Industry Mix, Plant Turnover and Productivity Growth: A Case Study of the Transportation Equipment Industry in Canada[1]

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ABSTRACT

The transportation equipment industry is one of the few Canadian industries that is as productive as its U.S. counterpart. However, labour productivity growth in the Canadian transportation equipment industry declined from 4.5 per cent per year in 1981-2000 to 1.7 per cent per year in 2000-2007. This article investigates whether restructuring and the reallocation of output and resources within the industry after 2000 contributed to this decline. It shows that the dramatic decline in productivity growth was mainly due to the slowdown in productivity growth in sub-industries, which can largely be traced to the decline in labour productivity growth of continuing plants. Finally, the article shows that even if the Canadian industry mix were the same as the U.S. mix, the productivity growth profile of the Canadian transportation equipment industry would not change.

RÉSUMÉ

L'industrie des matériels de transport est l'un des secteurs canadiens dont la productivité est comparable à celle des États-Unis. Force est cependant que le Canada a connu un ralentissement de la croissance de la productivité du travail dans ce secteur, de 4,5 % par an entre 1981 et 2000 à 1,7 % par an entre 2000 et 2007. Cette étude s'attache à déterminer si la restructuration de ce secteur et la réaffectation de la production et de ressources après 2000 ont participé à ce recul. Elle montre que la baisse spectaculaire de la croissance de la productivité est principalement due à un ralentissement de celle-ci dans les sous-industries, laquelle est en grande partie imputable à une baisse de la croissance de la productivité dans les usines établies. Les auteurs concluent en montrant que le profil de croissance de la productivité du secteur des matériels de transport au Canada serait resté inchangé, même si sa composition industrielle avait été identique à celle des États-Unis.

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The transportation equipment manufacturing industry is one of the few Canadian industries that is as productive as its U.S. counterpart. Van Biesebroeck (2007) finds that in 1994-2004, Canadian automobile assembly plants required about 1.5 less hours to assemble a vehicle than U.S. assembly plants. In addition, the transportation equipment manufacturing industry experienced high productivity growth in the previous two decades, and had contributed significantly to aggregate productivity growth in Canada in the 1995-2000 period. Motor vehicles, for example, contributed the third most to aggregate multifactor productivity (MFP) growth in that period, after finance, insurance and real estate (FIRE) and retail trade (Ho, Rao and Tang, 2004).

However, the productivity performance in the Canadian transportation equipment industry has weakened in recent years. According to Statistics Canada, labour productivity growth in this industry has declined from 4.5 per cent per year in 1981-2000 to 1.7 per cent per year in 2000-2007.[2] The industry alone accounted for 29.3 per cent of the productivity growth slowdown (3.6 percentage points per year) in the Canadian manufacturing sector between 1997-2000 and 2000-2007 (Sharpe and Thomson, 2010). Compared to its U.S. counterpart, its productivity advantage declined from 10.7 per cent in 2002 to 1.7 per cent in 2007 (Tang, Rao and Li, 2010). [3]

Is an unfavourable structural shift within this industry responsible for Canada's poor productivity growth in this industry over time as well as relative to its U.S. counterpart? This article investigates whether the restructuring and the reallocation of output and resources within this industry contributed to its productivity growth slowdown. The restructuring and/or reallocation includes the composition change of constituent industries (or industry mix), the entry of new firms and the exit of existing firms, and/or the growth and decline in continuing firms. These compnents of the restructuring/reallocation process are examined using data from the Annual Survey of Manufactures (ASM) from Statistics Canada for Canada and from the U.S. Census Bureau for the United States.

Productivity growth at the industry level is ultimately driven by firm growth and the competitive process that constantly shifts market shares from the exiting firms to the entrants and from declining firms to those firms in growth. 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.

This article first examines whether unfavourable structural shifts in the transportation equipment manufacturing in the 2000s contribute to Canada's weaker productivity growth in this industry over time as well as relative to its U.S. counterpart. It then traces the decline in the industry's productivity growth into its sources at the plant level. For the latter exercise, we address two questions: (a) has slower productivity growth at the plant level been responsible for the slower industry productivity and (b) has there been a change in reallocation and the entry and exit process that contributed to the slower productivity growth? In addressing these questions, this article focuses on labour productivity (due to data limitations).[4]

2 The data source is CANSIM Table 383-0022.

3 Similarly, MFP growth also slowed from 3.3 per cent per year to -0.3 per cent per year between these two periods. The slowdown in productivity performance in the industry is associated with a substantial decline in domestic demand for automobiles and the restructuring of the North American auto manufacturing industry.

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

The structure of this paper is as follows. In the first section, we present the analytical framework for the analysis of the impacts of industry structural shift and plant dynamics on labour productivity growth. In section two, we discuss data and measurement issues. In section three we present the empirical findings on the effect of industry mix. In section four, we present findings for plant turnover on the productivity growth of transport equipment manufacturing. The final section summarizes the key findings and discusses possible reasons for the productivity growth slowdown in this industry.

Analytical Framework

In this section, we present an analytical framework for the analysis of the impact of industry structural shifts and plant dynamics on labour productivity growth.

Industry Mix and Productivity Performance

The transportation equipment manufacturing industry is composed of many smaller sub-industries (Table 1). The productivity growth of the aggregate transportation equipment industry can be decomposed into a component reflecting productivity growth at the detailed industry level and components capturing the shifts in industry structure. To decompose the industry productivity growth into those various components, we follow the methodology used in our earlier study on industry mix for the Canadian electronic and electrical product manufacturing industry (Chan, Gu and Tang, 2011), which is based on the decomposition technique developed by Tang and Wang (2004).

Consider an industry with n sub-industries, with aggregate real output (V), aggregate nominal output (Q), aggregate implicit price index (P), and aggregate labour input (L). Aggregate labour productivity is then defined as real output per unit of labour input, i.e. $Z = V/L$. As real output is measured using deflated nominal output ($V = Q/P$), aggregate labour productivity can be expressed as $Z = Q/(PL)$.

Aggregate labour productivity can be decomposed into its components at the sub-industry level through the nominal output of each component:

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

Define $p^i = P^i/P$, which is the relative output price of industry i; $l^i = L^i/L$, the labour input share for 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 industry i. The labour share is adjusted by the relative output price because a change in output prices also affects the importance of the industry in aggregate output.[5] This change in turn influences the contribution of the industry to aggregate labour productivity even when the industry's labour share and labour productivity remain constant. Substituting the new variables into equation 1 yields the following:

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

Hence, aggregate labour productivity can be expressed as the weighted sum of individual labour productivities. The weight for each industry is equal to its relative size (which is equal to

5 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. This is because output prices have been used as weights in aggregation. The aggregation values an output more when its price rises and less when its price falls. This observation has led to the development of the decomposition technique (Tang and Wang, 2004).

labour share adjusted for relative output price). Due to the adjustment, the sum of the weights can be larger or smaller than one, depending on whether industries with large labour shares also have high relative output prices.

