Industry Mix, Plant Turnover and Productivity Growth: A Case Study of the Electronic and Electrical Product Manufacturing Industry*

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Abstract: Labour productivity growth in the Canadian electronic and electrical product manufacturing industry declined, from 21% per year in the period 1997-2000, to negative 4% per year in the period 2000-2006. This paper investigates if the restructuring and the reallocation of market share and resource within the industry following the bursting of the tech bubble in 2000 contributed to the slowdown in productivity growth. The reallocation may be a result of change in the composition of constituent sub-industries (industry mix), the entry of new firms and the exit of existing firms, and/or the growth and decline in continuing firms. This paper shows that the slowdown in productivity growth in the Canadian electronic and electrical product industry was mainly due to weaker productivity performance of the sub-industries, which can largely be traced to the decline in labour productivity growth of continuing plants. It finds that the reallocation had some impact, but it was not the primary factor behind the decline. Finally, the paper shows that even if the Canadian industry mix were the same as the U.S. industry mix over this period, the productivity growth profile of the Canadian electronic and electrical product manufacturing industry would not change.

Keywords: Industry mix, plant turnover, productivity growth
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1. Introduction

The electronic and electrical product manufacturing industry, which consists of computer and electronic product manufacturing (NAICS 334) and electrical equipment manufacturing (NAICS 335) is one of the most dynamic, skill intensive and innovative manufacturing industries (Chart 1). With its unprecedented technological progress, especially in computers and electronics, it contributed significantly to aggregate productivity growth in Canada in the pre-2000 period (Ho, Rao and Tang, 2004).

However, the productivity performance of this industry in Canada has deteriorated substantially since 2000. According to a recent study by Tang, Rao and Li (2010), output per hour worked was falling 3.0% per year in the period of 2000-2008, compared to a positive growth rate of 7.8% per year in the period 1987-2000, a difference of more than 10 percentage points between the two periods. Baldwin and Gu (2009) show that electronic product manufacturing made the largest contribution to the decline in labour productivity growth in the manufacturing sector between 1988- 2000 and 2000-2005 periods, accounting for 0.2 percentage points of the 2.4 percentage point slowdown in aggregate manufacturing labour productivity growth.

The Canadian industry has also underperformed its U.S. counterpart after 2000. Hao, et al. (2008) find that Canadian labour productivity in the electronics and electrical product industry fell from 86% of the U.S. productivity level in 2000 to 36% in 2004. The relatively poor productivity growth in this industry, versus

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the U.S., is an important factor underlying the widening Canada-U.S. productivity gap in the manufacturing sector, as well as in the business sector as a whole (Chart 2).

Research shows that reallocation of output and resources within the industry contributed to productivity growth in aggregation. Some of reallocation may be due to a change in the composition of constituent sub-industries (or industry mix). Some may be due to firm turnover as a result of the entry of new firms, the exit of existing firms, and reallocation of resources and output between incumbents firms.

Nadeau and Rao (2002) find that part of the reason for Canada's slower productivity growth in the manufacturing sector as a whole versus the U.S. before 2000 was that Canada was less successful than the U.S. in shifting resources towards activities with higher productivity and more rapid productivity growth. In addition, they show that Canada's weaker performance was partly due to the fact that Canada was heavily dependent on resource-based manufacturing industries, which were characterized by relatively moderate rates of productivity growth, while the U.S. enjoyed the benefits from a high concentration on dynamic industries such as computer and electronic manufacturing.

Productivity growth at the industry level is ultimately driven by growth taking place at the firm/plant level and by the competitive process that constantly shifts market share from the exits to the entrants and/or from declining firms to growing firms. Baldwin and Gu (2004) show the main source of productivity growth in most manufacturing industries is the competitive process or plant turnover that shifts output shares toward the plants that are more productive. Beckstead and Brown (2005) find that the Canadian information and communication technology industry, for example, maintained firm entry and exit rates higher than the manufacturing sector average, both during and after the bursting of the tech bubble in 2000.

This paper examines the contributions of structural shifts and firm dynamics to Canada's weaker productivity growth in the electronic and electrical product manufacturing industry. It first asks how much of the industry's weaker productivity growth, both in the 2000s and relative to its U.S. counterpart, was due to shift in industry mix and how much was due to weaker productivity growth at the sub-industry level. It then traces the decline in productivity growth at the sub-industry level in Canada into slower productivity growth at the plant level and a change in plant dynamics due to entry and exit as well as reallocation among continuing plants.

This paper concerns only labour productivity as investment or capital stock data at the plant level are not available in Canada.[1] The analyses are conducted in a value-added framework with labour productivity being defined as value added per hour worked.

The structure of the paper is as follows. In section 2, we present the analytical frameworks for the analysis of the impacts of industry structural shift and plant dynamics on labour productivity growth. In section 3, we discuss data and measurement issues. In sections 4 and 5, we discuss the empirical findings of the industry mix effect and plant turnover effect on productivity growth of the industry. The final section, section 6, summarizes the key findings of the paper and discusses possible reasons for the productivity growth slowdown in the industry.

2. Methodology

In this section, we present the methodology for the analysis of the impacts of industry structural shift and plant dynamics on labour productivity growth.

[1] For an analysis of plant dynamics and multifactor productivity performance using micro data on U.S. manufacturing plants, please see Baily, Hulten and Campbell (1992).

2.1. Industry mix and productivity performance

The electronic and electrical product manufacturing industry is composed of 17 sub-industries (Table 1). The industry's productivity growth can be decomposed into a component reflecting productivity growth at the detailed sub-industry level and components capturing the shifts in industry structure. To decompose the industry productivity growth into those various components, we follow the methodology of Tang and Wang (2004).

Consider the industry with n sub-industries, with nominal output (Q), implicit price index (P), and labour input (L). Then real industry labour productivity can be decomposed into its components at the sub-industry level:

$$Z = \frac{Q}{PL} = \frac{\sum_i Q^i}{PL} = \frac{\sum_i \left(P^i L^i Z^i\right)}{PL} = \sum_i \left[\left(\frac{P^i}{P}\right)\left(\frac{L^i}{L}\right) Z^i\right]. \quad (1)$$

Define $p^i = P^i / P$, which is the relative output price of sub-industry i; $l^i = L^i / L$, the labour input share for sub-industry i; and $s^i = p^i l^i$, the labour input share adjusted for its relative output price, which we refer to here as the relative size of sub-industry i. The labour share is adjusted by the relative output price because a change in output prices also affects the importance of the sub-industry in output in aggregation.[2] This change in turn influences the contribution of the sub-industry to total labour productivity even when the sub-industry's labour share and labour productivity remain constant.

Substitute the new variables into equation (1):

$$Z = \sum_i \left[\left(\frac{P^i}{P}\right)\left(\frac{L^i}{L}\right) Z^i\right] = \sum_i \left(p^i l^i Z^i\right) = \sum_i \left(s^i Z^i\right). \quad (2)$$

Thus industry labour productivity can be expressed as the weighted sum of labour productivities of the sub-industries. The weight for each sub-industry is equal to its relative size which is equal to labour share adjusted for relative output price.[3]

Using equation (2), industry labour productivity growth over a period (one year or more) from t-1 to t can be written as

$$\begin{aligned} g\left(Z_t\right) &= \frac{Z_t - Z_{t-1}}{Z_{t-1}} = \frac{\sum_i \left(s_t^i Z_t^i - s_{t-1}^i Z_{t-1}^i\right)}{Z_{t-1}} = \frac{\sum_i \left[s_t^i \left(Z_t^i - Z_{t-1}^i\right) + \left(s_t^i - s_{t-1}^i\right) Z_{t-1}^i\right]}{Z_{t-1}} \\ &= \sum_i \frac{Z_{t-1}^i}{Z_{t-1}} \left[s_t^i g\left(Z_t^i\right) + \left(s_t^i - s_{t-1}^i\right)\right] \end{aligned} \quad (3)$$

Define $z_{t-1}^i = Z_{t-1}^i / Z_{t-1}$ as the labour productivity level of sub-industry i relative to the industry labour productivity level at the beginning of the period, and $\Delta s_t^i = s_t^i - s_{t-1}^i$, the change in the relative size of sub-industry i from t-1 to t. Then add and subtract $\sum_i z_{t-1}^i \left[s_{t-1}^i g\left(Z_t^i\right)\right]$ from equation (3), leading to

$$g(Z_t) = \sum_i z_{t-1}^i \left\{s_{t-1}^i g(Z_t^i) + \left[1 + g(Z_t^i)\right]\Delta s_t^i\right\}. \quad (4)$$

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[2] Both Statistics Canada and the U.S. Bureau of Economic Analysis have been using the chained-Fisher index in estimating real output. In the chained-Fisher index world, an industry contributes to real aggregate output growth through two channels: an increase in real output or a rise in output price. The observation has led to the development of the decomposition technique (Tang and Wang, 2004).

