtained from Statistics Canada (STC) CANSIM table 031-0002, and the Canadian data for ICT capital stock come from the Investment and Capital Stock Division of Statistics Canada. All capital stock data for the U.S. come from the U.S. Bureau of Economic Analysis (BEA) fixed assets tables.

The data used for Canadian employment from 1997 onward is the total number of jobs from STC CANSIM table 383-0010. These data are extended back to 1987 using the growth rates of the total number of jobs from STC CANSIM table 383-0003. The employment data for the U.S. is the number of persons engaged in production. The source for the data from 1998 onward is the BEA NAICS-based GDP-by-industry tables, which are extended back to 1987 using the growth rates of the number of persons engaged in production from the BEA1987 SIC-based GDP-by-industry tables.

Investment Price Index

Investment price index is implicitly estimated using nominal and real investments. The data sources for investment are the same as those for capital stock.

Real Wage Rate

The real wage rate is defined as total labour compensation per worker, deflated using GDP deflator for total economy (1999=1). The Canadian data is converted into US dollar using the expenditure-based PPP exchange rate (STC CANSIM series v13930600).

The source of Canadian data on the total labour compensation for all jobs from 1997 onward is STC CANSIM table 383-0010. All these series are extended back to 1987 using the growth rate of labour compensation data from STC CANSIM table 381-0013. The total labour compensation for the U.S. is obtained from BEA NAICS-based GDP-by-industry tables.

Skills

The share of hours worked by workers with university degree and above in total hours worked is used as the indicator of skills. The data of hours worked by industry and by education for both

Canada and the U.S. for the period of 1987 to 2000 are obtained from Jorgensen (2004). The shares are assumed to be unchanged since 2000.

R&D Intensity

R&D intensity is defined as R&D expenditure to GDP ratio. The R&D expenditure data used for Canada is the intramural R&D expenditures that are obtained from the Science, Innovation and Electronic Information Division of Statistics Canada. The data from 1994 onward is NAICS-based. It is extended back to 1987 using the growth rates from the SIC-based data. The R&D data used for the U.S. is the total funds for industrial R&D performance. The sources of the data for non-agriculture industries are Table A-7 and Table A-13, Survey of Industrial Research and Development, 1998, 2000, 2001, the U.S. National Science Foundation. NAICS-based data are available for the period of 1997 to 2001 and SIC-based data are available for the period of 1988-1998. The growth rates from SIC-based data are used to extend NAICS-based data back to 1988. The data for 1987 are assumed to be the same as those for 1988, and the data for 2002 and 2003 are assumed to be the same as those for 2001. The data for the agriculture sector are obtained from the U.S. Department of Agriculture.

Short-term Real Interest Rate

Real interest rate is defined as the difference between nominal interest rate and inflation rate. The short-term nominal interest rates for both Canada and the U.S. are obtained from OECD outlook (A_CAN_IRS and A_USA_IRS). The inflation rates are calculated using Consumer Price Index (CPI) for all items. The source of CPI for Canada and the U.S. are STC CANSIM series v737344 and v11123, respectively.

Capacity Utilization

The output fluctuation is used as the indicator of capacity utilization because firms will adjust factor inputs accordingly in response to output change. The data used for output is real GDP by industry. The Hodrick-Prescott (H-P) filter is used to decompose GDP into two parts: the long-term trend and the short-term fluctuation. For normalization, the fluctuation is divided by the trend.

Tables and Charts

Table 1: GDP per capita and labour productivity levels in OECD countries, 2004 (U.S.=100)

	GDP per capita	GDP per hour worked
Australia	75.99	74.95
Austria	80.20	83.01
Belgium	77.90	109.87
Canada	78.83	76.07
Czech Republic	46.49	44.72
Denmark	79.65	88.33
Finland	76.69	84.61
France*	74.14	103.15
Germany	71.91	91.02
Greece	54.36	61.90
Hungary	40.13	46.45
Iceland	82.02	72.88
Ireland	89.80	101.75
Italy	69.60	78.40
Japan	74.71	70.19
Korea	52.62	40.27
Luxembourg	145.82	120.83
Mexico	25.35	29.11
Netherlands	78.17	95.44
New Zealand	60.29	57.13
Norway	97.47	122.36
Poland	31.83	38.14
Portugal	49.05	51.62
Slovak Republic	36.01	46.66
Spain	64.20	78.93
Sweden	76.44	86.18
Switzerland	84.74	79.41
Turkey**	19.35	27.54
United Kingdom	79.14	85.51

Note: * Includes overseas departments. ** GDP for Turkey is based on 1968 system of national accounts.