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

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

Define Z_{t-1}^i / Z_{t-1} as the labour productivity level of industry *i* relative to the aggregate 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 industry *i* from *t-1* to *t*. Then add and subtract $\sum_i Z_{t-1}^i [s_{t-1}^i g(Z_t^i)]$ from equation (3), leading to

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

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 industry *i* at the beginning of the period. Equation (4) can be rewritten as

$$g(Z_t) = \sum_i w_{t-1}^i g(Z_t^i) + \sum_i Z_{t-1}^i [1 + g(Z_t^i)] \Delta s_t^i \quad (5)$$

Thus, aggregate labour productivity growth can be decomposed into two components or effects. The pure productivity growth effect, $\sum_i w_{t-1}^i g(Z_t^i)$, is the sum of the weighted industry labour productivity growth rates, and the weight for each industry is equal to its nominal output share at the beginning of the period. The pure productivity growth effect thus captures industry contributions purely due to industrial labour productivity improvements. This 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*, $\sum_i Z_{t-1}^i [1 + g(Z_t^i)] \Delta s_t^i$, is the sum of the weighted changes in relative size, and the weight for each 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 reflects the change in importance of an industry in an economy, 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 industries of relatively high productivity levels and/or relatively high productivity growth.

Plant Turnover and Productivity Performance

Labour productivity growth for a sub-industry can be decomposed into a within-plant effect and effects from the reallocation of output and resources across individual plants. The within-plant effect measures the contribution to overall productivity growth of productivity improvements within surviving plants, holding their shares of inputs or outputs constant. The reallocation effect on aggregate productivity consists of the between-plant effect that represents the impact of the reallocation of output and inputs among surviving plants and the effect of plant turnover (entry and exit).

Different methods have been proposed to account for the effects of reallocation on productivity growth, for example, Griliches and Regev (1995), Foster, Haltiwanger and Krizan (2001), and Baldwin and Gu (2006).[6] 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 that entrants displace average firms and com-

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

pare 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 these different assumptions provide different estimates of contributions from entry and exit, the contribution of net entry (or the sum of the contributions of entry and exit) is similar across all those methods.

In this article, we follow Griliches and Regev (1995) or the GR method and focus on net entry. The decomposition process is similar to the decomposition of aggregate 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:

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

In equation (6), the weights *s* are equal to labour input share, with no price component. Because deflators at the plant level are not available, we assume that all plants in an industry sell their output at the same price, that is, we will apply the same deflator to the nominal value added of all plants within an industry.

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

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

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*, which allows us to rewrite equation (7) into a continuing plant component, an entrant component and an exit component:

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

After some rearrangement, the above equation can be rewritten as

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

where over-lined variables represent the two-period average between *t-1* and *t*, and $\bar{Z}^{j}$ is the two-period average 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 solely reflects improvements in the productivity performances of plants. The second term is the between-plant contribution and captures the effects of shifts in employment shares by continuing plants. This term is positive when plants that gain employment share are more productive than the industry average, and plants that lose employment share are less productive than the 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 industry average. When entrants are more productive than the industry average, their entry will have a positive effect on the productivity performance of this industry. Similarly, when exits are less productive, then their exit will also have a positive effect.

Data and Measurement Issues

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

Table 1
The Sub-Industries of the Transportation Equipment Manufacturing Industry for both Canada and the United States

Industries	NAICS code
Transportation equipment manufacturing	336
Motor vehicle (MV) manufacturing, and body and trailer*	3361+3362+3369
MV gasoline engine, transmission and power train**	33631+33635+33639
MV electrical and electronic equipment	33632
MV steering and suspension components	33633
MV brake system	33634
MV seating and interior trim	33636
MV metal stamping	33637
Aerospace, railroad, ship and boat building***	3364+3365+3366

*3369 is other transportation equipment manufacturing, such as manufactured armoured military vehicles, race cars, snowmobiles, powered golf carts, motorcycles, bicycles, and tricycles. For the United States, it accounts for 5 per cent of the combined output.

** 33639 is other motor vehicle parts manufacturing, such as air bag assemblies, exhaust system, convertible tops, filters, air-conditioning systems, racks, radiators and cores, and wheels. For the United States, it accounts for less than 5 per cent of the combined output.

*** For the United States, aerospace accounts for more than 80 per cent of the combined output.

Data Sources

For our empirical analyses, we make use of the data that are collected by the Census of Manufactures programs in both Canada and the United States, which are quite similar in collecting data on outputs and inputs.

The Canadian data for our analyses 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 2,300 plants are in the transportation equipment manufacturing industry.

For the United States, 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) and are also aggregated from the micro-records of the U.S. ASM administrated by the U.S. Bureau of Census. Note, however, unlike in Canada, that the value added for the United States 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 definition of labour productivity used in this analysis is real ASM value added per employee. Due to data limitations, nominal ASM value added in the United States is deflated using the deflator for the transportation equipment as a whole from the U.S. Bureau of Economic Analysis. For Canada, they are deflated using deflators at the four-digit industry level from Statistics Canada.

The transportation equipment manufacturing industry consists of 18 six-digit industries. To meet the Statistics Canada confidentiality policy on releasing data to the public as well as to facilitate Canada and U.S. comparisons, we group the 18 six-digit industries into 8 sub-industries (Table 1).

For motor vehicle parts industries, they are at the six-digit level, and for others, they are at a combined four-digit level.[7]

For our analysis, we choose the period of 1997-2006, over which we have data for both Canada and the United States.The industry mix and plant turnover effects on aggregate productivity growth are examined for two periods: 1997–2000 and 2000–2006. We use 2000, a business cycle peak in both countries, as a dividing point, as it has been frequently used in the literature for studying Canada's productivity performance.

Adjustments to the Data

To improve the data comparability over time and between the two countries, we made several adjustments to the industry level data obtained from the ASM data. These changes arose due to four main data issues.

First, the ASM data may not be entirely comparable over time due to change 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 used as intermediate inputs for production. The inclusion of purchased service in the analysis matters since the increased trend in outsourcing in services activities in the manufacturing sectors and the trend may differ between Canada and the United States. In addition, it does not include the output from those who are self-employed, which may be different between the two countries.

Third, as noted earlier, "value added" for Canada is manufacturing value added and for the United States, 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. Among other things, it excludes those classified as self-employed. In addition, we need to adjust employment to hours worked to reflect the change in work intensity over time.

To make those adjustments, we benchmark the aggregate 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).[8] For the United States, the data on census value added and employment from the U.S. ASM are benchmarked to the data on value added from the industry accounts of the U.S. Bureau of Economic Analysis and hours worked for all persons from the U.S. Bureau of Labor Statistics, respectively. Due to data availability, the adjustment is made at the four-digit level for Canada and at the three-digit level for the United States.

The adjustments at the aggregate level for both Canada and the United States are in Table 2. The adjustments had little effect on the growth rates of value-added and labour input for Canada and the United States. There is also no evidence of a significant change in work intensity or the effect of merchandising operations over the 1997-2006 period.

7 The industry grouping is necessary for meeting confidentiality requirements for discussing and reporting results from analyzing Statistic Canada's longitudinal micro-data based on the Annual Survey of Manufacturers.

8 For comparison, the benchmarking value added in basic prices for Canada is adjusted to value added at factor cost. Similarly, for the United States, value added in market prices is adjusted to value added at factor cost.

Table 2

Aggregate Adjustments for Output and Labour Input for the Canadian and the U.S. Transportation Equipment Industry, 1997-2006

Year	Canada			United States		
	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	0.70	2.04	0.34	0.68	2.55	0.27
1998	0.71	1.96	0.36	0.69	2.50	0.28
1999	0.73	1.98	0.37	0.67	2.55	0.26
2000	0.69	1.97	0.35	0.77	2.55	0.30
2001	0.72	2.04	0.35	0.75	2.51	0.30
2002	0.72	2.07	0.35	0.73	2.46	0.30
2003	0.79	1.99	0.40	0.71	2.45	0.29
2004	0.78	2.03	0.38	0.70	2.49	0.28
2005	0.75	2.00	0.37	0.69	2.54	0.27
2006	0.72	1.91	0.38	0.70	2.61	0.27

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

The adjustments do have an effect on the ouput level 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. Except for the period 2000-2002, the ratio of the value added from the national accounts to the value added from the ASM is larger in Canada. This is because the ASM value added for the United States is total value added while it is manufacturing value added for Canada.[9]

Empirical Findings on the Industry Mix Effect

Before we proceed to discuss the decomposition results for the industry mix effect, we first briefly describe the profile of the transportation equipment manufacturing industry in Canada, and compare it to its U.S. counterpart.

