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The Evolution of Manufacturing Employment in Canada: The Role of Outsourcing

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The Evolution of Manufacturing Employment in Canada: The Role of Outsourcing

Abstract

The objective of this report is to examine the impact of outsourcing on manufacturing's employment share in Canada. The report shows that outsourcing accounts for a small but significant part of the decline in the manufacturing employment share over the 1976-2008 period. Two approaches are used to determine the contribution of outsourcing to the evolution in manufacturing's employment share in the report. The first approach uses input-output (I-O) analysis to estimate the impact of changes in the I-O structure of the economy on employment shares by industry. The second approach uses aggregate industry-by-occupation employment data to decompose changes in employment shares by industry in various ways.

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Executive Summary

The relative importance of the manufacturing sector in Canada, as measured by the sector's share of total employment, has fallen considerably over the past half-century. In particular, the sector saw its employment share fall from 19.1 per cent in 1976 to 9.7 per cent in 2014, a decline of 9.4 percentage points. At the same time, the employment share of services industries – most notably, the professional and business services (PBS) industry and the health care industry – have increased dramatically.

Canada's experience is not unique: manufacturing employment has fallen in other developed economies over the past few decades, while employment in the service sector has increased. A number of explanations have been advanced for the decline in manufacturing's employment share, including: relatively above-average labour productivity growth in manufacturing; globalization; shifts in final demand expenditures from manufactured goods to services; and, finally, outsourcing from manufacturing to the service sector.[1]

This report examines the effect on outsourcing on manufacturing's employment share in Canada. It is well known that manufacturing firms have increasingly outsourced services (*e.g.*, accounting, consulting, legal services, and protection services). However, the empirical literature regarding the effect of outsourcing on manufacturing employment in Canada is non-existent. In contrast, there has been some research on the role of outsourcing in sectoral reallocation in the United States, most notably Berlingieri (2014).

Using the methodologies implemented in Berlingieri (2014), the report attempts to quantify the contribution of outsourcing to the decline in manufacturing's share of total employment in Canada between 1976 and 2008, with particular attention paid to the role of professional and business services (PBS) outsourcing. The report shows that outsourcing accounts for a small but significant part of the decline in the manufacturing employment share.

Two approaches are used to determine the contribution of outsourcing to the evolution in manufacturing's employment share in this report. The first approach uses input-output (I-O) analysis to estimate the impact of changes in the I-O structure of the economy on employment shares by industry. The second approach uses aggregate industry-by-occupation employment data to decompose changes in employment shares by industry in various ways.

[1] Outsourcing refers to the acquisition by firms of intermediate inputs (either goods or services) from unaffiliated suppliers. The definition of outsourcing includes both domestic outsourcing and offshoring (or foreign outsourcing).

Input-Output Analysis

The principal analysis in the report involves estimating employment shares using a gross output model in which employment shares are determined by changes in final demand shares and by changes in the I-O structure of the economy. This analysis is carried out for the 1976-2008 period and at a more disaggregated level for the 1987-2008 period.

In Canada, the evolution of the I-O structure of the economy, which captures changes in the composition of intermediate inputs for all industries, accounted for 76.3 per cent of the fall in the employment share of manufacturing over the 1976-2008 period. To look more closely at the role of outsourcing in the decline in manufacturing's employment share, the report performs several simulations in which the manufacturing sector's direct requirements for selected intermediate inputs are held constant over time. First and foremost, the report holds manufacturing's direct requirements for all intermediate inputs constant over time to provide an upper-bound for the contribution of outsourcing to the decline in manufacturing's employment share. The results of this exercise indicate that outsourcing accounted for 21.1 per cent of the decline in manufacturing's employment share. The report also holds manufacturing's direct requirements for only PBS and financial services (FS) intermediates constant over time to estimate the contribution of PBS and FS outsourcing to the decline in manufacturing's employment share. The results indicate that an increase in PBS and FS outsourcing accounted for only 3.5 per cent of the decline in manufacturing's employment share between 1976 and 2008.