Source: OECD estimates, September 2005.

Table 2: Canada-U.S. comparisons by sector, selected variables

	1995	2000	2004*	1995	2000	2004*
	GDP per worker (U.S.=1)			Total capital intensity (U.S.=1)		
Primary	0.81	0.83	0.98	0.94	1.18	1.43
Construction	1.07	1.32	1.50	1.01	0.88	0.86
Manufacturing	0.88	0.74	0.58	0.86	0.71	0.62
Services	0.62	0.61	0.55	0.90	0.87	0.79
Business Sector	0.72	0.70	0.63	0.99	0.97	0.89
	M&E capital intensity (U.S.=1)			ICT capital intensity (U.S.=1)		
Primary	0.30	0.37	0.52	0.15	0.23	0.27
Construction	1.07	0.81	0.79	0.42	0.28	0.36
Manufacturing	0.74	0.62	0.54	0.21	0.22	0.20
Services	0.51	0.52	0.49	0.58	0.55	0.50
Business Sector	0.60	0.59	0.56	0.51	0.48	0.45
	R&D spending/GDP (U.S.=1)			University hours/total hours (U.S.=1)		
Primary	0.13	0.09	0.09	0.41	0.64	
Construction	2.90	1.38	0.58	0.52	0.59	
Manufacturing	0.48	0.60	0.59	0.55	0.55	
Services	0.71	0.47	0.57	0.69	0.72	
Business Sector	0.55	0.56	0.54	0.64	0.68	
	Total investment price index (1987=1)			M&E investment price index (1987=1)		
Primary	0.93	0.95	0.81	0.98	1.12	1.00
Construction	0.93	1.21	1.14	0.99	1.27	1.12
Manufacturing	0.97	1.04	0.96	0.96	1.04	0.95
Services	0.97	0.99	1.00	0.87	0.89	0.85
Business Sector	0.98	1.06	1.04	0.93	1.00	0.95
	ICT investment price index (1987=1)			Real wage rate (U.S.=1)		
Primary	2.41	2.43	2.28	1.09	1.06	1.25
Construction	2.07	1.05	0.65	1.15	1.11	1.12
Manufacturing	1.05	0.86	0.73	0.82	0.73	0.68
Services	0.86	0.97	0.76	0.72	0.69	0.65
Business Sector	0.91	0.97	0.77	0.77	0.73	0.70

* The year of 2003 for ICT capital intensity, ICT investment price and R&D to GDP ratio.

Source: Authors' calculations based on data from Statistics Canada, U.S. Bureau of Economic Analysis, Dale Jorgenson of Harvard University, U.S. National Science Foundation, and U.S. Agriculture Department.

Table 3: Canada-U.S. labour productivity and capital intensity gaps by Industry* (U.S.=1)

Industry	NAICS Code	Labour Productivity			Total Capital Intensity		
		1995	2000	2004	1995	2000	2004
Agriculture	11	0.55	0.50	0.54	0.60	0.65	0.69
Mining	21	1.09	1.16	1.42	1.00	1.19	1.36
Utilities	22	0.69	0.65	0.49	1.13	1.11	0.91
Construction	23	1.07	1.32	1.50	1.01	0.88	0.86
Food, beverage, tobacco	311, 312	0.65	0.75	0.77	0.52	0.54	0.56
Textile	313, 314	0.76	0.74	0.54	0.82	0.65	0.51
Apparel and leather	315, 316	0.66	0.56	0.38	0.73	0.40	0.28
Wood	321	0.89	1.08	1.16	1.27	1.22	1.14
Paper	322	1.01	1.13	0.97	1.36	1.33	1.12
Printing	323	0.98	1.02	1.06	0.53	0.46	0.40
Petroleum and coal	324	1.06	0.63	0.80	1.20	0.88	0.99
Chemical	325	0.79	0.88	0.81	0.82	0.85	0.75
Plastics and rubber	326	0.63	0.57	0.50	0.65	0.53	0.46
Non metallic	327	0.89	0.93	0.89	0.84	0.74	0.64
Primary metals	331	1.16	1.22	1.12	0.90	0.98	0.87
Fabricated metal	332	0.50	0.49	0.47	0.46	0.36	0.31
Machinery	333	0.64	0.64	0.58	0.37	0.27	0.21
Computer and electronic	334	1.28	0.54	0.21	0.31	0.31	0.28
Electrical equipment	335	0.45	0.59	0.40	0.39	0.43	0.35
Transportation equipment	336	1.08	1.23	1.00	1.04	0.90	0.81
Furniture	337	0.66	0.71	0.67	0.78	0.62	0.54
Miscellaneous manufacturing	339	0.61	0.44	0.38	0.30	0.24	0.22
Wholesale trade	41	0.77	0.74	0.62	0.31	0.33	0.30
Retail trade	45 (or 44)	0.64	0.70	0.60	0.36	0.45	0.43
Transportation, Warehousing	48-49	0.83	0.85	0.81	0.82	0.89	0.86
Information and cultural	51	0.73	0.60	0.47	0.88	0.75	0.66
FIRE, management	52, 53, 55	0.62	0.60	0.59	0.91	0.85	0.78
Professional services	54	0.49	0.49	0.46	0.27	0.37	0.36
Administrative services	56	0.83	0.75	0.68	0.29	0.25	0.23
Arts, entertainment	71	0.52	0.51	0.49	0.50	0.44	0.41
Accommodation and food	72	0.85	0.79	0.70	0.55	0.49	0.45
Other private services	81	0.69	0.91	1.02	0.20	0.26	0.28