A Profile of the Transportation Equipment Manufacturing Industry in Canada and the U.S.

The transportation equipment manufacturing industry accounted for about 11.0 per cent of hours worked in the Canadian manufacturing sector in 2008, gradually declining from a share of 12.5 per cent in 1997. In terms of nominal value added, it accounted for 13.1 per cent of manufacturing value added in 2006, declining from 15.6 per cent in 1997. In the United States, the industry's share of hours worked in the manufacturing sector was similar to that in Canada, although it increased slightly from 11.5 per cent in 1997 to 12.0 per cent in 2008. In terms of value added, the share in the United States is smaller, and it also decreased, falling from 12.3 per cent in 1997 to 11.4 per cent in 2006.

In the Canadian transportation equipment manufacturing industry, the motor vehicle manufacturing and body and trailer industries made up a little over one third of nominal value added in 1997 and 2006, with a large temporary price-

9 The ratio of the benchmarking hours worked to the employment from the ASM is lower in Canada than in the United Staes since Canadian workers tend to work shorter hours than their U.S. counterparts.

Table 3
Output Shares and Relative Labour Productivity Levels in Canadian and U.S. Transportation Equipment Manufacturing Industries, 1997, 2000, and 2006

Industries	Nominal output share			Relative labour productivity level		
	1997	2000	2006	1997	2000	2006
			Canada			
Transportation equipment manufacturing	100.0	100.0	100.0	1.00	1.00	1.00
Motor vehicle (MV) mfg., body and trailer	34.6	46.8	35.7	1.11	1.13	1.20
MV gasoline engine, transmission and power train	20.0	15.5	18.3	1.01	1.02	0.96
MV electrical and electronic equipment	2.3	1.6	1.9	0.73	0.68	0.62
MV steering and suspension components	2.2	1.2	1.7	0.81	0.83	0.83
MV brake system	2.6	1.6	1.5	0.81	0.68	0.67
MV seating and interior trim	5.1	4.2	5.5	0.94	0.87	0.82
MV metal stamping	6.3	4.7	6.2	0.84	0.89	0.79
Aerospace, railroad, ship and boat building	27.0	24.4	29.3	1.00	0.95	1.03
			United States			
Transportation equipment manufacturing	100.0	100.0	100.0	1.00	1.00	1.00
Motor vehicle (MV) mfg., body and trailer	37.0	32.4	32.9	1.69	1.45	1.26
MV gasoline engine, transmission and power train	17.5	19.9	17.5	0.81	0.88	0.91
MV electrical and electronic equipment	4.2	4.9	3.6	0.68	0.77	0.76
MV steering and suspension components	2.3	2.3	1.5	0.87	0.82	0.65
MV brake system	1.8	2.0	1.9	0.76	0.84	0.90
MV seating and interior trim	1.9	2.2	1.8	0.72	0.69	0.57
MV metal stamping	4.8	4.8	4.6	0.70	0.75	0.73
Aerospace, railroad, ship and boat building	30.6	31.5	36.2	0.86	0.93	1.01

related increase to nearly half in 2000 (Table 3).[10] Motor vehicle manufacturing in the United States also made up about one third of nominal value added in 2000 and 2006, down from 37.0 per cent in 1997. Aerospace, railroad, and ship and boat made up the remainder, approximately one quarter of nominal value added in all three years.

The major difference between the output mixes of the transportation equipment industries between the two countries is that the United States has a larger output share in aerospace, railroad, and ship and boat building.

The differences in U.S. and Canadian industry mix are even larger on the employment side (Table 4). The U.S. motor vehicle and body and trailer industry was about 7 percentage points smaller in employment share than its Canadian counterpart in 2006. In contrast, the United States has a larger employment share than Canada for the aerospace, railroad, and ship and boat industry. In 2006, the share was more than 10 percentage points larger.

Table 4 also shows the differences in relative output price in the transportation equipment industry. In Canada, motor vehicle and body and trailer prices increased sharply in 1999 and remained high until 2004. This temporary price increase had a significant effect on the aggregate price deflator (Table 5). While we do not have detailed deflators for the U.S. industry, there is some indirect evidence showing that no corresponding increase in U.S. motor vehicle and body and trailer prices took place over this period.[11]

10 In this article, we refer to the motor vehicle manufacturing, and body and trailer as motor vehicle manufacturing.

Table 4

Relative Size of the Canadian and U.S. Transportation Equipment Manufacturing Industries, 1997, 2000, and 2006

Industries	Employment Share			Relative Output Price			Relative Size		
	1997	2000	2006	1997	2000	2006	1997	2000	2006
Canada									
Transportation equipment manufacturing	100.0	100.0	100.0	1.00	1.00	1.00	1.00	1.00	1.00
Motor vehicle (MV) mfg., body and trailer	31.2	32.7	33.1	1.00	1.26	0.90	0.31	0.41	0.30
MV gasoline engine, transmission and power train	19.8	18.3	19.8	1.00	0.83	0.96	0.20	0.15	0.19
MV electrical and electronic equipment	3.2	2.8	3.2	1.00	0.83	0.96	0.03	0.02	0.03
MV steering and suspension components	2.7	1.7	2.1	1.00	0.83	0.96	0.03	0.01	0.02
MV brake system	3.1	2.9	2.3	1.00	0.83	0.96	0.03	0.02	0.02
MV seating and interior trim	5.5	5.8	7.0	1.00	0.83	0.96	0.06	0.05	0.07
MV metal stamping	7.5	6.4	8.1	1.00	0.83	0.96	0.07	0.05	0.08
Aerospace, railroad, ship and boat building	27.1	29.4	24.5	1.00	0.88	1.16	0.27	0.26	0.28
United States									
Transportation equipment manufacturing	100.0	100.0	100.0	1.00	1.00	1.00	1.00	1.00	1.00
Motor vehicle (MV) mfg., body and trailer	21.9	22.3	26.1	1.00	1.00	1.00	0.22	0.22	0.26
MV gasoline engine, transmission and power train	21.7	22.6	19.3	1.00	1.00	1.00	0.22	0.23	0.19
MV electrical and electronic equipment	6.2	6.4	4.8	1.00	1.00	1.00	0.06	0.06	0.05
MV steering and suspension components	2.6	2.8	2.3	1.00	1.00	1.00	0.03	0.03	0.02
MV brake system	2.3	2.4	2.1	1.00	1.00	1.00	0.02	0.02	0.02
MV seating and interior trim	2.6	3.2	3.1	1.00	1.00	1.00	0.03	0.03	0.03
MV metal stamping	6.9	6.4	6.3	1.00	1.00	1.00	0.07	0.06	0.06
Aerospace, railroad, ship and boat building	35.8	34.0	36.0	1.00	1.00	1.00	0.36	0.34	0.36

Table 5

The Value Added Deflators in the Canadian and the U.S. Transportation Equipment Manufacturing Industry, 1997-2006

	Canada				United States
	Motor vehicle manufacturing, body, and trailers	Motor vehicle parts	Aerospace, railroad, ship, and boat building	Total	Total
1997	1.00	1.00	1.00	1.00	1.00
1998	1.13	1.07	0.97	1.05	1.01
1999	1.58	1.04	1.01	1.22	1.04
2000	1.49	0.98	1.04	1.18	1.05
2001	1.55	0.96	1.04	1.20	1.07
2002	1.69	0.98	1.08	1.27	1.04
2003	1.46	0.95	1.11	1.19	1.03
2004	1.22	0.84	1.07	1.04	1.01
2005	1.03	0.80	0.99	0.94	0.96
2006	0.79	0.84	1.01	0.87	0.90

Sources: Statistics Canada and U.S. Bureau of Economic Analysis.