In contrast, Berlingieri (2014) found that changes in the composition of intermediate inputs for all industries accounted for only 25.3 per cent of the fall in manufacturing's share of total employment in the United States over the 1948-2002 period, well below the result in this report (76.3 per cent), and that most of the effect of changes in the composition of intermediate inputs was related to PBS outsourcing. He found that changes in manufacturing's direct requirements for intermediate inputs accounted for 15.0 per cent of the decline in manufacturing's employment share in the United States between 1948 and 2002, which is similar to what was found in this report (21.1 per cent). However, Berlingieri also found that PBS outsourcing accounted for 16.1 per cent of the fall in manufacturing's employment share, well above the result in this report (3.5 per cent).

There are two reasons to doubt the predictive power of the gross output model for Canada. First, a significant portion of the predicted decline in the manufacturing employment share was driven by an increase in the direct requirements for mining and oil and gas extraction, which largely reflected an increase in the value of mineral fuels refined in Canada. This also led to an unrealistically large increase in the predicted employment share of mining and oil and gas extraction. Second, the model was unable to explain much (if any) of the actual change in employment shares for most of the industries included in the analysis.

The poor explanatory power of the gross output model has two possible explanations: 1) there may be certain weaknesses with the model (*e.g.*, its assumptions, specification, etc.), making it incapable of accurately explaining changes in sectoral employment shares; and 2) the use of current dollar data leads to major distortions resulting from changes in relative prices, such as the growth in the relative price of crude oil in the 2000s.

The first explanation is difficult to address. The model may have been unable to explain much of the actual changes in employment shares in Canada due to the data, the assumptions of the model, the level of aggregation, or other factors. In particular, the model assumes that there is no capital in the economy, and the predicted employment shares are not directly affected by differential labour productivity growth rates across industries. It is also possible that the model is more appropriate at higher levels of aggregation or for longer periods as in Berlingieri (2014), which may explain why the model's predictions were more accurate for the 1976-2008 period compared to the 1987-2008 period.

Another issue is the uncertainty regarding the extent to which the inaccuracy of the model is due to the use of current dollar data as opposed to constant (or chained) dollar data. Constant dollar data allows price changes (such as an increase in crude oil prices) to affect the evolution of I-O coefficients over time. Unfortunately, we do not attempt to use constant dollar data in this report, as only current dollar data are publically available in a consistent time series for Canada for the 1976-2008 period. Further research is needed to determine whether and to what extent the results of the report are affected by the use of constant dollar I-O data.

Two additional areas for future research include stripping imported intermediate inputs from the I-O data and looking at the determinants of and mechanisms behind outsourcing. With regard to the first area, it would be interesting to exclude imported intermediate inputs from the I-O data, as it would allow one to estimate the relative importance of domestic outsourcing versus offshoring. Further research on the determinants of and mechanisms behind outsourcing is also important, as it provides a deeper understanding of the observed trends in outsourcing. The report purposefully ignores the drivers of outsourcing in order to focus on an accounting of its impact on manufacturing's employment share.

Occupational Analysis

The report also performs a decomposition of the decline in manufacturing's employment share using aggregate occupational data. We found that 57.9 per cent of the decrease was due to workers within each occupation moving from manufacturing to other industries, while 43.4 per cent was due to changes in the share of each occupation in total employment. Furthermore, we found that the reallocation of PBS workers from manufacturing to other industries accounted for 13 to 29 per cent (depending on the definition of PBS occupations) of the decline in manufacturing's employment share. This suggests that outsourcing accounted for a significant

part of the decline in manufacturing's employment share, contradicting the results of the analysis based on I-O data. However, it is likely that these results overestimate the actual contribution of outsourcing to the decline in manufacturing's employment share because the occupational categories employed in this report were overly broad. For that reason, it would be interesting to redo this analysis using more detailed industry-by-occupation employment data.

Implications

Generally speaking, whether the decline in manufacturing's employment share is an issue depends primarily on the quality of the new jobs. If the quality of the new jobs is worse than the quality of those lost, then the decline in manufacturing's employment share should be considered an issue. According to Hirshhorn (2013), the decline in manufacturing's employment share may have implications for the quality of the workplace, as the service sector jobs that have increased in relative terms are quite different from manufacturing jobs. For instance, service sector jobs tend to "have a higher incidence of part-time and temporary workers, rely more on unpaid overtime and make greater use of flexible work arrangements" (Hirshhorn, 2013). In contrast, if the new jobs are created in innovative industries that require high-skill workers, then it is likely that the living standards of Canadians will improve.