Source: Authors' calculations based on data from Statistics Canada and the U.S. Bureau of Economic Analysis.

* Number of employees is used as labour input.

Table 4: Canada-U.S. M&E and ICT capital intensity gaps by Industry (U.S.=1)

Industry	NAICS Code	M&E capital intensity			ICT capital intensity		
		1995	2000	2004	1995	2000	2003
Agriculture	11	0.35	0.34	0.34	0.38	0.53	0.63
Mining	21	0.24	0.35	0.52	0.09	0.13	0.12
Utilities	22	0.75	0.77	0.63	0.30	0.75	0.75
Construction	23	1.07	0.81	0.79	0.42	0.28	0.36
Food, beverage, tobacco	311, 312	0.44	0.46	0.49	0.28	0.39	0.39
Textile	313, 314	0.71	0.57	0.43	0.35	0.43	0.36
Apparel and leather	315, 316	0.61	0.33	0.23	0.41	0.34	0.21
Wood	321	1.53	1.38	1.27	0.73	0.60	0.52
Paper	322	1.25	1.21	1.02	0.58	0.62	0.58
Printing	323	0.50	0.45	0.39	0.47	0.36	0.33
Petroleum and coal	324	0.24	0.21	0.47	0.17	0.16	0.42
Chemical	325	0.64	0.66	0.57	0.16	0.18	0.21
Plastics and rubber	326	0.57	0.49	0.43	0.75	0.51	0.43
Non metallic	327	0.78	0.70	0.62	0.23	0.40	0.36
Primary metals	331	0.80	0.91	0.79	0.39	0.64	0.50
Fabricated metal	332	0.31	0.28	0.24	0.13	0.14	0.11
Machinery	333	0.23	0.17	0.14	0.07	0.07	0.06
Computer and electronic	334	0.24	0.28	0.24	0.06	0.22	0.16
Electrical equipment	335	0.28	0.39	0.35	0.12	0.25	0.16
Transportation equipment	336	1.12	0.91	0.84	0.28	0.20	0.23
Furniture	337	0.51	0.46	0.41	0.25	0.43	0.34
Miscellaneous manufacturing	339	0.22	0.19	0.18	0.09	0.19	0.14
Wholesale trade	41	0.15	0.19	0.17	0.21	0.35	0.31
Retail trade	45 (or 44)	0.39	0.50	0.51	0.39	0.53	0.58
Transportation, Warehousing	48-49	0.35	0.41	0.44	0.07	0.15	0.13
Information and cultural	51	0.79	0.66	0.66	1.18	0.85	0.72
FIRE, management	52, 53, 55	0.55	0.59	0.59	0.46	0.49	0.45
Professional services	54	0.44	0.49	0.34	1.02	0.62	0.53
Administrative services	56	0.36	0.24	0.21	0.64	0.42	0.35
Arts, entertainment	71	0.14	0.15	0.15	0.33	0.64	0.55
Accommodation and food	72	0.12	0.10	0.07	0.13	0.12	0.13
Other private services	81	0.14	0.26	0.36	0.36	0.67	0.77

Source: Authors' calculations based on data from Statistics Canada and the U.S. Bureau of Economic Analysis.