11 As shown in Table 4. The price-spike seems to be unique for Canada. According to NBER-CES Manufacturing Industry Database, there was no spike in either prices of shipments and materials at the four-digit SIC level in the U.S. transportation equipment industry between 1997 and 2005 (the latest year from which data are available).

Table 6

Decomposition of Industry Labour Productivty Growth into Reallocation and Pure Productivity Effects in the Canadian Transportation Equipment Manufacturing Industry, 1997–2000 and 2000-2006

Industries	Labour Productivity Growth Rate (per cent per year)	Percentage Point Contribution to Transportation Equipnment		
		Total	Pure Productivity Growth	Reallocation
		1997-2000		
Transportation equipment manufacturing	8.8	8.8	8.5	0.3
Motor vehicle (MV) mfg., body and trailer	9.8	8.2	3.4	4.8
MV gasoline engine, transmission and power train	9.3	-0.1	1.9	-2.0
MV electrical and electronic equipment	6.0	-0.1	0.1	-0.2
MV steering and suspension components	10.1	-0.2	0.2	-0.4
MV brake system	1.8	-0.2	0.0	-0.2
MV seating and interior trim	5.8	0.1	0.3	-0.2
MV metal stamping	11.4	-0.1	0.7	-0.8
Aerospace, railroad, ship and boat building	6.7	1.3	1.8	-0.5
		2000-2006		
Transportation equipment manufacturing	1.6	1.6	2.2	-0.6
Motor vehicle (MV) mfg., body and trailer	2.7	-1.3	1.2	-2.5
MV gasoline engine, transmission and power train	0.6	0.8	0.1	0.7
MV electrical and electronic equipment	0.0	0.1	0.0	0.1
MV steering and suspension components	1.6	0.1	0.0	0.1
MV brake system	1.6	0.0	0.0	0.0
MV seating and interior trim	0.6	0.3	0.0	0.3
MV metal stamping	-0.4	0.3	0.0	0.4
Aerospace, railroad, ship and boat building	3.3	1.3	0.8	0.5

For both countries, the most productive transportation equipment industry is motor vehicle, body and trailer (Table 3). This sub-industry in Canada produced 11 per cent more of output per hour worked than the transportation industry average in 1997 and the productivity advantage increased to 20 per cent in 2006. In the United States, the productivity difference is more pronounced, with the sub-industry being 69 per cent more productive than the transportation equipment industry average in 1997 and 26 per cent in 2006.

In Canada, the poorest performer in terms of labour productivity levels was auto brakes with 33 per cent lower productivity than the aggregate average in 2006 while in the United States, it was seating and interior trim that was 43 per cent less productive.

The Productivity Effect of Industry Structural Shift

We now apply the Tang and Wang (2004) decomposition to productivity changes in the Canadian and U.S. transportation equipment industry over 1997–2000 and 2000–2006. We first discuss the Canadian experience and then compare them to that in the United States.

Canada

As shown in Table 6, the productivity changes in the Canadian transportation equipment industry in the two periods considered here were dominated by pure productivity changes within constituent industries and not by reallocation.

In 1997–2000, the aggregate productivity increased by 8.8 per cent per year. Pure productivity growth was the primary factor, accounting

Table 7

Decomposition of Industry Labour Productivty Growth into Reallocation and Pure Productivity Effects in the U.S. Transportation Equipment Manufacturing Industry, 1997–2000 and 2000-2006

Industries	Labour Productivity Growth Rate (per cent per year)	Percentage Point Contribution to Transportation Equipnment		
		Total	Pure Productivity Growth	Reallocation
1997-2000				
Transportation equipment manufacturing	3.4	3.4	3.4	0.0
Motor vehicle (MV) mfg., body and trailer	-1.8	-0.4	-0.7	0.3
MV gasoline engine, transmission and power train	6.8	1.5	1.2	0.2
MV electrical and electronic equipment	8.2	0.4	0.3	0.0
MV steering and suspension components	1.3	0.1	0.0	0.0
MV brake system	7.4	0.2	0.1	0.0
MV seating and interior trim	1.7	0.2	0.0	0.1
MV metal stamping	6.2	0.2	0.3	-0.1
Aerospace, railroad, ship and boat building	6.5	1.4	2.0	-0.6
2000-2006				
Transportation equipment manufacturing	6.7	6.7	6.2	0.4
Motor vehicle (MV) mfg., body and trailer	3.6	2.3	1.2	1.1
MV gasoline engine, transmission and power train	7.4	0.8	1.5	-0.7
MV electrical and electronic equipment	6.3	0.0	0.3	-0.3
MV steering and suspension components	1.8	0.0	0.0	-0.1
MV brake system	8.1	0.1	0.2	0.0
MV seating and interior trim	2.7	0.1	0.1	0.0
MV metal stamping	5.9	0.3	0.3	0.0
Aerospace, railroad, ship and boat building	8.6	3.2	2.7	0.5

for 8.5 percentage points of the total productivity growth. Reallocation accounted for a small positive component of 0.3 percentage points.

Among the sub-industries, motor vehicles and body and trailer dominated. It accounted for 8.2 percentage points of aggregate productivity growth, from both pure productivity improvement (3.4 percentage points) and positive reallocation to this sub-industry (4.8 percentage points). The reallocation effect was a result of an increase in its employment share and a significant improvement in relative output price. The motor vehicle parts sub-industries as well as aerospace, railroad, ship and boat building industries had positive pure growth contributions, but the productivity effects were offset by negative reallocation effects due to a decline in their relative sizes.

The picture in the post-2000 period is completely different. For the transportation equipment industry as a whole, labour productivity in Canada increased by 1.6 per cent per year. This was a decline of 7.2 percentage points compared to 1997-2000. This decrease in growth was primarily driven by the pure productivity growth term, which fell by 6.3 percentage points. At the same time, the reallocation effect decreased by 0.9 percentage points.