[3] Because of the adjustment, the sum of the weights can be larger or smaller than one, depending on whether industries with large (small) labour shares also have high (low) relative output prices.

Define $w_{t-1}^{i} = z_{t-1}^{i} s_{t-1}^{i}$, which is equal to Q_{t-1}^{i} / Q_{t-1}, the nominal output share of sub-industry *i* at the beginning of the period. Equation (4) can be rewritten as

$$g(Z_t) = \sum_i w_{t-1}^{i} g(Z_t^{i}) + \sum_i z_{t-1}^{i} \left[1 + g(Z_t^{i})\right] \Delta s_t^{i}. \qquad (5)$$

Thus, industry labour productivity growth can be decomposed into two components or effects. The pure productivity growth effect, $\sum_i w_{t-1}^{i} g\left(Z_t^{i}\right)$, is the sum of the weighted sub-industrial labour productivity growth rates, and the weight for each sub-industry is equal to its nominal output share at the beginning of the period. The pure productivity growth effect thus captures sub-industrial contributions purely due to sub-industrial labour productivity improvements. The isolation is important since this effect is independent of non-efficiency factors and is affected neither by the change in labour input share nor by the change in relative output price.

The *reallocation effect,* $\sum_i z_{t-1}^{i} \left[1 + g(Z_t^{i})\right] \Delta s_t^{i}$, is the sum of the weighted changes in relative size, and the weight for each sub-industry is equal to its relative labour productivity at the beginning of the period, adjusted for labour productivity growth. Note that a change in relative size in this paper reflects the change in importance of a sub-industry in an industry, which could be due to a change in labour input share or relative output price. The reallocation effect makes a positive contribution to productivity growth if a shift in importance is towards sub-industries of relatively high productivity and/or relatively high productivity growth.

2.2. Plant turnover and productivity performance

Labour productivity growth for a sub-industry can be decomposed into a within-plant effect and different components due to the reallocation of output and resources across individual plants. The within-plant effect measures the contribution from productivity improvements of continuing plants, holding their shares of inputs or outputs constant. The reallocation effect consists of the contribution from the reallocation of output and inputs among continuing plants and the contribution due to plant turnover (entry and exit).

Different methods have been proposed to account for the effect of reallocation on productivity growth, for example, Griliches and Regev (1995), Foster, Haltiwanger and Krizan (2001), and Baldwin and Gu (2006).[4] These methods mainly differ in their assumptions on the displacement process to separate contribution of entry from that of exit.

Griliches and Regev (1995) implicitly assume the entrants displace average firms and compare the entering and exiting firms to an average firm over a period. Foster, Haltiwanger and Krizan (2001) also implicitly assume that entrants displace average firms, but compare entrants and exits with an average firm at the start of the period. Baldwin and Gu (2006) assume that entrants displace exits and compare entrants to exits. While those different assumptions provide different estimates of contributions from entry and exit, the contribution of net entry (or sum of entry and exit's contributions) is similar across all those methods.

In this paper, we follow Griliches and Regev (1995) or the GR method and focus on net entry. The decomposition process is similar to the decomposition of industry productivity growth into components at the sub-industry level, but with the added dimension of plants entering and exiting.

First, sub-industry productivity can be expressed as the weighted sum of plant productivities:

[4] Baldwin and Gu (2006) examined the differences in the three decomposition methods and the underlying assumptions behind the alternate formulae.

$$Z^{i} = \sum_{j} s^{ij} Z^{ij} \ . \tag{6}$$

In equation (6), weight *s* is equal to plant employment share, adjusted for its relative output price. However, as discussed in section 3.2, deflators at the plant level are not available and we have to apply sub-industry deflator to all plants. As a result, relative output price for each plant is unity within the sub-industry, and weight *s* is equal to plant employment share.

The productivity growth of a sub-industry is equal to $g\left(Z_t^{i}\right) = \Delta Z_{t,t-1}^{i} / Z_{t-1}^{i}$ over the period from *t-1* to *t*. The productivity change over this period, $\Delta Z_{t,t-1}^{i}$, can be expressed as:

$$\Delta Z_{t,t-1}^{i} = \sum_{i} s_t^{ij} Z_t^{ij} - \sum_{i} s_{t-1}^{ij} Z_{t-1}^{ij} \ . \tag{7}$$

The plants in period *t* can be grouped into entrants (set *E*), which were not operating in period *t*-1, and continuing plants (set *C*), which were already present in period *t*-1. Similarly, plants in period *t*-1 can be grouped into continuing plants (set *C*) and exits (set *X*), which would not be operating in period *t*. The grouping allows us to rewrite equation (7) into a continuing plant component, an entrant component and an exit component:

$$\begin{aligned} \Delta Z_{t,t-1}^{i} &= \left(\sum_{j\in C} s_t^{ij} Z_t^{ij} + \sum_{j\in E} s_t^{ij} Z_t^{ij}\right) - \left(\sum_{j\in C} s_{t-\tau}^{ij} Z_{t-1}^{ij} + \sum_{j\in X} s_{t-1}^{ij} Z_{t-1}^{ij}\right) \\ &= \left(\sum_{j\in C} s_t^{ij} Z_t^{ij} - \sum_{j\in C} s_{t-1}^{ij} Z_{t-1}^{ij}\right) + \sum_{j\in E} s_t^{ij} Z_t^{ij} - \sum_{j\in X} s_{t-1}^{ij} Z_{t-1}^{ij} \end{aligned} \tag{8}$$

After some rearrangement, the above equation can be rewritten as

$$\begin{aligned} \Delta Z_{t,t-1}^{i} &= \sum_{j\in C} \overline{s}^{ij} (Z_t^{ij} - Z_{t-1}^{ij}) + \sum_{j\in C} (s_t^{ij} - s_{t-1}^{ij})(\overline{Z}^{ij} - \overline{Z}^{i}) \\ &+ \sum_{j\in E} s_t^{ij} (Z_t^{ij} - \overline{Z}^{i}) - \sum_{j\in X} s_{t-1}^{ij} (Z_{t-1}^{ij} - \overline{Z}^{i}) \end{aligned} \tag{9}$$

where over-lined variables represent the two-period average between *t*-1 and *t*, and $\overline{Z}^{i}$ is the two-period average sub-industry productivity.

The first term is the within-plant contribution from productivity change in continuing plants. The within term is independent of input allocation changes and reflects solely on improvements on the productivity performances of continuing plants. The second term is the between-plant contribution, capturing the effects of shifting in employment shares between continuing plants. This term is positive when plants that gain employment share are more productive than the sub-industry average, and plants that lose employment share are less productive than the sub-industry average.

The last two terms are the effects of entering and exiting plants, respectively. Like the between term, productivity of entrants and exits are compared with the sub-industry average. When entrants are more productive than the sub-industry average, their entry will have a positive effect on the productivity performance of this sub-industry. Similarly, when exits are less productive, then their exit will also have a positive effect. The sum of the entering and exiting effects is the net entry effect.

3. Data and measurement issues

This section provides the data sources for our analyses, and deals with measurement issues associated with the data.

3.1. Data sources

We make use of the data collected by the Census of Manufactures programs in Canada and the U.S. Both programs are quite similar in how they collect data on outputs and inputs.

The Canadian data comes from a longitudinal file that was constructed from the micro-records of Statistics Canada's Annual Survey (Census) of Manufactures (ASM). The file covers the entire Canadian manufacturing sector using both survey and administrative data, and permits plants and firms to be followed over time. It collects data on manufacturing value added and employment, together with other variables, for about 54,000 manufacturing plants, of which about 3,200 plants are in the electronic and electrical product manufacturing industry.

For the U.S., we obtain data for total value added and employment from the U.S. Census Bureau. These data are at the very detailed industry level (six-digit NAICS level). They are also aggregated from the micro-records of the U.S. ASM administrated by the U.S. Census Bureau. Note, however, unlike in Canada, that the value added for the U.S. is total value added, which consists of both manufacturing value added and value added from merchandising operations (i.e., the difference between the sales value and the cost of merchandise sold without further manufacture, processing, or assembly).

The electronic and electrical product manufacturing industry consists of computer and electronic product manufacturing (NAICS 334) and electrical equipment manufacturing (NAICS 335). For this paper, we divide the two manufacturing industries into 17 sub-industries, at five or six-digit NAICS level, which is the most-detailed industry level that meets the Statistics Canada confidentiality policy (Table 1).

For our analysis, we choose the period of 1997-2006, for which we have data for both Canada and the U.S. The industry mix and plant turnover effects on productivity growth are examined for two periods: 1997–2000 and 2000–2006. We use 2000 as a dividing point to contrast trends before and after the burst of the high-tech bubble.

3.2. Data adjustments

To improve the comparability over time and between the two countries, we made several adjustments to the industry level data obtained from the ASM data for both Canada and the U.S.