Table 5: Canada's Total, M&E and ICT capital intensities by Industry, 2004
(thousand US$ per worker)*

Industry	NAICS Code	Total Capital Intensity		M&E Capital Intensity		ICT Capital Intensity**	
		Canada	U.S.	Canada	U.S.	Canada	U.S.
Agriculture	11	102.8	148.2	24.4	70.8	0.57	0.91
Mining	21	1451.1	1068.1	98.8	189.4	1.63	13.40
Utilities	22	1778.6	1956.6	306.4	488.1	27.94	37.44
Construction	23	18.6	21.5	13.3	16.9	0.91	2.52
Food, beverage, tobacco	311, 312	57.2	103.0	27.3	55.8	1.57	4.05
Textile	313, 314	45.0	88.2	20.3	47.1	0.67	1.89
Apparel and leather	315, 316	11.9	42.2	4.4	19.2	0.35	1.62
Wood	321	57.5	50.5	32.4	25.5	0.81	1.56
Paper	322	206.8	184.6	133.1	130.3	3.63	6.24
Printing	323	23.9	59.4	15.4	39.5	1.25	3.78
Petroleum and coal	324	848.3	852.8	238.3	508.7	11.00	26.26
Chemical	325	183.6	245.2	74.5	130.6	4.02	18.88
Plastics and rubber	326	38.4	82.7	24.8	57.6	0.96	2.26
Non metallic	327	69.7	108.2	40.2	65.2	1.84	5.05
Primary metals	331	201.2	231.3	107.3	136.1	2.98	5.96
Fabricated metal	332	23.1	73.5	11.5	48.0	0.41	3.61
Machinery	333	26.7	126.1	11.7	84.3	0.98	16.85
Computer and electronic	334	50.1	179.0	25.8	106.0	4.51	27.76
Electrical equipment	335	33.8	96.4	16.7	48.3	1.01	6.26
Transportation equipment	336	84.0	104.1	52.0	62.1	2.41	10.38
Furniture	337	14.7	27.3	6.5	15.8	0.44	1.30
Miscellaneous manufacturing	339	13.3	59.0	5.7	31.0	0.57	4.19
Wholesale trade	41	19.5	64.9	7.9	45.4	3.55	11.30
Retail trade	45 (or 44)	20.3	46.6	5.6	10.9	1.30	2.24
Transportation, Warehousing	48-49	155.5	181.7	37.8	86.7	3.76	29.21
Information and cultural	51	187.0	282.3	81.6	123.8	77.03	107.26
FIRE, management	52, 53, 55	159.3	204.2	48.4	81.8	11.41	25.64
Professional services	54	12.3	34.0	8.9	26.0	6.32	12.00
Administrative services	56	5.0	21.8	2.6	12.2	1.43	4.06
Arts, entertainment	71	30.1	73.5	2.8	18.4	1.27	2.30
Accommodation and food	72	17.4	38.8	0.8	12.3	0.09	0.70
Other private services	81	13.9	48.8	2.6	7.1	1.01	1.32

* In 1999 price, PPP based. ** The year of 2003 for ICT capital intensity

Source: Authors' calculations based on data from Statistics Canada and the U.S. Bureau of Economic Analysis.

Table 6: Employment Share by Industry, 2004 (%)

Industry	NAICS Code	Business Sector		Manufacturing	
		Canada	U.S.	Canada	U.S.
Agriculture	11	3.34	2.33		
Mining	21	1.18	0.54		
Utilities	22	0.94	0.57		
Construction	23	7.54	8.99		
Food, beverage, tobacco	311, 312	2.02	1.72	12.94	11.69
Textile	313, 314	0.35	0.43	2.27	2.91
Apparel and leather	315, 316	0.72	0.35	4.61	2.41
Wood	321	1.08	0.59	6.92	3.99
Paper	322	0.82	0.49	5.27	3.36
Printing	323	0.71	0.71	4.55	4.81
Petroleum and coal	324	0.12	0.11	0.79	0.76
Chemical	325	0.75	0.89	4.81	6.07
Plastics and rubber	326	1.00	0.81	6.42	5.52
Non metallic	327	0.46	0.52	2.96	3.51
Primary metals	331	0.72	0.49	4.62	3.31
Fabricated metal	332	1.50	1.51	9.60	10.27
Machinery	333	1.08	1.16	6.93	7.89
Computer and electronic	334	0.69	1.34	4.39	9.08
Electrical equipment	335	0.38	0.45	2.47	3.06
Transportation equipment	336	1.79	1.79	11.49	12.18
Furniture	337	0.80	0.61	5.16	4.16
Miscellaneous manufacturing	339	0.60	0.74	3.82	5.03
Wholesale trade	41	6.97	5.83		
Retail trade	45 (or 44)	14.71	14.72		
Transportation, Warehousing	48-49	6.41	4.55		
Information and cultural	51	3.25	3.10		
FIRE, management	52, 53, 55	8.21	10.38		
Professional services	54	7.17	8.11		
Administrative services	56	6.40	8.20		
Arts, entertainment	71	2.58	2.04		
Accommodation and food	72	8.52	8.93		
Other private services	81	7.16	7.00		
Total		100.0	100.0	100.0	100.0

Source: Authors' calculations based on data from Statistics Canada and the U.S. Bureau of Economic Analysis.