Among the sub-industries, the decline in productivity growth can be solely attributed to motor vehicles and body and trailer. Its contribution fell from 8.2 percentage points in 1997-2000 to -1.3 percentage points in 2000-2006, a decline of 9.5 percentage points. Although the contribution of both pure productivity and reallocation decreased for the motor vehicles and

Table 8

Counterfactual Decomposition of Industry Labour Productivty Growth into Reallocation and Pure Productivity Effects in the Canadian Transportation Equipment Industry, Using U.S. Deflators

Industries	Labour Productivity Growth Rate	Percentage Point Contribution to Transportation Equipnment		
		Total	Pure Productivity Growth	Reallocation
		1997-2000		
Transportation equipment manufacturing	14.0	14.0	13.4	0.6
Motor vehicle (MV) mfg., body and trailer	27.8	10.6	9.6	1.0
MV gasoline engine, transmission and power train	6.4	0.7	1.3	-0.6
MV electrical and electronic equipment	3.3	0.0	0.1	-0.1
MV steering and suspension components	7.2	-0.2	0.2	-0.3
MV brake system	-0.6	-0.1	0.0	-0.1
MV seating and interior trim	3.1	0.3	0.2	0.1
MV metal stamping	8.3	0.2	0.5	-0.4
Aerospace, railroad, ship and boat building	6.0	2.6	1.6	0.9
		2000-2006		
Transportation equipment manufacturing	-0.8	-0.8	-0.5	-0.3
Motor vehicle (MV) mfg., body and trailer	-4.7	-2.1	-2.2	0.1
MV gasoline engine, transmission and power train	0.6	0.3	0.1	0.2
MV electrical and electronic equipment	0.1	0.0	0.0	0.0
MV steering and suspension components	1.6	0.1	0.0	0.1
MV brake system	1.6	0.0	0.0	-0.1
MV seating and interior trim	0.6	0.2	0.0	0.1
MV metal stamping	-0.4	0.2	0.0	0.2
Aerospace, railroad, ship and boat building	6.2	0.6	1.5	-0.9

body and trailer industry, the most significant decline was from the reallocation effect, which is associated with relative size. It fell from a positive 4.8 percentage points in the first period to negative 2.5 percentage points, while the pure productivity effect fell from 3.4 percentage points to 1.2 percentage points. Although small, the contributions from the other sub-industries of the transportation equipment industry increased, mainly due to a favourable change in relative size.

United States

Unlike in Canada, labour productivity growth in the U.S. transportation equipment industry accelerated from 3.4 per cent per year in 1997-2000 to 6.7 per cent in 2000-2006 (Table 7). The productivity growth acceleration was mainly driven by two sub-industries: motor vehicle, body and trailer as well as aerospace, railroad, ship and boat building. For motor vehicle, body and trailer, its total contribution increased from negative 0.4 percentage points in 1997-2000 to 2.3 percentage points in 2000-2006, largely due to an acceleration in pure productivity growth in this sub-industry. Similarly, for aerospace, railroad, ship and boat building, its contribution increased from 1.4 percentage points to 3.2 percentage points over these two periods, due to both acceleration in pure productivity growth and a favourable change in relative size resulting from the changes in employment share (Table 7).

In sum, unlike the Canadian transportation equipment industry, the U.S. industry did not

Table 9

Counterfactual Decomposition of Industry Labour Productivty Growth into Reallocation and Pure Productivity Effects in the Canadian Transportation Equipment Industry, Using U.S. Output and Employment Shares

Industries	Labour Productivity Growth Rate	Percentage Point Contribution to Transportation Equipnment		
		Total	Pure Productivity Growth	Reallocation
		1997-2000		
Transportation equipment manufacturing	6.8	6.8	8.5	-1.7
Motor vehicle (MV) mfg., body and trailer	9.8	6.6	3.6	3.0
MV gasoline engine, transmission and powertrain	9.3	0.4	1.6	-1.3
MV electrical and electronic equipment	6.0	0.0	0.3	-0.3
MV steering and suspension components	10.1	0.1	0.2	-0.1
MV brake system	1.8	-0.1	0.0	-0.1
MV seating and interior trim	5.8	0.1	0.1	0.0
MV metal stamping	11.4	-0.1	0.5	-0.6
Aerospace, railroad, ship and boat building	6.7	-0.4	2.0	-2.4
		2000-2006		
Transportation equipment manufacturing	3.3	3.3	2.1	1.3
Motor vehicle (MV) mfg., body and trailer	2.7	-0.2	0.9	-1.0
MV gasoline engine, transmission and power train	0.6	0.1	0.1	0.0
MV electrical and electronic equipment	0.0	-0.1	0.0	-0.1
MV steering and suspension components	1.6	0.0	0.0	0.0
MV brake system	1.6	0.0	0.0	0.0
MV seating and interior trim	0.6	0.1	0.0	0.1
MV metal stamping	-0.4	0.1	0.0	0.1
Aerospace, railroad, ship and boat building	3.3	3.3	1.0	2.2

experience a widespread productivity growth slowdown after 2000. In fact, almost all sub-industries in the United States maintained or experienced faster productivity growth after 2000 (only metal stamping fell).

Counterfactual Analysis

As previously discussed, the Canadian transportation equipment industry had a different industry mix than its U.S. counterpart. Most notably, the U.S. aerospace, railroad, and ship and boat industry has a larger employment share than its Canadian counterpart. Conversely, the Canadian motor vehicle manufacturing industry is larger in terms of its employment share.

Another difference between the two countries is related to price. The Canadian motor vehicles experienced a large output price increase from 1999 until 2004 while in the United States, the price was relatively stable. Although the weakness of the Canadian dollar over this period was an important factor for the price change in Canada, we can not rule out the use of different methodologies in estimating output prices being a factor.

In this sub-section, we examine how these differences affect the productivity performance estimates of the transportation equipment industry in Canada, using a counterfactual analysis.

Counterfactual 1: Replacing Canadian Deflators by U.S. Deflators

The first counterfactual analysis investigates what would be the productivity performance of the Canadian industry if we deflated Canadian nominal output using U.S. deflators. This could change the contribution calculations through

Table 10
Distribution of Entering, Continuing, and Exiting Plants in the Canadian Transportation Equipment Manufacturing Industry, 1997–2006
(per cent)

	1997–2000			2000–2006		
	exiting plants (1)	continuing plants (2)	entering plants (3)	exiting plants (4)	continuing plants (5)	entering plants (6)
Transportation equipment	0.23	0.77 0.63	0.37	0.51	0.49 0.52	0.48
Motor vehicle (MV) mfg., body and trailer	0.19	0.81 0.59	0.41	0.50	0.50 0.49	0.51
MV gasoline engine, transmission and powertrain	0.34	0.66 0.58	0.42	0.44	0.56 0.54	0.46
MV parts excluding powertrain	0.20	0.80 0.65	0.35	0.50	0.51 0.49	0.51
Aerospace, railroad, ship and boat building	0.22	0.78 0.67	0.33	0.56	0.50 0.55	0.45

Notes: (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.

two channels: productivity growth as a result of the change in the deflated real output and changes in the relative sizes of the sub-industries due to the change in relative output price.

When the Canadian industry assumes the U.S. deflators, productivity in the Canadian transportation equipment industry would grow at a faster pace than before in the first period (14.0 per cent vs. 8.8 per cent) and at a slower pace than before in the second period (-0.8 per cent vs. 1.6 per cent) (Table 8). The slowdown in productivity growth between 1997-2000 and 2000-2006 would be much larger than before (14.8 percentage points vs. 7.2 percentage points)

Thus, the counterfactual analysis shows that the replacing Canadian deflators by U.S. deflators would not change the fact that productivity growth in the Canadian industry slowed dramatically from 1997-2000 to 2000-2006.

Counterfactual 2: Replacing Canadian Industry Structure by U.S. Industry Structure

The second counterfactual analysis is to see what the productivity performance of this industry in Canada would be if the Canadian industry mix were the same as in the United States. Basically, we replace Canadian sub-industry output and employment shares by corresponding U.S. output and employment shares in the decomposition, keeping others as before.