Service sector jobs, which will continue to account for an increasingly large share of total employment, tend to require higher levels of educational attainment than manufacturing jobs. Therefore, it will be important for policymakers to continue to promote an improvement in educational attainment among Canadians. It will also be important for policymakers to help retrain workers who have lost jobs in industries with falling employment like manufacturing so that they can be redeployed into industries with expanding employment.

Furthermore, policymakers must pay attention to the role of outsourcing on productivity growth. As PBS outsourcing continues to increase, the PBS industry will increasingly influence the productivity performance of other industries. Several researchers have shown that domestic outsourcing and offshoring have significant effects on productivity growth (Tang and do Livramento, 2008; Cheung, Rossiter, Zheng, 2008; Houseman and Mandel, 2015). It is imperative for policymakers to understand the drivers of productivity growth, as productivity growth is the primary determinant of living standards in the long run.

The Evolution of Manufacturing Employment in Canada: The Role of Outsourcing[2]

I. Introduction

The relative importance of the manufacturing sector in Canada, as measured by the sector's share of total employment, has fallen drastically over the last half century. At the same time, the employment share of services industries – most notably, the professional and business services (PBS) industry and the health care industry – have increased dramatically. A number of explanations have been advanced to explain these development, including: more rapid labour productivity growth in manufacturing than in non-manufacturing sectors; globalization; shifts in final demand expenditures away from manufactured goods toward services; and, finally, rapid growth in outsourcing[3] from manufacturing to the service sector.[4]

Related to this last explanation, Berlingieri (2014) found that, in the United States, the evolution of the input-output (I-O) structure, which captures changes in the composition of intermediate inputs in the economy, accounted for 25.3 per cent of the fall in the employment share of manufacturing over the 1948-2002 period. He also shows that professional and business services (PBS) outsourcing, which accounts for a large part of the changes in the I-O structure, accounted for 16.1 per cent of the decrease in manufacturing's employment share over this period. Canada has high quality, and highly underutilized, annual I-O tables starting in 1961, allowing an analysis similar to that undertaken by Berlingieri to be carried out for this country.

The objective of this report is to examine the impact of outsourcing on manufacturing's employment share in Canada, with a particular focus on the role of outsourcing of various functions (*e.g.*, accounting, engineering, consulting, legal services as well as lower-end services such as janitorial services and protection services) to service sector firms, especially firms in the PBS industry. The report shows that outsourcing accounts for a small but significant part of the decline in the manufacturing employment share over the 1976-2008 period. More importantly, a recent CSLS research report suggests that above-average labour productivity growth explains

[2] This report was written by Evan Capeluck under the supervision of Andrew Sharpe. The CSLS would like to thank Industry Canada for their financial support and for comments on an earlier draft. We would also like to thank Matthew Calver for his comments. Direct any questions or comments to andrew.sharpe@csls.ca.

[3] Outsourcing refers to the acquisition by firms of intermediate inputs (either goods or services) from unaffiliated suppliers. The definition of outsourcing includes both domestic outsourcing and offshoring (or foreign outsourcing). The particular form of outsourcing is not important for the purposes of the report. For example, it does not matter whether firms are purchasing new inputs in response to new needs or substituting inputs purchased from unaffiliated suppliers for inputs that were produced in-house. Box 1 discusses the definition of outsourcing in more detail.

[4] All other things being held constant, outsourcing from manufacturing to the service sector lowers employment growth in manufacturing and raises employment growth in the service sector, both of which lead to a reduction in the manufacturing employment share.

most of the decline in the manufacturing employment share before 2000, while below-average real output growth explains most of the decline after 2000 (Capeluck, 2015).

The report is divided into five sections. The current section introduces the report. The second section presents the methodology developed by Berlingieri (2014) in his analysis of the impact of outsourcing on manufacturing employment in the United States and discusses how it can be applied to Canadian data. The third section reviews the input-output and employment data to be used in the analysis, highlighting its strengths and weaknesses. The fourth section conducts an analysis similar to Berlingieri (2014) for Canada for the 1976-2008 period. It reviews the descriptive statistics on trends in the outsourcing of services in the Canadian manufacturing sector. The section also presents and discusses the findings from multiple input-output simulations and decompositions. A brief conclusion follows.

Box 1: What is Outsourcing?