First, the ASM data may not be entirely comparable over time due to changes in industry classification (e.g., from 1997 NAICS to 2002 NAICS) and in sampling methodology. For instance, for Canada, the micro-records of the ASM for the 1997-1999, the 2000-2003, and the 2004-2006 sub-periods are drawn from different populations.

Second, "value-added" from the ASM is often referred to as "census value-added," and is inclusive of payments for purchased services, which is part of intermediate inputs for production. Including purchased service in the analysis has a significant effect, since the increased trend in outsourcing in services activities in the manufacturing sectors and the development may differ between Canada and the U.S. In addition, census value-added does not include the output from those who are self-employed.

Third, as discussed in section 3.1, "value added" for Canada is manufacturing value added and for the U.S., it is total value added, which also includes value added from non-manufacturing activities, i.e., merchandising operations.

Finally, the number of employees from the Census of Manufactures is not exactly equal to the number of employees used by the statistical agencies to produce the official productivity statistics, and it needs to add those that are classified as being self-employed. In addition, we need to adjust part-time and full-time employment to hours worked to reflect the change in work intensity over time.

To make these adjustments, we benchmark the industry employment and value-added obtained from the ASM to the data on hours worked and value-added from Statistics Canada's productivity program for

Canada (CANSIM tables 383-0021 and 383-0009).[5] For the U.S., the data from the U.S. ASM are benchmarked to the data on value-added and employment from the industry accounts of the U.S. Bureau of Economic Analysis (value added) and the U.S. Bureau of Labor Statistics (hours worked for all persons). Due to data availability, the adjustment is made at the four-digit level for Canada and at the three-digit level for the U.S.

The adjustment at the industry level for both Canada and the U.S. are in Table 2. The benchmarking adjustment has little effect on the growth rates of value added and labour for Canada. For the U.S. the adjustment has little effect on the growth rates of value added. But it affects the growth of labour for the U.S. The growth of hours worked from the U.S. BEA is higher than the growth of employment obtained from the ASM. This partly reflects the increased work intensity in the U.S. in the industry over this period.

The adjustment has an effect on the level of the output as the value added from the ASM includes the cost of purchased services, while the value-added from the industry accounts or productivity program excludes the cost of purchased services. The ratio of the value added from the national accounts to the value-added from the ASM is larger in Canada as the ASM value added for the U.S. is total value added while it is manufacturing value added for Canada. The ratio of the benchmarking hours worked to the employment from the ASM is lower in Canada than in the U.S., since Canadian workers tend to work shorter hours than their U.S. counterparts.

For real value added, we need value added price deflators to deflate nominal value added. The price deflators are not available at the plant-level or the detailed industry level as in Table 1. So we have to rely on price deflators at a more aggregated industry level. For the U.S., we use deflators at the three-digit NAICS level: computers and electronic products (334) and electric products (335), which are from U.S. Bureau of Economic Analysis. For Canada, the deflators are at four-digit NAICS or combined four-digit NAICS industry level from Statistics Canada.

4. Electronic and electrical product manufacturing industry in Canada and the U.S.

In Canada, the computer and electronic product industry was more productive than the electrical equipment industry (Table 3). In 2006, the computers and electronics industry was 12% more productive than the industry average while the electrical equipment industry was 25% less productive.[6] The most productive sub-industry was the computer and peripheral equipment industry.

The productivity profile of the electronic and electrical product industry in the U.S. was generally similar to that in Canada. However, the productivity difference between the computers and electronic product industry and the electrical equipment was even larger. In 2006, the US computer and electronic product industry was 38% more productive than the industry average while the electric equipment industry was 76% less productive. The most productive sub-industry was telephone apparatus, followed by the computer and peripheral equipment industry.

The electronic and electrical product manufacturing industry is smaller in Canada than in the U.S. It accounted for about 7.5% of hours worked in the Canadian manufacturing sector in 2008 and the share has been fairly stable since 1997. In terms of nominal value added, however, its share declined from 7.7% in

[5] For comparison, the benchmarking value added in basic prices for Canada is adjusted to value added at factor cost. Similarly, for the U.S., value added in market prices is adjusted to value added at factor cost.
[6] The productivity level comparisons should be undertaken with the understanding that the relative levels are sensitive to the base year.

1997 to 6.2% in 2008. In contrast, the industry is much more important for the U.S. manufacturing sector where it accounted for more than 12% of hours worked and nominal value added in 2007.

In Canada, the computers and electronic product sub-industry made up more than two thirds of nominal value added, while electrical equipment made up less than one third (Table 3). Of these 17 sub-industries, only three sub-industries produced more than ten percent of nominal value added in 2006. They were radio, TV, and wireless communication equipment (11.0%), semiconductors (13.7%), and instruments (21.7%).

In the U.S., computer and electronic product manufacturing was larger than electrical equipment manufacturing, making up 72.2% of the output in 2006, while for Canada, it was 66.6%. In particular, the U.S. semiconductors sub-industry was much larger and had a share of 23.9% in 2006, while, in Canada its share was 13.7%. On the other hand, the radio, TV and wireless communication equipment sub-industry in the U.S. was relatively smaller than in Canada, with the output share being 6.1% and 11.0%, respectively.

It is interesting to note that the value added share for telephone apparatus as well as for semiconductors declined substantially in Canada from 2000 to 2006. The value added share for telephone apparatus declined from 24.5% in 2000 to 4.6% in 2006. Similarly, for semiconductor, the share decreased from 20.0% to 13.7%. At the same time, radio, TV and wireless communication equipment as well as instruments in Canada saw their shares more than doubled from 5.0% in 2000 to 11.0% in 2006 and from 11.0% to 21.7%, respectively.

As in Canada, telephone apparatus as well as semiconductor in the U.S. also experienced a decline in value added share, but the decline was more moderate (from 10.1% to 4.6% for telephone apparatus and from 29.6% to 23.9% for semiconductor). Also like Canada, the U.S. also saw its value added share for instruments increased from 17.0% to 23.7% over this period.

In both countries, there were also important shifts in industry structure in terms of employment share, although they were more moderate than the changes in value added share. The employment shift was mainly within the computer and electronic product industry after 2000 (Table 4). Both countries experienced a decline in employment share in computer and peripheral equipment, telephone apparatus, and semiconductors. In Canada, the lost employment share was picked up mainly by radio, TV and wireless communications equipment and instruments while in the U.S., it was taken over by instruments.

In terms of relative size, which also takes into account of the relative output price of a sub-industry, the decline in importance of computer and electronic product manufacturing was more pronounced, especially in the U.S. This is because the differences in relative output prices between computer and electronic product and electrical equipment were much smaller in Canada than in the U.S. It reflects a much faster decline in the output prices of computer and electronic products in the U.S. than in Canada over the time period.

5. Empirical findings on the industry mix effect

We now apply the Tang and Wang (2004) decomposition to productivity changes in the Canadian and U.S. electronic and electrical product industry over 1997–2000 and 2000–2006. We first discuss the Canadian experiences and then compare them to the U.S.

Canada

As shown in Table 5, the productivity changes in the Canadian electronic and electrical product industry in those two periods were dominated by pure productivity changes within constituent sub-industries and the reallocation effect was small.

In 1997–2000, the industry productivity increased by 21.1% per year. Pure productivity growth was the primary factor, accounted for 90% of the total productivity growth. Computer and electronic product manufacturing accounted for 77% of the growth, again primarily driven by pure productivity growth.

Among the sub-industries, semiconductors accounted for 29% of the industry productivity growth, followed by telephone apparatus accounting for 27%. It is interesting to note that the computers and peripheral equipment, which experienced the largest productivity growth over this period, had a minimal contribution. This was because its large pure productivity growth effect was offset by a large negative relative size change effect, due to a substantial decline in relative output price and to a lesser extent to the decline in its employment share.

In 2000–2006, the industry productivity in Canada fell by 4.1% per year. This was a decline of 25.2 percentage points compared to 1997-2000, largely driven by negative pure productivity growth, which accounted for 88% of the productivity growth slowdown. About 80% of the productivity growth slowdown was due to the productivity growth decline in computer and electronic product manufacturing, mainly from telephone apparatus and semiconductors.

U.S.

Similar to the Canadian situation, the productivity growth in the U.S. electronic and electrical product industry declined a 21.1 percentage-points difference between the pre- and post-2000 periods (Table 6). However, unlike in Canada, where productivity growth was negative 4.1% per year in the post-2000 period, labour productivity in the U.S. continued to grow at a healthy pace at 25.6% per year.

Also, as in Canada, the decomposition shows that computer and electronic product manufacturing was the driving force of productivity trends in the U.S., accounting for more than two-thirds of the productivity growth. The largest contributor was semiconductors and instruments in both periods, which was again entirely driven by pure productivity growth.

Counterfactual Analysis

As discussed in section 4, the Canadian electronic and electrical product industry had a different industry mix than its US counterpart. Most notably, semiconductors and instruments in the U.S. were much larger in terms of both employment and output than in Canada.