The counterfactual analysis shows that the productivity profile of the Canadian transportation equipment industry would grow slightly slower than before in the 1997-2000 period (6.8 per cent vs. 8.8 per cent), but slightly faster than before in the 2000-2006 period (3.3 per cent vs. 1.6 per cent) (Table 9). Importantly, it shows that the productivity growth slowed over these two periods, although the deceleration was smaller than before. Also as before, the slowdown was mainly driven by the deceleration of

Table 11: Average Employment Per Plant of Entering, Continuing, and Exiting Plants in the Canadian Transportation Equipment Manufacturing Industry, 1997–2006
(Average employment of continuing plants=1.00 in 1997 or 2000)

	1997–2000			2000–2006		
	exiting plants (1)	continuing plants (2)	entering plants (3)	exiting plants (4)	continuing plants (5)	entering plants (6)
Transportation equipment	0.42	1.00 0.99	0.24	0.38	1.00 0.87	0.40
Motor vehicle (MV) mfg., body and trailer	0.25	1.00 0.99	0.19	0.34	1.00 0.98	0.22
MV gasoline engine, transmission and powertrain	0.58	1.00 1.01	0.29	0.47	1.00 0.83	0.57
MV parts excluding powertrain	0.68	1.00 0.89	0.30	0.67	1.00 1.00	0.69
Aerospace, railroad, ship and boat building	0.28	1.00 1.07	0.22	0.25	1.00 0.71	0.33

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

productivity growth in motor vehicle and body and trailer.

In sum, the two counterfactual analyses suggest that the difference in industry structure or output price of the transportation equipment industry between Canada and the United States is not an important factor in explaining the weaker productivity performance of the industry in Canada after 2000.

Empirical Findings on the Plant Turnover Effect in Canada

For Canada, we deepen our investigation into the role played by plant turnover in productivity performance. To this end, we divide each sub-industry into three groups: continuing plants, entrants and exits. Because of the further division, some previous sub-industries have to be aggregated to meet the Statistics Canada's confidentiality policy. We combined five parts sub-industries: motor vehicle electronic and electrical parts, steering and suspension, brake systems, seating and interior, and metal stamping. For simplicity, we shall refer to the newly combined group "motor vehicle parts excluding powertrain." The other three sub-industries are the same as before.

Plant Turnover in the Canadian Transportation Equipment Industry

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

1997-2000

In the pre-2000 period, exiting plants that had exited by 2000 made up 23 per cent of the 1997 plant population, and entering plants that had entered between 1997 and 2000 made up 37 per cent of the 2000 plant population (Table 10), which suggests that there was a net increase in the number of plants. These exit and entrant ratios were relatively consistent across constituent sub-industries.

Table 12

Relative Productivity Levels of Entering, Continuing, and Exiting Plants in the Canadian Transportation Equipment Manufacturing Industry, 1997–2006

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

	1997–2000			2000–2006		
	exiting plants (1)	continuing plants (2)	entering plants (3)	exiting plants (4)	continuing plants (5)	entering plants (6)
Transportation equipment	0.46	1.00 1.28	0.73	0.53	1.00 1.10	0.62
Motor vehicle (MV) mfg., body and trailer	0.27	1.00 1.35	0.65	0.50	1.00 1.06	0.54
MV gasoline engine, transmission and powertrain	0.53	1.00 1.20	0.83	0.55	1.00 1.01	0.75
MV parts excluding powertrain	0.74	1.00 1.19	1.16	0.65	1.00 0.95	0.80
Aerospace, railroad, ship and boat building	0.64	1.00 1.25	0.52	0.59	1.00 1.20	0.81

Notes: (1) Average productivity of plants that existed in 1997, but did 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 of plants that did not exist in 1997, but did in 2000.
(4) Average productivity of plants that existed in 2000, but did 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 of plants that did not exist in 2000, but did in 2006.

Entrants and exits were typically smaller than continuing plants. They employed about 24 per cent and 42 per cent, respectively, of the employment per plant of continuing plants in 1997-2000 (Table 11). There was more dispersion in exit size than entrant size among sub-industries. The range of entrant sizes was from 19 per cent to 30 per cent of 2000 continuing plants while the range of exit sizes was from 25 per cent to 68 per cent of 1997 continuing plants. The two auto parts industries had larger exiting plants. Meanwhile, continuing plants' average plant size was fairly stable, falling by only 1 per cent at the aggregate level.

Entrants and exits were both less productive than continuing plants in this period (Table 12). Exiting firms were 54 per cent less productive than the continuing plants in 1997 and entrants were 43 per cent less productive than the continuing plants in 2000. Over this period, continuing plants improved productivity by 28 per cent. The productivity profile was found across sub-industries.

On average, the productivity gap between exits and continuing plants (54 per cent) was larger than the productivity gap between entrants and continuing plants (43 per cent). The result held for all sub-industries except for aerospace, railroad, ship building and boat building where the entrants tended to be much less productive than exits when they were compared to continuing plants.

2000-2006

In the post-2000 period, there was a decline in plant population. Exiting plants made up 51 per cent of the 2000 plant population, but entering plants made up only 48 per cent of the 2006 population (Table 10).[12]

12 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.

Table 13

Plant-level GR Decomposition of Labour Productivity Growth of Constituent Industries in the Canadian Transportation Equipment Manufacturing Industry, 1997-2000 and 2000–2006

(percentage points per year)

	Labour productivity growth rate	Within continuing plants	Between continuing plants	Net entry	Entering plants	Exiting plants
			1997-2000			
Motor vehicle (MV) mfg., body and trailer	9.81	12.67	-2.91	0.05	-0.25	0.30
MV gasoline engine, transmission and powertrain	9.35	4.74	1.77	2.84	-0.60	3.44
MV parts excluding powertrain	7.68	5.82	-0.16	2.03	0.49	1.54
Aerospace, railroad, ship and boat building	6.69	5.95	1.39	-0.65	-1.27	0.62
Weighted sum*	8.48	8.01	-0.31	0.78	-0.46	1.24
			2000-2006			
Motor vehicle (MV) mfg., body and trailer	2.67	-0.66	1.72	1.61	-0.04	1.65
MV gasoline engine, transmission and powertrain	0.58	-0.04	0.14	0.49	-0.51	1.00
MV parts excluding powertrain	0.36	-0.76	-0.06	1.18	-0.52	1.69
Aerospace, railroad, ship and boat building	3.32	3.21	-0.32	0.42	-0.86	1.28
Weighted sum*	2.20	0.37	0.74	1.09	-0.37	1.47
			Difference: 2000-2006 minus 1997-2000			
Motor vehicle (MV) mfg., body and trailer	-7.14	-13.33	4.63	1.56	0.21	1.35
MV gasoline engine, transmission and powertrain	-8.76	-4.78	-1.63	-2.35	0.09	-2.44
MV parts excluding powertrain	-7.33	-6.58	0.11	-0.85	-1.01	0.15
Aerospace, railroad, ship and boat building	-3.37	-2.74	-1.70	1.07	0.41	0.67
Weighted sum*	-6.29	-7.64	1.05	0.31	0.08	0.22

* 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.

As in 1997–2000, entrants and exits in 2000-2006 were smaller than continuing plants in aggregate, though the relative employment of the average entrant has increased from about one quarter in 2000 to 40 per cent of the continuing plant in 2006 (Table 11). Exiting plants ranged from employing 75 per cent fewer workers than continuing plants in the aerospace, railroad and ship and boat industry to hiring 33 per cent fewer workers than continuing plants in the motor vehicle parts excluding powertrain industry. Entering plants ranged from employing 78 per cent fewer workers per plant in motor vehicle manufacturing to employing 31 per cent fewer workers per plant in the motor vehicle parts (excluding engines, powertrain, and transmission) industry. The increase in entrant relative plant size is mostly driven by relatively larger entrants in the auto parts sub-industries.