Outsourcing refers to the acquisition by firms of intermediate inputs (either goods or services) from unaffiliated suppliers. Outsourcing takes many forms and has multiple motivations. For instance, firms may substitute inputs produced in-house with either identical or alternative inputs purchased from specialized firms. Alternatively, outsourcing may involve the purchase of new inputs from the market in response to new needs. Firms may decide to outsource in order to reduce their costs or to focus on their core activities. On the other hand, regulatory and technological developments may make it increasingly difficult to produce certain inputs in-house, leading firms to rely on specialized external suppliers.

In the input-output analyses carried out in this report, the coefficients in the direct requirements tables are used to measure changes in outsourcing. These coefficients show the value of the intermediate inputs from the industry at the beginning of the row that is needed to produce a dollar of gross output in the industry at the top of the column. Therefore, an increase in a coefficient indicates that more intermediate inputs are needed from the industry at the beginning of the row per dollar of gross output in the industry at the top of the column.

If an industry requires more of any given intermediate input per unit of gross output, then we say that its demand for that intermediate input (or its intermediate demand for the output of the industry that produced that intermediate input) has increased. For example, if the manufacturing sector purchases more PBS (*e.g.*, accounting, engineering, consulting, legal services as well as lower-end services such as janitorial services and protection services) from the PBS industry per unit of gross output, then manufacturing's intermediate demand for PBS has increased. This increase in demand for intermediate inputs can be interpreted as an increase in outsourcing from manufacturing to the PBS industry.

An increase in the demand for intermediate inputs can be interpreted as an increase in outsourcing because it reflects the decision of establishments to purchase more intermediate inputs from establishments classified in other industries instead of producing them in-house. For example, the above-mentioned increase in demand for PBS is a form of outsourcing because it reflects the decision by manufacturing establishments to purchase these services from establishments classified in the PBS industry rather than producing them in-house. It does not matter for this report why an industry started purchasing more intermediate inputs, all that matter is that inter-industry transactions are accounted for correctly.

In Canada, industries are composed of establishments. Establishments are classified into an industry if their principal activity meets the definition of the industry.[1] Changes in the direct requirements coefficients reflect changes in the value of inter-industry purchases of intermediate inputs. Since industries are composed of establishments, changes in the direct requirements coefficients more precisely reflect changes in the value of purchases of intermediate inputs between establishments in different industries.

For the purposes of this report, outsourcing includes both domestic outsourcing and offshoring (or foreign outsourcing), as the input-output tables used in this report do not distinguish between intermediate inputs purchased from domestic suppliers versus those purchased from foreign suppliers. For example, the value of intermediate inputs purchased by the manufacturing sector may reflect both an increase in the value of foreign intermediate inputs purchased by manufacturing establishments and an increase the value of domestic intermediate inputs purchased by manufacturing establishments.

[1] According to Statistics Canada, the establishment is defined as the smallest operating entity for which records provide information on the cost of inputs employed to produce the units of output. While the establishment is generally a single physical location (*e.g.*, a factory, store or office building), there can exist multiple establishments at a single physical location (e.g., shops in a hotel or a cafeteria in a factory).

II. Methodology

This section presents the methodology developed by Berlingieri (2014) in his analysis of the impact of changes in the composition of intermediate inputs and changes in the level of outsourcing on manufacturing employment in the United States and discusses how it can be applied to Canadian data.

Berlingieri (2014) examines the structural shift away from manufacturing toward services in the United States, as manifested in the evolution of employment shares. In particular, Berlingieri investigates whether and to what extent changes in the input-output (I-O) structure of the economy – that is, the composition of intermediate inputs used by industries – can explain the rise in services employment and decline in manufacturing employment over the 1948-2002 period. The I-O structure of the economy has evolved over time in response to changes in the demand for intermediate inputs. For instance, Berlingieri shows that the desire of firms to purchase more professional and business services (PBS) from the market has lead to an increase in the relative importance of PBS as an intermediate input.

More importantly, Berlingieri (2014) delves into the drivers of changes in the I-O structure of the economy. He argues that one of the key forces driving changes in the composition of intermediate inputs has been outsourcing, with firms substituting inputs produced internally with alternative ones purchased from specialized external suppliers and purchasing additional services from the market in response to new needs. More specifically, Berlingieri examines whether and to what extent the outsourcing of PBS by the manufacturing sector has contributed to the increase in the relative importance of the service sector and to the decrease in the relative importance of manufacturing in terms of employment. Berlingieri (2014:6) recognizes that "there is much evidence that many other types of services have been outsourced over the same period," but, by focusing on PBS outsourcing, he hopes to provide a lower-bound estimate of the contribution of outsourcing to the sectoral transformation.