Table 7: Contribution of the industrial structure differences to the Canada-U.S. capital intensity gap (percentage points)

		1987	1990	1995	2000	2004*
Panel A: in percentage points						
Total	Manufacturing	-4.1	-3.7	-6.8	-0.6	0.6
	Total Business Sector	-10.9	-10.1	-4.6	-9.1	-12.8
M&E	Manufacturing	-10.0	-10.3	-8.7	-1.7	0.2
	Total Business Sector	-9.1	-8.7	-9.3	-8.0	-6.9
ICT	Manufacturing	4.9	3.8	3.1	8.7	9.8
	Total Business Sector	13.7	13.1	6.7	1.3	0.1
Panel B: in percent (%)						
Total	Manufacturing	-38.9	-59.0	-53.1	-5.8	1.9
	Total Business Sector	-84.5	-114.1	-405.3	-262.4	-121.0
M&E	Manufacturing	-27.9	-40.5	-33.6	-4.3	0.3
	Total Business Sector	-19.1	-20.4	-23.3	-19.2	-15.5
ICT	Manufacturing	5.7	4.7	3.9	11.0	12.2
	Total Business Sector	23.9	23.4	13.7	2.4	0.2

Source: Authors' estimates.

* The year of 2003 for ICT.

Table 8: Effective corporate tax rates on capital by industry for medium and large corporations, Canada and the U.S., percent

	2000		2002		2003		2005	
	Canada	U.S.	Canada	U.S.	Canada	U.S.	Canada	U.S.
Forestry	32.4	23.1	31.9	15.7	30.1	17.6	28.0	21.5
Mining	12.5	4.1					7.9	14.8
Oil and gas	4.9	1.6					6.3	16.8
Manufacturing	24.0	21.6	18.8	16.8	28.4	21.3	28.6	25.9
Construction	37.2	25.3	29.3	19.8	34.9	23.2	33.2	24.4
Transportation & Storage	28.1	12.6	24.6	10.3	31.9	14.8	30.2	24.3
Communications	28.3	12.4	22.7	12.2	28.8	5.4	27.8	15.6
Utilities	26.0	19.8	29.5	13.8	25.7	2.3	23.3	13.8
Wholesale trade	34.6	21.3	29.4	19.6	38.3	24.1	37.2	27.1
Retail trade	33.9	18.3	29.4	17.1	40.2	24.2	40.0	30.4
Other services	28.8	18.9	30.6	19.2	34.2	23.8	33.5	27.1
Structures			22.1	17.8	24.2	16.3		
Machinery			26.1	14.7	34.4	24.9		
Inventory			39.3	17.7	38.1	18.7		
Land			22.1	17.7	21.2	18.3		
Aggregate	27.1	18.5	24.3	16.8	31.8	20.1	28.8	24.1

Source: Chen and Mintz (2003a, 2003b, 2005) and Mintz (2001).

Table 9: Canada-U.S. relative investment price (1987=1)