In this sub-section, we examine how industry structure differences affect the productivity performance of the electronic and electrical product industry in Canada, using a counterfactual analysis. To this end, we replace Canadian sub-industry output and employment shares by corresponding U.S. output and employment shares in the decomposition, keeping the values of other variables as before.

The counterfactual analysis shows that the productivity profile of the Canadian electronic and electrical product industry would grow almost at the same pace as before (Table 7). At the sub-industry level, as expected, the shift in industry structure would increase significantly the importance of semiconductor in contribution to industry labour productivity growth. But, at the same time, it would decrease the importance of some other sub-industries. For example, the contribution from telephone apparatus would be reduced by more than half.

In sum, the counterfactual analysis suggests that the differences in industry structure of the electronic and electrical product industry between Canada and the U.S. are not a factor for the weaker productivity performance of the industry in Canada than in the U.S.

6. Empirical findings on the plant turnover effect in Canada

In this section, we deepen our investigation for Canada by examining the role played by plant turnover in productivity performance. To this end, we divide the participants in each sub-industry into three groups: continuing plants, entrants and exits. Because of the further disaggregation, some sub-industries have to be combined to meet the Statistics Canada's confidential policy. As a result, we end up with six combined sub-industries: computers and peripheral equipment; communications equipment; semiconductors; instruments; other electronic products; and electrical equipment. The first four sub-industries made up 59% of the industry value added and 56% of total employment in 2006. We combine the telephone apparatus industry with other electronic products, despite its large output share and productivity changes, because plant entry and exit data for the sub-industry is confidential.

6.1. Plant Turnover in the Canadian electronic and electrical product industry Canada

In this section, we discuss plant turnover in the Canadian electronic and electrical product industry and how it differs between the pre- and post-2000 periods.

1997-2000

In the pre-2000 period, exiting plants made up about a quarter of the 1997 plant population, and entering plants made up almost 40% of the 2000 plant population (Table 8).[7] There was a net increase in the number of plants. This ratio was relatively consistent across constituent sub-industries.

Entrants and exits were typically smaller than continuing plants. They employed about 80% and 36%, respectively, of the employment of continuing plants in 1997-2000 (Table 9). There was more dispersion in the size of exits than of entrants among sub-industries. Exits ranged from as little as 31% smaller than continuing plants in electrical equipment to 4% smaller in computers and peripheral equipment. Meanwhile, continuing plants' employment expanded by an average of 15%.

Entrants and exits were both less productive than continuing plants in this period (Table 10). Exits were 22% less productive than the continuing plants in 1997 and entrants were 30% less productive than the continuing plants in 2000. Over this period, continuing plants improved productivity by 58%.

The productivity distribution was wide among sub-industries. In 1997, exiting plants ranged from being 63% less productive than continuing plants in the semiconductors sub-industry to 50% more productive in the computers and peripheral equipment sub-industry. Similarly, in 2000, entrants ranged from 73% less productive than continuing plants in the other electronic product sub-industry, to 15% more productive in the instruments sub-industry.

2000-2006

The high-tech bubble popped after the turn of the century. As a result, there was decline in plant population as large number of plants exited the industry. There were more exits than entrants. Exiting plants made up 51% of the 2000 plant population, but entering plants made up only 44% of the 2006 population (Table 8).[8]

As in 1997–2000, entrants and exits in 2000-2006 were generally smaller than continuing plants, but there was a large dispersion of employment across sub-industries (Table 9). Exiting plants ranged from employing 32% fewer workers than continuing plants in computers and peripheral equipment manufacturing to hiring

[7] Plant turnover due to changes in industry classification was minor, accounting for about 1-2% of the turnover in total

[8] Note, however, that since the number of continuing plants relative to the number of entrants and exits can only decrease over time, the employment shares of entrants and exits should increase with time, assuming other factors being constant.

25% more workers than continuing plants in the semiconductors sub-industry. Entering plants ranged from employing 53% fewer workers in computers and peripheral equipment to employing 1% more workers in semiconductor.

For the industry as a whole, continuing plants increased employment share by 1% over this period, but there was large dispersion across sub-industries, from employing 41% fewer workers in computers and peripheral equipment to employing 33% more workers in communications equipment.

On average, exits were 33% more productive and entrants were 14% less productive than continuing plants (Table 10). At the sub-industry level, however, exiting plants were 43% less productive than continuing plants in 2000 in computer and peripheral equipment and communications equipment, to 86% more productive in the other electronic product industry.[9] Similarly, there was a large difference between the productivity of entering plants and the productivity of continuing plants. Entering plants ranged from 32% less productive than the continuing plants in semiconductor in 2006 to 34% more productive than continuing plants in computers and peripheral equipment.

The observation that exiting firms are on average more productive than continuing firms in the period 2000-2006 contrasts with the previous finding that exits tend to be on average less productive than incumbents in manufacturing (for example, Baldwin and Gu, 2006, Foster, Haltiwanger and Krizan, 2001).

Productivity of continuing plants fell on average by 9% over this period. But, in computer and peripheral equipment and instruments sub-industries, continuing plants improved their productivity, by 100% and 9%, respectively.

6.2. The productivity effect of plant turnover

As shown in Table 5, the decline in labour productivity growth in the Canadian electronic and electrical product industry between the pre-2000 and post-2000 periods was mainly from the decline in productivity growth at the sub-industry level. The effect is referred to as the pure productivity growth effect, which is equal to the weighted sum of labour productivity growth of the sub-industries, with the weight being the nominal output share of each sub-industry at the beginning of each period.

In this section, we decompose labour productivity growth at the sub-industry level into components associated with continuing plants, entrants and exits, using the GR decomposition framework described in section 2.2. The results are reported in Table 11. A positive number for entrants (exits) represents the entrants (exits) being on average more (less) productive than the industry average, and vice versa. The component related to net entry is the sum of the components for entrants and exits.

The GR decomposition results show that the dramatic decline in labour productivity growth in the continuing plants between pre-2000 and post-2000 periods was mainly responsible for the dramatic decline in productivity growth in the Canadian sub-industries (Table 11). The contributions from resource reallocation between continuing plants, entrant and exit were relatively small, but significant. For instance, in 1997–2000, productivity in the computer and peripheral equipment sub-industry grew at a rate of 47.5% per year while in 2000-2006, the growth rated declined to 25.8% per year. The sharp in decline in productivity growth rate was largely due to the decline in productivity growth of continuing plants.

[9] Unfortunately, we could not pin down the source due to the lack of identification of those exiting plants. Presumably, the falling of high flying high-tech companies such as Nortel Networks and JDS Uniphase during the high-tech boom might have contributed to the anti-intuitive result.

The weaker labour productivity performance of continuing plants (i.e., the within plants contribution) was responsible for two-thirds of the decline in the pure productivity growth effect.[10] The latter in turn, as shown in Section 4, was mainly responsible for the decline in labour productivity growth of the Canadian electronic and electrical product industry between the pre- and post-2000 periods. While net entry had a positive contribution to productivity growth before 2000, it made a negative contribution after 2000, accounting for 23.1% of the productivity growth slowdown. The resource reallocation between continuing plants was responsible the remaining 10.9% of the slowdown.

7. Concluding remarks

Productivity growth in the Canadian electronic and electrical product industry declined between the pre-2000 and post-2000 period, despite observed technological advancement and intense competition (high plant turnover) in the industry.

This paper shows that the dramatic decline in productivity growth was mainly due to the slowdown in productivity growth in sub-industries. About two-thirds of the productivity growth decline in sub-industries can be traced to the decline in labour productivity growth in continuing plants, mainly within computers, communications equipment and semiconductors manufacturing. The remaining one-third of the decline was due to the net entry of less efficient plants and to a lesser extent the reallocation of labour between continuing plants. Finally, the paper shows that even if the Canadian industry mix were the same as the U.S. industry mix over these periods, the productivity growth profile of the Canadian industry would not change.

Many factors might have contributed to the productivity growth slowdown. Two of these factors were: large restructuring/adjustment costs and lower capacity utilization within the industry following the burst of the high-tech bubble in 2000. The high-tech bubble, partly due to the media hype and exaggeration of the Y2K problem (the millennium bug), led to overinvestment of information technology equipment and created considerable excess capacity in this industry.[11] For instance, the value of shipments of Canadian computer and electronic product industry increased from \$27.3 billion in 1999 to \$37.3 billion in 2000, a 37% jump (Table 12).[12]

But, the demand for computer and electronic products collapsed immediately following the turn of the century. This is evidenced by the decline of the value of shipments from \$37.3 billion in 2000 to \$27.0 billion in 2001.[13] As a result, the industry experienced the lowest levels of capacity utilization, from 97 percent in 2000 to 72 percent in 2001 and 67 percent in 2002.