Over this period, continuing plants decreased employment share by 13 per cent at the aggregate. At the sub-industry level, they ranged from employing 29 per cent fewer workers in aerospace, railroad, and ship and boat to no change in motor vehicle parts excluding powertrain.

Table 14
Selected Economic Indicators for the Canadian and U.S. Transportation Equipment Industry, 1994-2008

	Canada			United States		
	Shipments ($CAN Billions)	Exports ($CAN Billions)	Capacity Utilization	Shipments ($US Billions)	Exports ($US Billions)	Capacity Utilization
1994	73.4	61.3	81.9	496.2	89.0	77.9
1995	83.0	66.4	86.2	508.0	86.5	75.7
1996	84.5	67.8	84.8	514.9	97.2	75.2
1997	92.8	73.2	86.4	576.2	113.5	78.8
1998	101.1	83.2	86.4	611.1	126.1	80.0
1999	130.0	101.0	89.5	676.5	125.9	80.6
2000	132.3	101.8	89.0	638.6	121.8	75.5
2001	122.6	100.2	86.0	601.4	123.0	71.3
2002	126.5	101.6	88.1	637.0	124.0	73.7
2003	120.6	92.8	83.3	655.5	122.2	72.6
2004	123.2	95.1	85.0	657.1	129.7	71.4
2005	124.8	92.9	87.3	688.6	147.2	74.0
2006	118.8	88.0	86.2	696.1	178.0	72.2
2007	116.1	84.6	86.8	744.8	202.2	76.4
2008	97.0	68.4	68.5	666.4	202.0	66.4

Sources: Statistics Canada for Canadian data and for the United States, U.S.Census Bureau for shipments, U.S. International Trade Commission for exports, and U.S. Federal Reserve for capacity utilization.

At the aggregate level, exits were 47 per cent less productive and entrants were 44 per cent less productive than continuing plants, similar to the 1997-2000 period. The relative productivity of exits was similar across sub-industries, but there were larger differences in entrant productivity across sub-industries (Table 12). At the sub-industry level, exiting plants were between 35 per cent and 50 per cent less productive than their continuing counterparts. However, entering plants were between 16 per cent and 41 per cent less productive than the continuing plants in motor vehicles and body and trailer in 2006.

Productivity of continuing plants increased by 10 per cent at the aggregate level over this period. This was mainly driven by continuing plants in aerospace, railroad, and ship and boat, where productivity increased by 20 per cent. For all other sub-industries, continuing plants were between 5 per cent less productive and 6 per cent more productive in 2006 than in 2000.

The Productivity Effect of Plant Turnover

As shown in Table 6, the decline in labour productivity growth in the Canadian transportation equipment industry between the pre-2000 and post-2000 periods was mainly from a broad decline in productivity growth at the sub-industry level. The effect is referred 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 sub-industry labour productivity growth into continuing plants, entrants and exits using the GR decomposition framework as described earlier. The results are reported in Table 13. A positive number for entrants (exits) means that the entrants (exits) are on average more (less) productive than the industry average, and vice versa. The component associated with 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 13).[13] The decline was pervasive across all sub-industries, with motor vehicle, body and trailer experiencing the largest slowdown.

On the other hand, the effect on productivity growth from resource reallocation between continuing plants as well as from net entry improved somewhat in the post-2000 period when compared to the pre-2000 period. The improvement in resource reallocation between continuing plants mainly took place in motor vehicles, body and trailer, which was partly offset by deterioration in resource allocation in motor vehicle gasoline engine, transmission and powertrain and aerospace, railroad, ship and boat building. The improvement in net entry was mainly in motor vehicles, body and trailer as well as in aerospace, railroad, ship and boat building, which was partly offset by deterioration in motor vehicle gasoline engine, transmission and powertrain.

Concluding Remarks

Productivity growth in the Canadian transportation equipment industry declined between pre-2000 and post-2000 period. The slowdown in productivity growth would not change even if the Canadian industry mix were the same as the U.S. industry mix over these periods.

This article shows that the dramatic decline in productivity growth was mainly due to the slowdown in productivity growth in sub-industries, which can be traced to the decline of continuing plants in labour productivity growth in all sub-industries. The largest decline was in the motor vehicle and body and trailer manufacturing industries.

The effect from the decline of continuing plants on labour productivity growth was partially offset by a relatively smaller negative impact from entry and more efficient allocation of resources (labour) between continuing plants in the post-2000 period relative to the pre-2000 period.

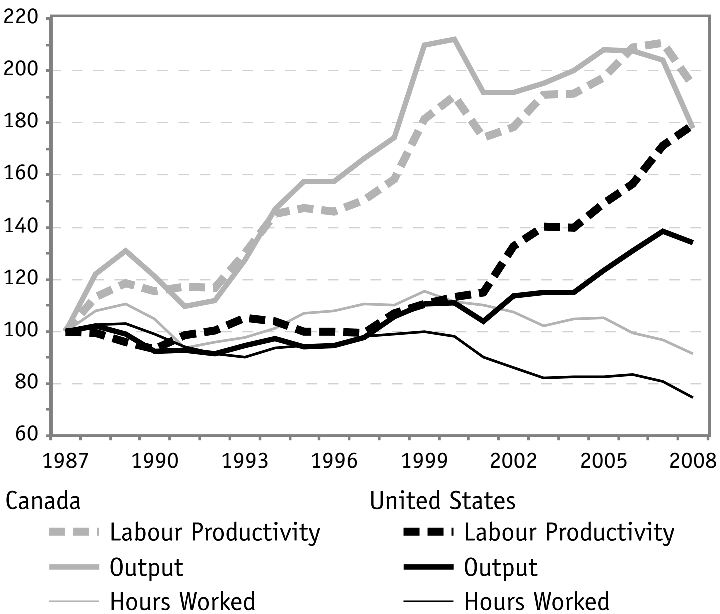
There are a number of factors that may contribute to the productivity growth slowdown in the Canadian transportation equipment industry. First, it can be traced to lower capacity utilization in post-2000 period (Table 14). Over the period 2000-2006, shipments of transportation equipment decreased from $132 billion to $119 billion. Similarly, the value of exports decreased from $102 billion in 2000 to $88 billion in 2006.[14] As a result, the capacity utilization decreased from 89 per cent to 86 per cent. In the Appendix, we present the decomposition results for the transportation equipment industry using an alternative decomposition method as recently proposed by Baldwin, Gu and Yan (2011). The alternative method shows that most of the decline in labour productivity growth after 2000 is due to the decline in capacity utilization, and to lesser extent due to the decline in capital deepening.[15]

13 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). The discrepancy is due to a higher level of disaggregation of the transportation equipment industry for plant turnover analysis than for industry mix analysis. Also note that the dominant effect from within-plants is reconfirmed by an alternative decomposition method as discussed in the Appendix.

14 The appreciation of the Canadian dollar after 2002 was also playing a role in the decline of value in shipments or exports, but the decline in physical production is real, as shown in Table 15 in terms of number of autos being produced between 2000 and 2006.

15 Capacity utilization in the U.S. transportation equipment industry also declined somewhat between 2000 and 2006. However, its shipment and export value increased 9 per cent and 46 per cent over this period, respectively.

Chart 1
Output, Hours Worked and Labour Productivity in the Canadian and U.S. Transportation Equipment Industries, 1987-2008
(1987=100)



Sources: Authors' calculation based on data from Statistics Canada, U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics.