Industry	NAICS Code	Total capital			M&E capital			ICT capital		
		1995	2000	2004	1995	2000	2004	1995	2000	2003
Agriculture	11	0.99	1.04	0.94	0.98	1.07	0.91	0.95	1.00	1.02
Mining	21	0.91	0.90	0.72	0.97	1.19	1.08	2.77	2.97	2.77
Utilities	22	0.92	0.90	0.84	0.89	0.77	0.64	0.62	0.81	0.69
Construction	23	0.93	1.21	1.14	0.99	1.27	1.12	2.07	1.05	0.65
Food, beverage, tobacco	311, 312	0.90	0.87	0.81	0.90	0.87	0.79	0.81	0.60	0.54
Textile	313, 314	0.89	0.97	1.12	0.88	0.99	1.05	1.10	0.97	0.92
Apparel and leather	315, 316	0.96	0.89	0.72	0.85	0.68	0.61	1.49	1.10	0.93
Wood	321	0.92	1.05	0.95	0.98	1.12	1.01	1.47	1.45	1.36
Paper	322	0.93	0.99	0.90	0.94	1.00	0.91	0.97	0.93	0.88
Printing	323	0.53	0.84	0.70	0.53	0.85	0.71	1.13	1.29	1.05
Petroleum and coal	324	0.93	1.02	0.92	0.75	0.82	0.73	0.59	0.46	0.33
Chemical	325	0.95	1.07	1.02	0.93	1.07	0.97	0.86	0.67	0.54
Plastics and rubber	326	0.87	0.90	0.81	0.84	0.87	0.78	1.12	0.91	0.77
Non metallic	327	1.02	1.14	1.03	1.04	1.16	1.01	1.04	1.31	1.07
Primary metals	331	0.97	1.07	0.99	0.96	1.08	0.96	1.08	1.04	1.03
Fabricated metal	332	0.98	1.06	0.98	0.97	1.07	0.96	1.22	1.19	1.03
Machinery	333	0.95	1.00	0.92	0.92	0.96	0.87	0.96	0.75	0.56
Computer and electronic	334	0.87	0.74	0.59	0.85	0.71	0.54	0.91	0.54	0.41
Electrical equipment	335	0.82	0.71	0.54	0.80	0.68	0.52	1.08	0.80	0.66
Transportation equipment	336	1.08	1.19	1.10	1.09	1.22	1.14	1.05	0.87	0.75
Furniture	337	0.95	0.90	0.85	0.93	0.91	0.79	1.10	0.90	0.73
Miscellaneous manufacturing	339	0.90	0.75	0.65	0.87	0.68	0.57	0.70	0.49	0.38
Wholesale trade	41	0.82	0.76	0.75	0.75	0.65	0.61	1.10	1.06	0.97
Retail trade	45 (or 44)	0.85	0.75	0.68	0.84	0.73	0.63	0.84	0.88	0.65
Transportation, Warehousing	48-49	0.96	1.04	1.06	0.93	0.98	0.99	1.16	0.85	0.59
Information and cultural	51	0.85	0.88	0.86	0.82	0.84	0.80	1.08	1.58	1.10
FIRE, management	52, 53, 55	1.12	1.28	1.31	0.96	1.21	1.19	0.63	0.83	0.89
Professional services	54	0.34	0.24	0.24	0.33	0.22	0.21	0.43	0.48	0.48
Administrative services	56	0.54	0.41	0.37	0.55	0.39	0.33	0.43	0.27	0.20
Arts, entertainment	71	0.90	0.70	0.72	0.77	0.50	0.61	1.10	1.00	1.04
Accommodation and food	72	0.88	0.84	1.44	0.76	0.70	1.30	0.58	0.72	0.60
Other private services	81	0.64	0.51	0.43	0.54	0.44	0.37	1.30	1.55	1.13

Source: Authors' calculations based on data from Statistics Canada and the U.S. Bureau of Economic Analysis.

Table 10: Canada-U.S. relative real wage rate, educational attainment and R&D intensity by Industry (U.S.=1)

Industry	NAICS Code	Real wage rate			R&D spending/GDP			University hours/total hours	
		1995	2000	2004	1995	2000	2003	1995	2000
Agriculture	11	1.32	1.14	1.32	0.04	0.05	0.05	0.34	0.54
Mining	21	0.82	0.83	0.93	4.82	0.52	0.48	0.57	0.73
Utilities	22	0.73	0.69	0.55	4.47	8.34	9.29	0.72	0.67
Construction	23	1.15	1.11	1.12	2.90	1.38	0.58	0.52	0.59
Food, beverage, tobacco	311, 312	0.84	0.77	0.73	0.53	0.39	0.28	0.59	0.64
Textile	313, 314	0.98	0.86	0.84	0.71	1.22	1.08	0.74	0.81
Apparel and leather	315, 316	0.87	0.78	0.72	0.79	1.22	0.83	0.74	0.81
Wood	321	1.13	1.07	1.00	6.45	1.01	0.48	0.70	0.66
Paper	322	0.95	0.90	0.81	0.45	0.41	0.73	0.54	0.56
Printing	323	0.81	0.75	0.77	0.13	0.07	0.06	0.53	0.57
Petroleum and coal	324	0.83	0.71	0.50	0.67	0.45	0.80	0.83	0.85
Chemical	325	0.74	0.63	0.53	0.49	0.50	0.80	0.71	0.76
Plastics and rubber	326	0.92	0.83	0.78	0.49	0.42	0.19	0.63	0.67
Non metallic	327	0.87	0.79	0.77	0.37	0.20	0.06	0.70	0.68
Primary metals	331	0.93	0.90	0.87	0.98	1.14	1.57	0.67	0.63
Fabricated metal	332	0.80	0.83	0.78	0.80	0.47	0.42	0.60	0.56
Machinery	333	0.80	0.77	0.73	0.58	0.54	0.47	0.62	0.61
Computer and electronic	334	0.61	0.52	0.52	1.35	2.85	4.35	0.90	0.93
Electrical equipment	335	0.83	0.78	0.73	0.66	0.59	0.37	0.46	0.48
Transportation equipment	336	0.78	0.80	0.68	0.20	0.25	0.35	0.40	0.35
Furniture	337	0.94	0.83	0.84	0.39	0.18	0.24	0.70	0.66
Miscellaneous manufacturing	339	0.59	0.56	0.49	0.61	0.49	0.29	0.50	0.44
Wholesale trade	41	0.75	0.69	0.60	0.35	0.35	0.31	0.54	0.58
Retail trade	45 (or 44)	0.69	0.75	0.68	0.35	0.35	0.31	0.60	0.60
Transportation, Warehousing	48-49	0.78	0.77	0.75	1.67	0.60	0.09	0.40	0.43
Information and cultural	51	0.65	0.55	0.51	0.34	0.22	0.40	0.65	0.63
FIRE, management	52, 53, 55	0.69	0.68	0.64	3.27	0.37	0.74	0.62	0.61
Professional services	54	0.57	0.57	0.58	2.05	1.07	1.23	1.12	1.10
Administrative services	56	1.04	0.77	0.71	3.70	1.01	0.42	1.12	1.10
Arts, entertainment	71	0.61	0.70	0.66	3.70	1.01	0.42	0.65	0.62
Accommodation and food	72	0.92	0.81	0.73	3.70	1.01	0.42	0.65	0.62
Other private services	81	0.68	0.81	0.81	3.70	1.01	0.42	0.65	0.62