Berlingieri (2014) performs five core analyses. First, he estimates the extent to which the change in the shares of manufacturing and services in total employment is driven by changes in the I-O structure of the economy, holding final demand constant over time. Second, Berlingieri estimates the contribution of outsourcing to the change in sectoral employment shares by running several simulations in which the demand for selected intermediates is held constant over time. Third, he allows final demand to evolve over time and compares the results to those of the first exercise. Fourth, Berlingieri uses occupational data to determine whether the increase in employment in the PBS industry was due to workers within each occupation moving to the PBS industry (as opposed to workers moving to PBS occupations from other occupations), as this would support the argument that outsourcing drove the increase in employment in the PBS

industry rather than a widespread increase in demand for PBS. Fifth, Berlingieri performs an econometric analysis to identify the most important mechanisms behind PBS outsourcing.[5]

We will now discuss each of these analyses in greater detail and describe how they will be implemented in this report.

A. The Effect of Changes in the I-O Structure on Sectoral Allocation

The major contribution of Berlingieri (2014) is to quantify the impact of transformations in the I-O structure of the economy – that is, the composition of intermediate inputs used by each sector – on sectoral employment shares in the United States. To do this, he uses a standard growth accounting model with intermediate inputs, which will be applied to Canadian data in this report. In his model, sectoral employment shares depend on both final demand shares and the I-O structure of the economy. Therefore, when final demand is held constant over time, changes in the composition of intermediate inputs provoke a reallocation of workers across sectors. In particular, the point of this exercise is to determine the extent to which the change in the shares of manufacturing and services in total employment are driven by changes in the I-O structure of the economy.

Berlingieri's (2014) analysis is based on a simple growth accounting model with intermediate inputs.[6] He imposes a Cobb-Douglas formulation of the production function in which gross output is a function of the level of productivity, the amount of labour input, and the amount of intermediate inputs purchased from each sector. There is no capital in his model. Nevertheless, Berlingieri (2014:7) uses the Cobb-Douglas formulation, because it is quite common in growth accounting and "it can be very easily and intuitively calibrated in the data."

Berlingieri (2014) shows that the employment share of each sector l_j can be represented by the following equation:

$$l_j = \frac{L_j}{L} = \frac{\beta_j P_j Y_j}{wL} = \beta_j X_j + \beta_j \sum_{k=1}^{J} \gamma_{jk}(1-\beta_k)\frac{P_k Y_k}{wL} \tag{1}$$

where L is the total endowment of labour, L_j is the labour input in sector j, w is the rental price of labour (wages), $P_j Y_j$ is gross output in sector j, wL is value added in the total economy, wL_j is value added in sector j, $\beta_j = \frac{wL_j}{P_j Y_j}$ is the share of value added in gross output in sector j, $X_j = \frac{P_j C_j}{wL}$

[5] Given that the main focus on this report is to account for changes in sectoral employment shares using Canadian I-O data, we will not perform this econometric analysis for Canada. Therefore, this exercise will not be discussed in this section. Further research is needed to determine the mechanisms behind outsourcing in Canada.

[6] Consult Berlingieri (2014:6-9) for a formal description of his theoretical framework.

is the consumption (or final uses) expenditure share of sector *j*, $\gamma_{jk}(1-\beta_k)$ measures the degree to which the gross output of sector *j* is utilized as an intermediate input by each sector, and *J* is the number of sectors in the economy.[7] Therefore, employment shares are determined by "the presence of intermediate inputs and the interrelation of sectors" (Berlingieri, 2014:8).