The good news is that there is some evidence to suggest that the painful restructuring or adjustment in the Canadian electronic and electrical product industry might have been completed. Over the period 2006-2008, labour productivity grew at an annual rate of 4.5% in the Canadian computer and electrical product industry and 4.8% in the electrical equipment industry. The hypothesis of recovery is also supported by increased capacity utilization in the two industries to an above-average level around 88% for computer and electronic product manufacturing and 83% for electrical equipment manufacturing in recent years.

[10] The weighted sum of total components is similar but not identical to the pure productivity growth effect in the industry mix analysis, that is, the first term in equation (5) in section 2.1. The discrepancy is due to a higher level of disaggregation of the electronic and electrical product industry for plant turnover analysis than for industry mix analysis.

[11] In a recent study, Baldwin, Gu and Yan (2011) show that most of the decline in labour productivity growth in the Canadian manufacturing sector after 2000 was due to the decline in capacity utilization.

[12] About 90% of the Canadian shipments were exported.

[13] Part of the further decline in demand after 2002 was due to the appreciation of the Canadian dollar relative to the U.S. dollar and increased competition from China in the U.S. market. As shown in Table 13, the Chinese share of the U.S. imports increased substantially, especially for the computer and electronic products,

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Table 1. Definitions of constituent sub-industries in the electronic and electrical product manufacturing industry

Industries	NAICS code	
	Canada	US
Electronic and electrical product		
Computer and electronic product	**334**	**334**
Computers and peripheral equipment	334110	33411
Telephone apparatus	334210	334210
Radio, TV and wireless communication equipment	334220	334220
Other communication equipment	334290	334290
Audio and video equipment	334310	334310
Semiconductors	334410	33441
Instruments	33451	33451
Magnetic and optical media	334610	33461
Electrical equipment	**335**	**335**
Small electrical appliances	335210	335210
Major appliances	33522	33522
Power, distribution, and specialty transformers	335311	335311
Motors and generators	335312	335312
Switchgear, and relay and industrial control apparatus	335315	335313 & 335314
Batteries	33591	33591
Communication and energy wire and cable	335920	335920
Wiring devices	335930	335930
Electric lighting equipment and other electrical products	3351 & 33599	3351 & 33599

Table 2. The industry adjustments for the Canadian and the U.S. electronic and electrical product industry, 1997-2006

Year	**Canada**			**U.S.**		
	Output-related Adjustment $\tilde{Q}/Q$ (1)	Labour related Adjustment $\tilde{H}/L$ (2)	Total Adjustment (1)/(2)	Output-related Adjustment $\tilde{Q}/Q$ (1)	Labour related Adjustment $\tilde{H}/L$ (2)	Total Adjustment (1)/(2)
1997	0.76	2.05	0.37	0.64	2.39	0.27
1998	0.74	2.01	0.37	0.66	2.39	0.27
1999	0.75	2.00	0.37	0.63	2.39	0.26
2000	0.74	2.04	0.36	0.68	2.38	0.28
2001	0.70	2.01	0.35	0.65	2.28	0.28
2002	0.73	1.97	0.37	0.67	2.43	0.27

2003	0.74	1.93	0.38	0.66	2.47	0.27
2004	0.75	2.15	0.35	0.62	2.56	0.24
2005	0.79	2.23	0.36	0.62	2.65	0.23
2006	0.73	2.04	0.36	0.67	2.68	0.25

Note: $\tilde{Q}$ and $\tilde{H}$ are benchmarking value added and hours worked, and Q and L are ASM "value added" and employment.

Table 3. Output share and relative labour productivity level in the Canadian and U.S. electronic and electrical product manufacturing industries, 1997–2006

Industries	Nominal output share			Relative labour		
	1997	2000	2006	1997	2000	2006
Canada						
Electronic and electrical product	**100.0**	**100.0**	**100.0**	**1.00**	**1.00**	**1.00**
Computer and electronic product	**69.6**	**72.4**	**66.6**	**1.04**	**1.13**	**1.12**
Computers and peripheral equipment	8.5	7.0	7.0	0.83	1.24	4.19
Telephone apparatus	22.8	24.5	4.6	2.29	2.32	0.79
Radio, TV and wireless communication equipment	5.4	5.0	11.0	0.83	0.85	1.01
Other communication equipment	1.6	2.0	3.9	0.65	0.63	0.95
Audio and video equipment	0.6	0.5	1.3	0.57	0.56	1.05
Semiconductors	13.9	20.0	13.7	0.96	1.10	0.85
Instruments	13.6	11.0	21.7	0.71	0.64	0.90
Magnetic and optical media	3.2	2.5	3.3	1.03	0.90	1.30
Electrical equipment	**30.4**	**27.6**	**33.4**	**0.92**	**0.71**	**0.75**
Small electrical appliances	1.6	0.6	0.8	1.14	0.63	1.19
Major appliances	5.0	3.0	3.7	1.18	0.77	0.96
Power, distribution, and specialty transformers	2.7	2.7	3.5	0.81	0.63	0.66
Motors and generators	2.4	1.7	3.0	0.94	0.59	0.74
Switchgear, and relay and industrial control	4.5	3.8	5.7	0.88	0.66	0.66
Batteries	1.0	0.5	0.6	1.14	0.58	0.48
Communication and energy wire and cable	4.8	9.5	6.7	1.09	1.09	0.93
Wiring devices	1.5	1.5	3.3	0.78	0.58	0.83
Electric lighting equipment and other electrical products	6.8	4.3	6.1	0.74	0.47	0.58
U.S.						
Electronic and electrical product	**100**	**100**	**100**	**1.00**	**1.00**	**1.00**
Computer and electronic product	**77.2**	**78.6**	**72.2**	**1.01**	**1.22**	**1.38**
Computers and peripheral equipment	13.5	12.2	11.0	1.24	1.52	2.18
Telephone apparatus	7.3	10.1	4.6	1.55	2.36	2.90
Radio, TV and wireless communication equipment	6.7	6.7	6.1	0.88	1.08	1.47

Other communication equipment	0.8	0.8	0.8	0.70	0.88	0.92
Audio and video equipment	0.7	0.9	1.0	0.53	0.81	1.09
Semiconductors	28.8	29.6	23.9	1.09	1.23	1.32
Instruments	17.8	17.0	23.7	0.81	0.92	1.18
Magnetic and optical media	1.7	1.3	1.0	0.69	0.75	0.68
Electrical equipment	**22.8**	**21.4**	**27.8**	**0.96**	**0.44**	**0.24**
Small electrical appliances	1.1	0.9	0.8	1.04	0.45	0.23
Major appliances	2.9	2.6	4.1	1.04	0.41	0.26
Power, distribution, and specialty transformers	1.0	0.9	1.2	0.95	0.43	0.21
Motors and generators	2.4	1.8	2.7	0.83	0.33	0.21
Switchgear, and relay and industrial control	4.2	3.8	5.1	0.98	0.44	0.24
Batteries	1.4	1.4	1.6	1.10	0.51	0.23
Communication and energy wire and cable	2.5	2.9	2.7	1.13	0.56	0.29
Wiring devices	2.4	2.6	3.3	0.88	0.45	0.26
Electric lighting equipment and other electrical products	4.8	4.6	6.3	0.92	0.42	0.24

Table 4. Relative size of the Canadian and U.S. electronic and electrical product manufacturing industries, 1997–2006

Industries	Employment share			Relative output price			Relative size		
	1997	2000	2006	1997	2000	2006	1997	2000	2006
Canada									
Electronic and electrical product	**100.0**	**100.0**	**100.0**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Computer and electronic product	**66.9**	**67.7**	**65.6**	**1.00**	**0.94**	**0.91**	**0.67**	**0.64**	**0.60**
Computers and peripheral equipment	10.2	11.5	7.4	1.00	0.49	0.23	0.10	0.06	0.02
Telephone apparatus	9.9	10.1	5.3	1.00	1.04	1.11	0.10	0.11	0.06
Radio, TV and wireless communication equipment	6.5	5.6	9.8	1.00	1.04	1.11	0.07	0.06	0.11
Other communication equipment	2.5	3.0	3.7	1.00	1.04	1.11	0.03	0.03	0.04
Audio and video equipment	1.0	0.8	1.1	1.00	1.04	1.11	0.01	0.01	0.01
Semiconductors	14.5	17.5	14.5	1.00	1.04	1.11	0.15	0.18	0.16
Instruments	19.2	16.5	21.6	1.00	1.04	1.11	0.19	0.17	0.24
Magnetic and optical media	3.1	2.7	2.3	1.00	1.04	1.11	0.03	0.03	0.03
Electrical equipment	**33.1**	**32.3**	**34.4**	**1.00**	**1.20**	**1.30**	**0.33**	**0.39**	**0.45**
Small electrical appliances	1.4	0.9	0.8	1.00	0.98	0.93	0.01	0.01	0.01
Major appliances	4.2	4.0	4.2	1.00	0.98	0.93	0.04	0.04	0.04
Power, distribution, and specialty transformers	3.3	3.4	3.8	1.00	1.25	1.39	0.03	0.04	0.05