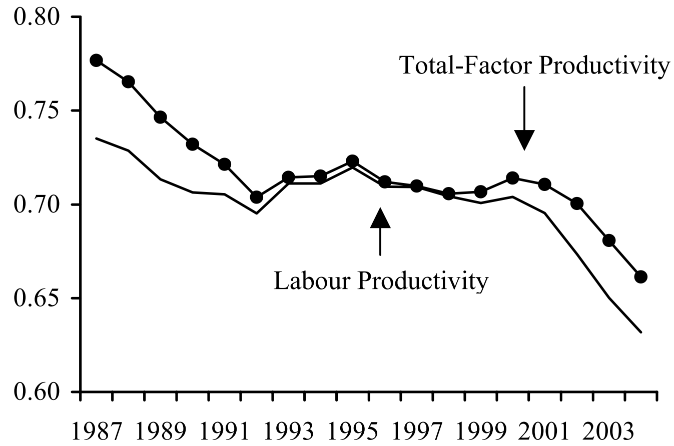
Source: Authors' calculations based on data from Statistics Canada, the U.S. Bureau of Economic Analysis, Dale Jorgenson of Harvard University, U.S. National Science Foundation, and U.S. Agriculture Department.

Table 11: Panel estimation results

Dependent Variables: Canada-U.S. relative capital intensity (U.S.=1)[+]						
Explanatory variables	Total capital		M&E capital		ICT capital	
	(1)	(2)	(1)	(2)	(1)	(2)
Intercept	Yes		Yes		Yes	
Investment price index[+]					-0.4656*** (0.0000)	-0.4832*** (0.0000)
1-year lagged investment price index[+]	-0.0643*** (0.0015)	-0.0516** (0.0105)	-0.1169*** (0.0000)	-0.0810*** (0.0000)		
2-year lagged investment price index[+]	-0.0882*** (0.0006)	-0.0830*** (0.0011)				
3-year lagged investment price index[+]	-0.0709*** (0.0009)	-0.0602*** (0.0049)				
Real wage rate[+]	0.4595*** (0.0000)	0.4567*** (0.0000)	0.3296*** (0.0000)	0.3109*** (0.0000)	0.0071 (0.8462)	0.0193 (0.5619)
Share of university hours[+]					0.0886** (0.0365)	0.0935** (0.0212)
1-year lagged share of university hours[+]	-0.0370 (0.1323)	-0.0390 (0.1176)	0.0528** (0.0426)	0.0775*** (0.0028)		
R&D intensity[+]					0.0456*** (0.0000)	0.0273*** (0.0000)
1-year lagged R&D intensity[+]	0.0086** (0.0201)	0.0082** (0.0266)	0.0162*** (0.0002)	0.0186*** (0.0000)		
Real interest rate[++]					-0.0030 (0.1031)	-0.0017 (0.3415)
1-year lagged real interest rate[++]	-0.0018** (0.0382)	-0.0018** (0.0374)	-0.0001 (0.9640)	-0.0000 (0.9674)		
Capacity utilization[++]	-0.0946*** (0.0000)	-0.0840*** (0.0000)	-0.0172* (0.0547)	-0.0307*** (0.0006)	-0.0186*** (0.0000)	-0.0246*** (0.0000)
Industry dummies		Yes		Yes		Yes
Adjusted R^2	0.4444	0.4537	0.2802	0.4715	0.2037	0.5404
Observations	615	615	697	697	697	697
D.W. statistics	1.9965	1.9965	1.9970	1.9970	1.9970	1.9970