Given that equation (1) forms a system of *J* equations, Berlingieri (2014) is able to re-write and solve for the employment share of each sector simultaneously. He shows that the employment share of all sectors at time *t* can be represented by the following equation:

$$\boldsymbol{l}_t = \boldsymbol{\beta}_t \Omega_t^{-1} \mathbf{X}_t \tag{2}$$

where

$$\boldsymbol{l}_t = \begin{pmatrix} l_1 \\ \vdots \\ l_J \end{pmatrix} \quad \boldsymbol{\beta}_t = \begin{pmatrix} \beta_1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \beta_J \end{pmatrix} \quad \mathbf{X}_t = \begin{pmatrix} X_1 \\ \vdots \\ X_J \end{pmatrix} \quad \Omega_t = \begin{pmatrix} 1-\gamma_{11}(1-\beta_1) & \cdots & -\gamma_{1J}(1-\beta_J) \\ \vdots & \ddots & \vdots \\ -\gamma_{J1}(1-\beta_1) & \cdots & 1-\gamma_{JJ}(1-\beta_J) \end{pmatrix}$$

The matrix Ω_t is defined as $\Omega_t = I - D_t$, where I is an identity matrix and D_t is an industry-by-industry direct requirements matrix. The matrix Ω_t^{-1} is an industry-by-industry total requirements table, also known as the Leontief inverse matrix, and can be easily calculated using I-O data.[8] The coefficients in the Leontief inverse matrix tell us the value of gross output that is required from each sector to meet one dollar of final demand in a given sector.[9] Simply put, the Leontief inverse matrix captures the structure of inter-industry transactions in the economy.

According to equation (2), sectoral employment shares are determined by: 1) final uses (or final demand) expenditure shares ($\mathbf{X}_t$); and 2) the I-O structure of the economy, as represented by $\boldsymbol{\beta}_t$ and Ω_t^{-1}.[10] In order to examine the impact of changes in the I-O structure, Berlingieri (2014) holds final demand shares ($\mathbf{X}_t$) constant over time and takes $\boldsymbol{\beta}_t$ and Ω_t^{-1} from the I-O data, thereby allowing the I-O structure of the economy to evolve over time.[11]

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[7] While only final consumption expenditure C_j is included in this model, Berlingieri (2014) includes other final uses in his empirical application, such as government consumption and gross fixed capital formation. Thus, X_j should be interpreted as the final uses expenditure share of sector *j*.

[8] See Appendix I for the technique used to derive the total requirements table for Canada.

[9] According to the Bureau of Economic Analysis (BEA) definition, the "industry-by-industry total requirements table shows the production required, both directly and indirectly, from the industry at the beginning of the row per dollar of delivery to final use of the industry at the top of the column" (Horowitz and Planting, 2009:12-8).

[10] Berlingieri (2014) uses a gross output model instead of a value added model because it is impossible to evaluate the effect of a change in I-O structure on sectoral employment shares in the latter. In a value added model, the share of intermediate inputs in gross output $(1-\beta_j)$ is always equal to zero. As a result, Ω_t^{-1} becomes an identity matrix and the sectoral employment shares are solely determined by final uses shares ($\mathbf{X}_t$).

[11] It is important to note that, rather than simply taking final uses from the I-O data, Berlingieri (2014) calibrates final uses to employment shares in 1948 according to the following equation:

Berlingieri (2014) finds that changes in the I-O structure of the economy account for 8.1 percentage points (or 36.2 per cent) of the increase in the share of services in total employment and 4.6 percentage points (or 25.3 per cent) of the decrease in the share of manufacturing in total employment in the United States from 1948 to 2002 (Table 1).

Table 1: Predicted versus Actual Changes in Sectoral Employment Shares, United States, 1948-2002

Sector	Actual Change (Percentage Points)	Predicted Change (Percentage Points)	Share of Actual Change (Per cent)
	A	B	B/A*100
Agriculture	-3.99	-3.45	86.47
Manufacturing	-18.28	-4.62	25.27
Services	22.28	8.07	36.22

Note: The actual and predicted changes in the employment share are expressed as percentage points of total employment. The predicted changes are the results of the proposed gross output model.
Source: Berlingieri (2014:15)

In this report, we will perform the aforementioned analysis for Canada for the 1976-2008 period. The major differences in methodology between this report and Berlingieri (2014) are related to data sources and levels of aggregation. For instance, while Berlingieri aggregated up to three major sectors – namely, agriculture, manufacturing and services –, the analyses presented in this report use data for twenty-two industries.[12]

B. The Effect of Outsourcing on Sectoral Allocation

Using the framework developed in the previous sub-section, Berlingieri (2014) conducts four counterfactual exercises, three of which will also be carried out in this report. The point of these simulations is to quantify the contribution of outsourcing to changes in sectoral employment shares in the United States.