Motors and generators	2.5	2.3	3.0	1.00	1.25	1.39	0.03	0.03	0.04
Switchgear, and relay and industrial control apparatus	5.1	4.6	6.2	1.00	1.25	1.39	0.05	0.06	0.09
Batteries	0.9	0.8	0.9	1.00	1.25	1.39	0.01	0.01	0.01
Communication and energy wire and cable	4.4	6.9	5.1	1.00	1.25	1.39	0.04	0.09	0.07
Wiring devices	2.0	2.1	2.9	1.00	1.25	1.39	0.02	0.03	0.04
Electric lighting equipment and other electrical products	9.2	7.2	7.5	1.00	1.25	1.39	0.09	0.09	0.10
U.S.									
Electronic and electrical product	**100**	**100**	**100**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Computer and electronic product	**76.3**	**75.8**	**75.2**	**1.00**	**0.85**	**0.70**	**0.76**	**0.65**	**0.52**
Computers and peripheral equipment	10.8	9.4	7.2	1.00	0.85	0.70	0.11	0.08	0.05
Telephone apparatus	4.7	5.0	2.3	1.00	0.85	0.70	0.05	0.04	0.02
Radio, TV and wireless communication equipment	7.5	7.3	6.0	1.00	0.85	0.70	0.08	0.06	0.04
Other communication equipment	1.1	1.0	1.2	1.00	0.85	0.70	0.01	0.01	0.01
Audio and video equipment	1.4	1.3	1.4	1.00	0.85	0.70	0.01	0.01	0.01
Semiconductors	26.5	28.2	26.0	1.00	0.85	0.70	0.27	0.24	0.18
Instruments	21.9	21.5	28.9	1.00	0.85	0.70	0.22	0.18	0.20
Magnetic and optical media	2.4	2.0	2.2	1.00	0.85	0.70	0.02	0.02	0.02
Electrical equipment	**23.7**	**24.2**	**24.8**	**1.00**	**2.02**	**4.63**	**0.24**	**0.49**	**1.15**
Small electrical appliances	1.1	1.0	0.8	1.00	2.02	4.63	0.01	0.02	0.04
Major appliances	2.8	3.1	3.4	1.00	2.02	4.63	0.03	0.06	0.16
Power, distribution, and specialty transformers	1.1	1.1	1.2	1.00	2.02	4.63	0.01	0.02	0.06
Motors and generators	3.0	2.7	2.8	1.00	2.02	4.63	0.03	0.05	0.13
Switchgear, and relay and industrial control apparatus	4.3	4.3	4.6	1.00	2.02	4.63	0.04	0.09	0.21
Batteries	1.3	1.3	1.6	1.00	2.02	4.63	0.01	0.03	0.07
Communication and energy wire and cable	2.2	2.5	2.0	1.00	2.02	4.63	0.02	0.05	0.09
Wiring devices	2.7	2.8	2.7	1.00	2.02	4.63	0.03	0.06	0.13
Electric lighting equipment and other electrical products	5.2	5.4	5.7	1.00	2.02	4.63	0.05	0.11	0.27

Table 5. Industry contribution to labour productivity growth in the Canadian electronic and electrical product manufacturing industry, 1997–2000 and 2000-2006

Industries	Labour productivity growth rate (% per year)	Contribution		
		Total	Pure productivity growth	Reallocation
1997-2000				
Electronic and electrical product	**21.1**	**21.1**	**19.0**	**2.1**
Computer and electronic product	**25.8**	**16.2**	**17.1**	**-1.0**
Computers and peripheral equipment	47.5	1.0	4.0	-3.1
Telephone apparatus	21.6	5.7	4.9	0.8
Radio, TV and wireless communication equipment	21.8	0.9	1.2	-0.3
Other communication equipment	19.1	0.5	0.3	0.2
Audio and video equipment	19.7	0.1	0.1	0.0
Semiconductors	28.5	6.2	4.0	2.2
Instruments	15.9	1.5	2.2	-0.7
Magnetic and optical media	13.8	0.3	0.4	-0.1
Electrical equipment	**9.1**	**4.9**	**1.8**	**3.0**
Small electrical appliances	-3.1	-0.2	0.0	-0.2
Major appliances	1.9	0.0	0.1	-0.1
Power, distribution, and specialty transformers	9.2	0.6	0.2	0.4
Motors and generators	1.0	0.1	0.0	0.1
Switchgear, and relay and industrial control	7.4	0.6	0.3	0.2
Batteries	-5.6	0.0	-0.1	0.0
Communication and energy wire and cable	21.1	3.5	1.0	2.6
Wiring devices	7.6	0.3	0.1	0.2
Electric lighting equipment and other electrical products	1.5	0.1	0.1	0.0
2000-2006				
Electronic and electrical product	**-4.1**	**-4.1**	**-3.3**	**-0.8**
Computer and electronic product	**-4.3**	**-3.7**	**-2.5**	**-1.3**
Computers and peripheral equipment	25.8	-0.3	1.8	-2.1
Telephone apparatus	-12.4	-3.5	-3.0	-0.5
Radio, TV and wireless communication equipment	-1.6	0.5	-0.1	0.6
Other communication equipment	2.3	0.2	0.0	0.1
Audio and video equipment	7.1	0.1	0.0	0.0
Semiconductors	-6.9	-1.6	-1.4	-0.2
Instruments	1.0	0.9	0.1	0.7

Magnetic and optical media	1.5	0.0	0.0	0.0
Electrical equipment	**-3.5**	**-0.4**	**-0.9**	**0.5**
Small electrical appliances	7.0	0.0	0.0	0.0
Major appliances	-0.9	0.0	0.0	0.0
Power, distribution, and specialty transformers	-3.4	0.0	-0.1	0.1
Motors and generators	-1.0	0.1	0.0	0.1
Switchgear, and relay and industrial control	-4.1	0.1	-0.2	0.2
Batteries	-6.4	0.0	0.0	0.0
Communication and energy wire and cable	-5.9	-0.7	-0.6	-0.2
Wiring devices	1.1	0.2	0.0	0.1
Electric lighting equipment and other electrical products	-1.2	0.0	-0.1	0.1

Table 6. Industry contribution to labour productivity growth in the US electronic and electrical product manufacturing industry, 1997–2000 and 2000-2006

Industries	Labour productivity growth rate (% per year)	Contribution		
		Total	Pure productivity growth	Reallocation
1997-2000				
Electronic and electrical product	**46.7**	**46.7**	**49.0**	**-2.3**
Computer and electronic product	**62.9**	**37.2**	**48.3**	**-11.2**
Computers and peripheral equipment	64.7	5.3	8.7	-3.5
Telephone apparatus	88.5	5.6	6.4	-0.8
Radio, TV and wireless communication equipment	64.5	3.2	4.3	-1.1
Other communication equipment	67.0	0.4	0.5	-0.1
Audio and video equipment	88.4	0.5	0.6	-0.1
Semiconductors	57.5	14.1	16.6	-2.5
Instruments	57.6	7.7	10.3	-2.5
Magnetic and optical media	54.5	0.5	0.9	-0.5
Electrical equipment	**2.9**	**9.5**	**0.6**	**8.9**
Small electrical appliances	1.4	0.4	0.0	0.3
Major appliances	-1.4	1.1	0.0	1.2
Power, distribution, and specialty transformers	2.7	0.4	0.0	0.4
Motors and generators	-1.7	0.6	0.0	0.7
Switchgear, and relay and industrial control	2.5	1.6	0.1	1.5
Batteries	3.7	0.6	0.1	0.6

Communication and energy wire and cable	6.0	1.5	0.1	1.3
Wiring devices	8.1	1.3	0.2	1.1
Electric lighting equipment and other electrical products	3.1	2.1	0.1	2.0
2000-2006				
Electronic and electrical product	**25.6**	**25.6**	**28.8**	**-3.3**
Computer and electronic product	**31.3**	**17.4**	**27.3**	**-9.9**
Computers and peripheral equipment	44.0	2.6	5.4	-2.8
Telephone apparatus	35.3	0.3	3.6	-3.3
Radio, TV and wireless communication equipment	40.7	1.5	2.7	-1.3
Other communication equipment	27.8	0.2	0.2	0.0
Audio and video equipment	40.5	0.3	0.4	-0.1
Semiconductors	28.6	5.2	8.5	-3.3
Instruments	37.2	7.2	6.3	0.9
Magnetic and optical media	21.4	0.2	0.3	0.0
Electrical equipment	**6.8**	**8.2**	**1.5**	**6.7**
Small electrical appliances	5.1	0.2	0.0	0.1
Major appliances	9.8	1.3	0.3	1.1
Power, distribution, and specialty transformers	3.7	0.4	0.0	0.4
Motors and generators	10.0	0.8	0.2	0.6
Switchgear, and relay and industrial control	6.5	1.5	0.2	1.3
Batteries	2.3	0.5	0.0	0.5
Communication and energy wire and cable	5.2	0.7	0.1	0.5
Wiring devices	7.8	1.0	0.2	0.7
Electric lighting equipment and other electrical products	7.5	1.9	0.3	1.6