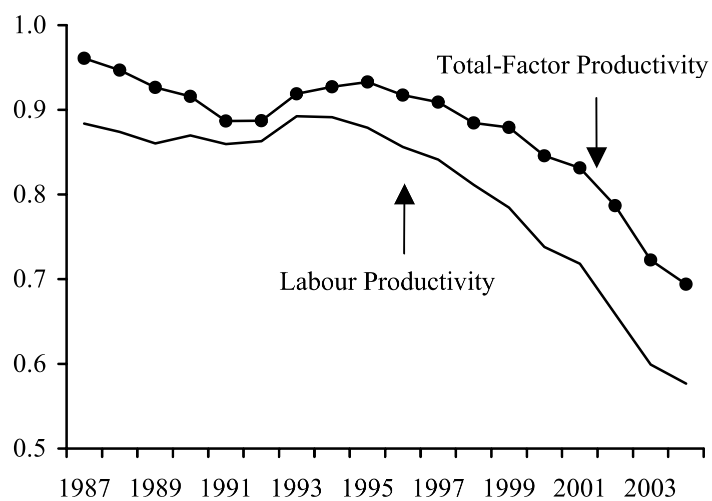
Note: *** significant at 1% level, ** significant at 5% level, * significant at 10% level. Figures in parentheses are p-values.
[+] Denotes Canada-U.S. relative values (US=1), in natural logarithm.
[++] Denote differences in Canada-U.S. values.
Source: Authors' estimates.

Figure 1: Canada-U.S. Relative Labour Productivity and TFP Levels*, Business Sector (U.S.=1)



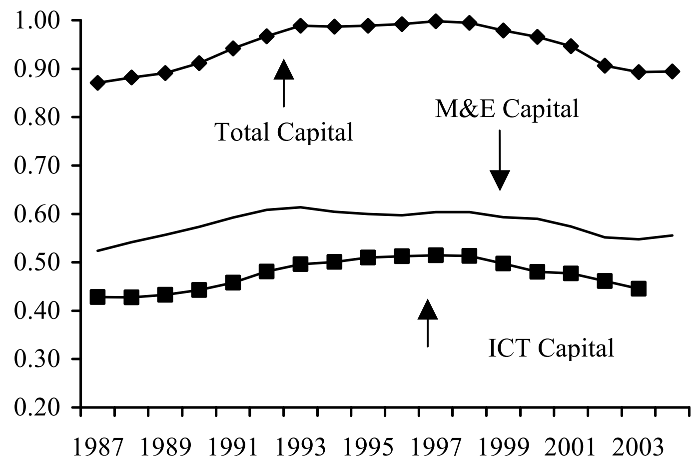
Source: Authors' calculations based on data from Statistics Canada and the U.S. Bureau of Economic Analysis.
* Number of employees is used as labour inputs.

Figure 2: Canada-U.S. Relative Labour Productivity and TFP Levels*, Manufacturing (U.S.=1)



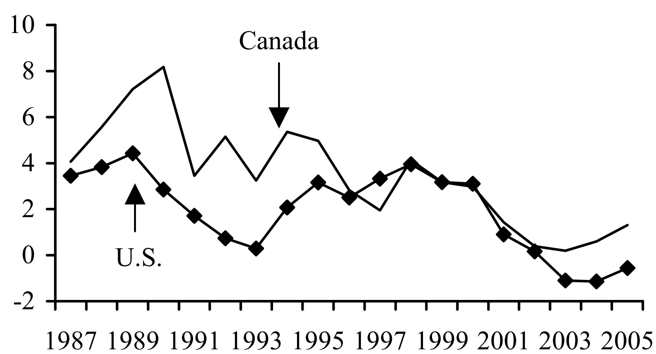
Source: Authors' calculations based on data from Statistics Canada and the U.S. Bureau of Economic Analysis.
* Number of employees is used as labour inputs.

Figure 3: Canada-U.S. Relative Capital Intensity Levels*, Business Sector
(U.S.=1)



Source: Authors' calculations based on data from Statistics Canada and the U.S. Bureau of Economic Analysis.
* Number of employees is used as labour inputs.

Figure 4: Real interest rates, Canada and the U.S. (%)



Source: Authors' calculations based on data from Statistics Canada and OECD outlook.