The first exercise involves estimating the contribution of all types of outsourcing to changes in sectoral employment shares by fixing the *demand* for intermediate inputs in manufacturing to its 1947 level.[13] To do this, Berlingieri (2014) holds the coefficients in the direct requirements matrix for all intermediate inputs in manufacturing constant over time. In

$$\mathbf{X}_t = \Omega_t \boldsymbol{\beta}_t^{-1} \boldsymbol{l}_t \quad (3)$$

He then keeps $\mathbf{X}_t$ fixed over time, and takes I-O data on $\boldsymbol{\beta}_t$ and Ω_t directly from the BEA to predict sectoral employment shares according to equation (2).

[12] Given that the I-O data used by Berlingieri (2014) switch from the SIC to the NAICS after 1997, a high level of aggregation was required. Fortunately, Canadian I-O data have been historically revised such as it is possible to obtain a long time series classified consistently according to the NAICS. See Appendix A in Berlingieri (2014) for more information on the industries included in these three sectors.

[13] In this report, a change in the value of a direct requirements coefficient for any given industry is referred to as a change in the intermediate demand for that industry's output. For example, if the coefficient for the PBS industry in manufacturing's column of the direct requirements table increased, then we would saw manufacturing's demand for intermediate inputs from the PBS industry increased. See Box 1 for further discussion of this issue.

other words, he simulates what would have happened to sectoral employment shares if manufacturing establishments did not change their demand for intermediate inputs over the 1948-2002 period.

Compared to the results of the analysis presented in the previous sub-section (the "baseline case"), which predicted an increase of 8.1 percentage points in the employment share of services and a fall of 4.6 percentage points for manufacturing, the first simulation predicts an increase of 3.0 percentage points for services and a decrease of 1.9 percentage points for manufacturing (Berlingieri, 2014:16) (Table 2). Therefore, changes in the demand for intermediate inputs in manufacturing account for about two-thirds of the changes in sectoral employment shares in the baseline case, and for 15.0 per cent of the decrease in the employment share of manufacturing and 22.6 per cent of the increase in the employment share of services from 1948 to 2002.

Table 2: Effect of Outsourcing on Manufacturing and Services Employment Shares, United States, 1948-2002

Counterfactual Exercise	Manufacturing			Services		
	Predicted Change (Percentage Points)	Difference with Baseline (Percentage Points)	Share of Actual Change (Per Cent)	Predicted Change (Percentage Points)	Difference with Baseline (Percentage Points)	Share of Actual Change (Per Cent)
	A_i	$Bi = -4.62 - A_i$	$B_i/-18.28*100$	C_i	$D_i = 8.07 - C_i$	$D_i/22.28*100$
Baseline Case	-4.62	0.00	...	8.07	0.00	...
First Counterfactual	-1.87	-2.75	15.04	3.03	5.04	22.62
Second Counterfactual	-1.67	-2.95	16.14	5.03	3.04	13.64
Third Counterfactual	-4.42	-0.20	1.09	7.87	0.20	0.90
Fourth Counterfactual	-4.59	-0.03	0.16	8.04	0.03	0.13

Note: The predicted change and the difference with respect to the baseline case are expressed in percentage points of total employment. The ratio to data is the prediction of the simulation expressed as percentage share of the actual change in the data.
Source: Berlingieri (2014:16)

Similarly, the second exercise involves estimating the contribution of PBS outsourcing to the change in sectoral employment shares by keeping the demand for PBS intermediates in manufacturing fixed at its 1947 level. More specifically, Berlingieri (2014) holds the coefficients in the direct requirements matrix for PBS intermediates in manufacturing constant over the 1948-2002 period. Put simply, he simulates what would have happened if manufacturing firms did not change their demand for PBS intermediates over time. This counterfactual predicts a 5.0 percentage-point increase in the share of services in total employment and a 1.7 percentage-point decrease in the share of manufacturing in total employment (Table 2). Therefore, PBS outsourcing accounts for a large part of the changes predicted in the baseline case, and for 16.1 per cent of the decrease in the employment share of manufacturing and 13.6 per cent of the increase in the employment share of services from 1948 to 2002 (Berlingieri, 2014:17).