Table 7. Counterfactual industry contribution to labour productivity growth in the Canadian electronic and electrical product manufacturing industry, using US output and employment shares, 1997–2000 and 2000-2006

Industries	Labour productivity growth rate	Contribution		
		Total	Pure productivity growth	Reallocation
1997-2000				
Electronic and electrical product	**22.4**	**22.4**	**22.1**	**0.3**
Computer and electronic product	**25.8**	**19.2**	**21.0**	**-1.8**
Computers and peripheral equipment	47.5	2.2	6.4	-4.2
Telephone apparatus	21.6	2.2	1.6	0.7
Radio, TV and wireless communication equipment	21.8	1.5	1.5	0.0

Other communication equipment	19.1	0.1	0.1	0.0
Audio and video equipment	19.7	0.1	0.1	0.0
Semiconductors	28.5	9.9	8.2	1.7
Instruments	15.9	3.0	2.8	0.2
Magnetic and optical media	13.8	0.1	0.2	-0.1
Electrical equipment	**9.1**	**3.2**	**1.1**	**2.0**
Small electrical appliances	-3.1	-0.1	0.0	0.0
Major appliances	1.9	0.2	0.1	0.1
Power, distribution, and specialty transformers	9.2	0.2	0.1	0.1
Motors and generators	1.0	0.1	0.0	0.1
Switchgear, and relay and industrial control	7.4	0.7	0.3	0.4
Batteries	-5.6	0.0	-0.1	0.1
Communication and energy wire and cable	21.1	1.1	0.5	0.6
Wiring devices	7.6	0.4	0.2	0.2
Electric lighting equipment and other electrical products	1.5	0.5	0.1	0.4
2000-2006				
Electronic and electrical product	**-1.0**	**-1.0**	**-0.4**	**-0.5**
Computer and electronic product	**-4.3**	**-0.8**	**0.0**	**-0.8**
Computers and peripheral equipment	25.8	1.6	3.2	-1.6
Telephone apparatus	-12.4	-1.5	-1.2	-0.2
Radio, TV and wireless communication equipment	-1.6	-0.2	-0.1	-0.1
Other communication equipment	2.3	0.1	0.0	0.0
Audio and video equipment	7.1	0.1	0.1	0.0
Semiconductors	-6.9	-2.1	-2.1	-0.1
Instruments	1.0	1.3	0.2	1.1
Magnetic and optical media	1.5	0.1	0.0	0.0
Electrical equipment	**-3.5**	**-0.2**	**-0.5**	**0.2**
Small electrical appliances	7.0	0.0	0.1	0.0
Major appliances	-0.9	0.0	0.0	0.0
Power, distribution, and specialty transformers	-3.4	0.0	0.0	0.0
Motors and generators	-1.0	0.0	0.0	0.1
Switchgear, and relay and industrial control	-4.1	-0.1	-0.2	0.1
Batteries	-6.4	-0.1	-0.1	0.0
Communication and energy wire and cable	-5.9	-0.2	-0.2	-0.1
Wiring devices	1.1	0.1	0.0	0.0
Electric lighting equipment and other electrical products	-1.2	0.0	-0.1	0.1

Table 8. Percent of entering, continuing, and exiting plants in the Canadian electronic and electrical product manufacturing industry, 1997–2006

	1997–2000 exiting plants (1)	1997–2000 continuing plants (2)	1997–2000 entering plants (3)	2000–2006 exiting plants (4)	2000–2006 continuing plants (5)	2000–2006 entering plants (6)
Electronic and electrical product	**24.0**	**76.0** **61.5**	**38.5**	**50.6**	**49.4** **56.3**	**43.7**
Computer and electronic product	**25.0**	**75.0** **58.8**	**41.2**	**53.7**	**46.3** **56.1**	**43.9**
Computers and peripheral equipment	29.9	70.1 63.6	36.4	60.7	39.3 54.0	46.1
Communication equipment	26.8	73.2 56.3	43.7	53.0	47.0 49.0	51.1
Semiconductors	14.7	85.3 62.5	37.5	53.9	46.1 53.9	46.1
Instruments	27.7	72.4 58.8	41.2	49.0	51.0 61.6	38.4
Other electronic products	25.6	24.4 50.0	50.0	60.5	39.5 51.7	48.3
Electrical equipment	22.2	77.8 66.7	33.3	44.6	55.4 56.8	43.2

Note: (1) Share in 1997 of plants that existed in 1997, but not in 2000. (2) Share of plants that existed in both 1997 and 2000. The numbers are shares of those plants in 1997 and 2000, respectively. (3) Share in 2000 of plants that did not exist in 1997, but in 2000. (4) Share in 2000 of plants that existed in 2000, but not in 2006. (5) Share of plants that existed in both 2000 and 2006. The numbers are share of those plants in 2000 and 2006, respectively. (6) Share in 2006 of plants that did not exist in 2000, but in 2006.

Table 9. Relative employment of entering, continuing, and exiting plants in the Canadian electronic and electrical product manufacturing industry, 1997–2006

(Employment of continuing plants=1.00 in 1997 or 2000)

	1997–2000 exiting plants (1)	1997–2000 continuing plants (2)	1997–2000 entering plants (3)	2000–2006 exiting plants (4)	2000–2006 continuing plants (5)	2000–2006 entering plants (6)
Electronic and electrical product	**0.80**	**1** **1.15**	**0.41**	**0.82**	**1** **1.01**	**0.74**
Computer and electronic product	**0.85**	**1** **1.19**	**0.36**	**0.78**	**1** **0.95**	**0.82**

Computers and peripheral equipment	0.96	1	0.52	0.32	1	0.28
		1.47			0.59	
Communication equipment	0.90	1	0.44	0.72	1	1.06
		1.08			1.33	
Semiconductors	0.82	1	0.42	1.25	1	0.98
		1.29			0.97	
Instruments	0.83	1	0.36	0.68	1	0.99
		1.02			1.30	
Other electronic products	0.85	1	0.18	0.79	1	0.62
		1.23			0.66	
Electrical equipment	0.69	1	0.51	0.90	1	0.59
		1.05			1.06	

Note: (1) Relative employment in 1997 plants that existed in 1997, but not in 2000. (2) Relative employment of plants that existed in both 1997 and 2000. The numbers are relative employment of those plants in 1997 and 2000, respectively. (3) Relative employment in 2000 of plants that did not exist in 1997, but in 2000. (4) Relative employment in 2000 of plants that existed in 2000, but not in 2006. (5) Relative employment of plants that existed in both 2000 and 2006. The numbers are relative employment of those plants in 2000 and 2006, respectively. (6) Relative employment in 2006 of plants that did not exist in 2000, but in 2006.

Table 10. Relative productivity of entering, continuing, and exiting plants in the Canadian electronic and electrical product manufacturing industry, 1997–2006

(Productivity of continuing plants=1.00 in 1997 or 2000)

	1997–2000 exiting plants (1)	1997, 2000 continuing plants (2)	1997–2000 entering plants (3)	2000–2006 exiting plants (4)	2000, 2006 continuing plants (5)	2000–2006 entering plants (6)
Electronic and electrical product	**0.78**	**1**		**1.33**	**1**	
		1.58	**1.11**		**0.91**	**0.78**
Computer and electronic product	**0.73**	**1**		**1.42**	**1**	
		1.74	**0.92**		**0.95**	**0.78**
Computers and peripheral equipment	1.50	1		0.57	1	
		3.03	1.52		1.99	2.66
Communication equipment	1.14	1		0.57	1	
		1.61	1.82		0.88	0.68
Semiconductors	0.49	1		1.25	1	
		1.94	0.71		0.79	0.54
Instruments	0.73	1		0.98	1	
		1.34	1.54		1.09	0.97
Other electronic products	0.70	1		1.86	1	
		1.71	0.46		0.64	0.45
Electrical equipment	0.92	1		1.08	1	
		1.24	1.46		0.83	0.75

Note: (1) Average productivity in 1997 of plants that existed in 1997, but not in 2000. (2) Average productivity of plants that existed in both 1997 and 2000. The numbers are average productivity of those plants in 1997 and 2000, respectively. (3) Average productivity in 2000 of plants that did not exist in 1997, but in 2000. (4) Average productivity in 2000 of plants that existed in 2000, but not in 2006. (5) The average productivity of plants that existed in both 2000 and 2006. The numbers are average productivity of those plants in 2000 and 2006, respectively. (6) Average productivity in 2006 of plants that did not exist in 2000, but in 2006.