Second, Verdoorn's law may also play an important role here, which predicts that labour productivity growth is highly correlated with output growth.[16] As shown in Chart 1, labour productivity growth moved in tandem with output growth in the Canadian transportation equipment manufacturing industry in the period 1987-2008. According to the law, this happens because increases in output (or scale) lead to more division in labour, more specialization, and lower overhead costs. Verdoorn's law seems to play a less important role in the U.S. transportation equipment industry, especially in the post-2000 period, which may be due to the U.S. labour market being more dynamic than its Canadian counterpart.

And, finally, the number of different car and light truck models produced in North America has increased enormously over the last decade. In response to such demand uncertainty (including demanding for variety) and increased competition, the Canadian auto industry, as well as its U.S. counterpart, has increased its manufacturing flexibility by boosting its ability to manufacture several products on the same production line and switch seamlessly among them. Goyal *et al.* (2006) and Van Biesebroeck (2007) show that this use of flexibility results in lower productivity. This is because the capacity for manufacturing flexibility is costly and it reduces benefits from production specialization.

Why did the U.S. transportation equipment industry experience acceleration in labour productivity growth in the post-2000 period compared to the pre-2000 period, as shown in Chart 1? We do not have a satisfactory answer to this question. One possible factor is that the U.S. auto industry continued to shift toward producing more trucks (mainly light trucks) relative to the Canadian auto industry (Table 15). Light trucks require a similar number of hours per vehicle as cars to produce, but each vehicle has much higher value added. The switch towards light truck products therefore had a positive effect on productivity performance in the U.S. (Baily *et al.* 2005). Also the choice of the break year for the periods matters, although it will not change the main result. If the break year is 2001, then the productivity growth gap between Canada and the U.S. would be smaller, as shown in Chart 1.

More recently, the transportation equipment industry has been hit by a large negative demand shock, as indicated by a sharp decline in auto production in both countries in recent years (Table 15). Partly as a result of the financial crisis of 2008, General Motors and Chrysler entered bankruptcy protection, followed by large government intervention plans to help the

16 For a discussion, see Sharpe and Thomson (2010).

Table 15
Auto Production in Canada and the United States, 1997-2010
(Thousands of motor vehicles)

Year	Canada			United States		
	Cars	Trucks	Cars/Trucks	Cars	Trucks	Cars/Trucks
1997	1,373	1,198	1.15	5,878	6,252	0.94
1998	1,481	1,089	1.36	5,492	6,510	0.84
1999	1,626	1,431	1.14	5,578	7,447	0.75
2000	1,551	1,413	1.10	5,471	7,303	0.75
2001	1,275	1,260	1.01	4,808	6,617	0.73
2002	1,369	1,264	1.08	4,957	7,322	0.68
2003	1,340	1,213	1.11	4,453	7,634	0.58
2004	1,400	1,311	1.07	4,166	7,794	0.53
2005	1,407	1,281	1.10	4,266	7,681	0.56
2006	1,428	1,144	1.25	4,312	6,949	0.62
2007	1,342	1,237	1.09	3,867	6,885	0.56
2008	1,195	887	1.35	3,731	4,941	0.76
2009	822	668	1.23	2,196	3,514	0.62
2010	684	714	0.96	1,856	3,240	0.57

Source: Ward's AutoInfoBank.

two firms survive. Capacity utilization in motor vehicle manufacturing fell to little over 60 per cent of 2007 levels in 2009Q3 (Browarski 2009). The switch by GM, Ford, and Daimler-Chrysler toward light trucks, which had improved their productivity, became a liability as North American demand for these vehicles fell after 2004 (for full-frame vehicles) and 2005 (for large frame vehicles). The trend against light trucks is expected to continue, driven by high energy prices, fuel efficiency regulations, and changes in consumer preferences (Industry Canada 2010).

Looking forward, sales and capacity utilization in the automotive sector are expected to improve by 2012, but production will still fall behind the 2007 peak level in 2014 (Browarski 2009). In addition, the Canadian auto industry is facing increased competition from Mexico as well as the shift in global demand from North America to emerging markets. The Mexican share of light vehicle production in North America surpassed Canada's share in 2008 and is expected to continue to grow at Canada's expense in the near future (Industry Canada 2010). Globally, emerging markets, such as China and India, will contribute the majority of growth in auto production.

These trends suggest that the Canadian auto industry will continue to face challenges in adjusting their production capacity and reducing the cost of production. But at the same time, this creates pressure for Canadian automobile manufacturers to be more innovative and productive.

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Appendix: Sources of Slower Productivity Growth in the Canadian Transportation Equipment Industry After 2000

In this appendix, we account for the slower productivity growth in the Canadian transportation equipment industry using an alternative decomposition method as recently proposed by Baldwin, Gu and Yan (2011). Like Griliches and Regev (1995), the alternative method decomposes aggregate labour productivity growth into three components: the within-plant effect, the between-plant effect, and the net entry. However, unlike the previous methods, it delves deeper. The within-plant effect is further decomposed into four components, reflecting the effect of capital deepening, technological progress, scale economies, and input utilization at the plant level. The between-plant component is also decomposed further into three components, reflecting the effect of the reallocation of inputs and outputs across plants on aggregate capital deepening and aggregate multifactor productivity growth.

The question of interest, in the context of current study, is the extent to which most of the decline in labour productivity growth came from a decline in capacity utilization or whether it came from other sources—a decline in general efficiency or a decline in the impact of the reallocation of resources that generally tends to contribute to productivity growth.

Table A1 presents the decomposition results.[17] It shows that the slowdown in labour productivity growth in 2000-2006 by comparing

17 We used the coefficient estimates on the scale economies and the effect of capacity utilization obtained from SYS-GMM method. For a detailed discussion of the methodology, see Baldwin, Gu and Yan (2011).

Table A1
An Alternative Decomposition of Aggregate Labour Productivity Growth in the Canadian Transportation Equipment Industry

	1990-99	2000-06	2000-06 minus 1990-99
Aggregate labour productivity growth	6.39	1.41	-4.98
Within-plant	7.00	0.70	-6.31
MFP growth	2.67	2.05	-0.62
Scale economies	0.03	0.00	-0.03
Input utilization	2.55	-1.77	-4.33
Capital deepening	1.74	0.41	-1.33
Between-plant	-1.33	0.63	1.96
Reallocation of capital on MFP	-0.45	-0.70	-0.26
Reallocation of labour on MFP	-0.33	0.24	0.57
Reallocation effect on capital deepening	-0.55	1.22	1.77
Net entry	0.72	0.08	-0.64

Note: Labour productivity is defined as census value added per employee. The results are based on the Annual Survey of Manufactures, with no adjustment to the data from national accounts.

to 1990-1999 was entirely due to the decline in the within-plant effect over these two periods. The contributions from the other two components were relatively small, with the between-plant effect being positive and net entry negative. The results reconfirmed our findings as shown in Table 13.[18]

By further decomposing the within-plant effect, the alternative method shows that most of the decline in the within-plant effect after 2000 is largely due to the decline in capacity utilization, and to lesser extent due to the decline in capital deepening.

18 There are some differences in the size of the between-plant effect, the within-plant effect and net entry between the two decomposition methods. The differences can be traced to the difference in level of industry aggregation at which the decomposition is carried out. The results in Table A1 are obtained by decomposition at the aggregate transportation equipment manufacturing, while the decomposition in Table 13 is obtained from decomposition at more detailed transportation equipment industries.