Table 11. Plant-level GR decomposition of labour productivity growth of constituent industries in the Canadian electronic and electrical product manufacturing industry, 1997-2000 and 2000–2006

	Labour productivity growth rate	Within continuing plants	Between continuin g plants	Net entry	Entering plants	Exiting plants
1997-2000						
Computers and peripheral equipment	47.5	43.0	2.7	1.7	-2.2	3.9
Communication equipment	20.1	14.6	0.2	5.3	3.6	1.6
Semiconductors	28.5	20.1	8.3	0.1	-3.6	3.7
Instruments	15.9	12.0	-2.5	6.4	2.7	3.7
Other electronic products	22.1	13.0	8.2	0.9	-3.5	4.4
Electrical equipment	9.8	7.8	-1.3	3.3	2.1	1.1
Weighted sum*	**20.4**	**14.9**	**2.9**	**2.6**	**-0.4**	**3.0**
2000-2006						
Computers and peripheral equipment	25.8	12.9	0.3	12.6	6.4	6.2
Communication equipment	-0.5	-5.6	4.2	1.0	-1.1	2.1
Semiconductors	-6.9	-1.4	0.0	-5.5	-2.6	-3.0
Instruments	1.0	1.1	-0.1	0.0	-0.3	0.3
Other electronic products	-10.4	-1.6	-0.6	-8.3	-3.0	-5.3
Electrical equipment	-3.6	-2.4	0.6	-1.8	-0.8	-1.1
Weighted sum*	**-3.4**	**-0.7**	**0.3**	**-2.9**	**-1.2**	**-1.7**
Difference: 2000-2006 minus 1997-2000						
Computers and peripheral equipment	-21.7	-30.1	-2.4	10.9	8.6	2.3
Communication equipment	-20.6	-20.2	4	-4.3	-4.7	0.5
Semiconductors	-35.4	-21.5	-8.3	-5.6	1	-6.7
Instruments	-14.9	-10.9	2.4	-6.4	-3	-3.4
Other electronic products	-32.5	-14.6	-8.8	-9.2	0.5	-9.7
Electrical equipment	-13.4	-10.2	1.9	-5.1	-2.9	-2.2
Weighted sum*	**-23.8**	**-15.6**	**-2.6**	**-5.5**	**-0.8**	**-4.7**

* The weights are the nominal output shares of the sub-industries at the beginning of each period, corresponding to those for the pure productivity growth effect in equation (5) in Section 2.1.

Table 12. Selected economic indicators in the electronic and electrical product industry

	Shipments ($billion)		**Value added** ($billion)		**Hours worked** (millions)		**Capacity utilization**		**Exchange rate** ($US/$CAN
	334	**335**	**334**	**335**	**334**	**335**	**334**	**335**	
1994	18.1	6.9	5.7	2.9	166.5	94.1	77.3	82.4	0.73
1995	22.8	7.6	6.3	2.9	180.6	93.2	84.9	79.4	0.73
1996	22.1	7.8	6.3	3.2	180.1	90.8	76.2	83.6	0.73

1997	23.2	8.1	7.4	3.2	186.6	92.5	79.3	85.2	0.72
1998	25.4	8.5	7.9	3.5	193.3	90.1	85.0	91.0	0.67
1999	27.3	10.5	10.6	3.6	191.2	101.9	90.8	93.7	0.67
2000	37.3	11.6	11.4	4.4	211.2	100.7	96.7	92.5	0.67
2001	27.0	11.6	6.3	4.4	190.2	104.2	72.1	76.3	0.65
2002	22.7	10.1	5.7	3.8	177.5	98.3	66.8	74.0	0.64
2003	20.8	9.5	6.3	3.2	175.6	91.8	69.6	73.6	0.71
2004	20.7	9.5	6.8	3.5	189.8	93.4	80.8	77.3	0.77
2005	19.8	9.9	7.1	3.6	182.0	90.8	85.3	76.3	0.83
2006	19.5	10.5	6.9	3.5	176.4	92.4	87.0	79.7	0.88
2007	19.0	10.7	7.2	3.5	173.6	85.9	88.1	83.6	0.93
2008	19.1	10.4	7.2	3.5	172.1	83.6	88.7	83.3	0.94

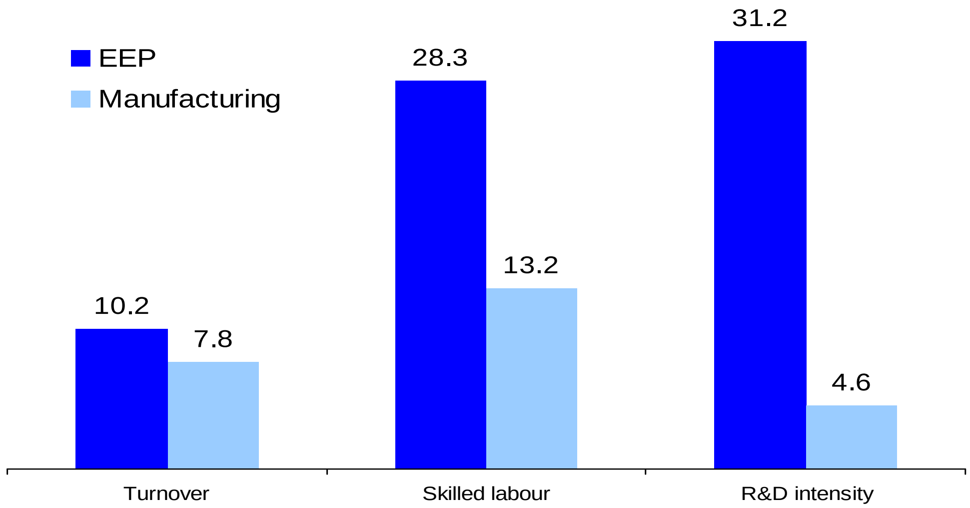
Source: Statistics Canada.

Table 13. Country share of U.S. electronic and electrical products imports (percent)

	Computer and Electronic Products			Electrical Equipment and Appliances		
	Canada	China	Rest of world	Canada	China	Rest of world
1997	6.2	6.8	87.0	9.7	18.2	72.2
1998	6.2	8.2	85.5	10.4	18.7	70.9
1999	6.0	9.0	85.0	10.5	20.1	69.4
2000	7.2	9.8	83.0	10.0	21.6	68.4
2001	5.6	11.8	82.6	10.1	23.1	66.8
2002	4.2	16.1	79.6	9.3	26.2	64.5
2003	3.7	20.5	75.8	8.2	28.0	63.8
2004	3.6	25.7	70.7	7.9	30.0	62.1
2005	3.8	29.4	66.7	7.8	31.1	61.1
2006	3.3	32.4	64.3	7.7	32.3	59.9
2007	3.2	34.3	62.5	7.3	32.3	60.4
2008	3.1	35.6	61.3	7.1	33.4	59.5
2009	2.8	38.2	59.0	6.3	35.4	58.3

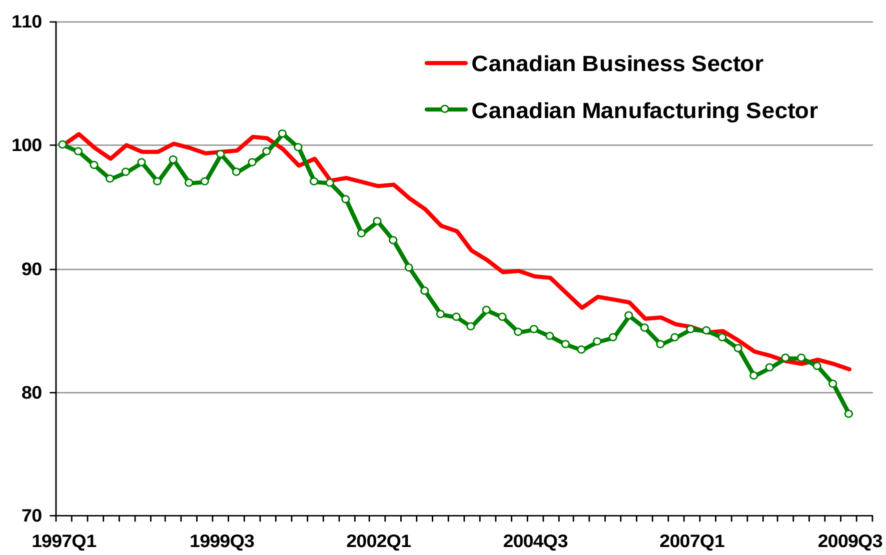
Source: U.S. International trade commission database.

Chart 1: Plant Turnover, Skilled Labour and Innovation in the Electronic and Electrical Product (EEP) Industry Relative to the Manufacturing Sector



Turnover: average annual share (%) of entrants and exits in total number of plants in 1997-2006
Skilled labour: average share (%) of hours worked by workers with university education or above in 1997-2006.
R&D intensity: average ratio (%) of business expenditures on research and development to value added in 1997-2007.
Source: Statistics Canada

Chart 2: Labour Productivity in Canada Relative to the U.S. (1997Q1=100)



Source: Statistics Canada and U.S. Bureau of Labor Statistics

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