Berlingieri (2014) focuses on this simulation because it provides the most concrete evidence regarding the contribution of outsourcing to sectoral reallocation. In particular, Berlingieri is able to distinguish between the external and internal production of PBS in the I-O data. After controlling for the internal production of PBS, increases in the use of externally-produced PBS in manufacturing can be correctly interpreted as increased PBS outsourcing.

In Canada and the United States, I-O data are currently compiled under the North American Industry Classification System (NAICS). The NAICS classifies establishments into industries according to their primary activity. Therefore, establishments within manufacturing firms that are primarily engaged in PBS (*e.g.,* head offices and holding companies) would be classified under services instead of manufacturing. In particular, these auxiliary units were classified under management of companies and enterprises (NAICS code 55). Hence, an increase in the production of PBS within manufacturing firms would be reflected in an increase in the use of PBS intermediates in manufacturing in the I-O data (Berlingieri, 2014:12). In contrast, it is impossible to distinguish between the external and internal production of other intermediates in the I-O data, as there is no reason to suspect that their production is isolated to auxiliary units.

Prior to 1997, the I-O data used by Berlingieri (2014) were compiled under the Standard Industrial Classification (SIC). In contrast to the NAICS, the SIC classifies establishments according to the industry of the establishment it serves. Therefore, auxiliary units within manufacturing firms were classified under manufacturing, and an increase in the production of PBS within manufacturing firms led to an increase in PBS output in manufacturing.

Fortunately, the I-O data are disaggregated enough under both classification systems to allow for the exclusion of auxiliary units from this simulation.[14] Therefore, Berlingieri (2014:6) is able to "control for internal production under both classifications and hence to correctly identify outsourcing." More specifically, excluding auxiliary units allows Berlingieri to estimate how much of the change in employment shares is due to increases in the use of externally-produced PBS in manufacturing. The results of this exercise provide a lower-bound estimate for the contribution of outsourcing to changes in sectoral employment shares in the United States, as outsourcing was not limited to PBS intermediates. Unfortunately, it is difficult to distinguish between the internal and external production of other intermediates.

The third and fourth exercises use the same methodology, but they focus on financial services outsourcing and PBS offshoring, respectively.[15] However, financial services outsourcing

[14] It is important to note that many manufacturing firms do not isolate their internal production of PBS to auxiliary units, especially smaller firms. Therefore, part of the increase in the demand for PBS intermediates may result from increased internal production, even after controlling for auxiliary units.

[15] Financial services outsourcing consists of outsourcing to the financial industry. PBS offshoring consists of outsourcing to foreign suppliers of PBS.

and PBS offshoring are found to account for negligible shares of the change in sectoral employment shares (Table 2).

This report performs the first, second and third simulations using Canadian I-O data. Unlike the I-O data used by Berlingieri (2014), which switch from the SIC to the NAICS after 1997, Statistics Canada publishes I-O tables for the 1961-2011 period that are classified according to the NAICS. Therefore, we do not have to aggregate industries to the same extent as Berlingieri to maintain consistency over time.

Unfortunately, we are not able to distinguish between the internal and external production of PBS intermediates in this report, as management of companies and enterprises (NAICS code 55) – the NAICS industry that contains auxiliary units – is aggregated with the financial sector in Canadian I-O data. Therefore, we are only able to approximately measure the contribution of PBS outsourcing to the rise in services and the decline in manufacturing.

C. The Effect of Changes in Final Demand on Sectoral Allocation

In order to determine whether final demand channels overshadow the results of the previous exercises, Berlingieri (2014) allows final uses expenditure shares ($\mathbf{X}_t$) to evolve over time. The purpose of this exercise is to show "that the contribution of sectoral linkages, and of outsourcing in particular, is not negligible even when the standard channels in the literature are present" (Berlingieri, 2014:17).

Berlingieri (2014:17) models the evolution of final uses expenditure shares over time using a consumer optimization framework in which consumers are assumed to be utility-maximizing agents with "homothetic preferences with a less than unitary elasticity of substitution between goods." In other words, he introduces a model to estimate the change in final uses shares ($\mathbf{X}_t$) over time. In this model, consumers maximize their utility in period *t* subject to their budget constraint, taking sectoral goods prices P_{jt} as given. Berlingieri (2014) shows that the ratio of the final uses expenditure on sectoral good *j* to the final uses expenditure on manufacturing good *m* (x_{jt}) can be represented by the following equation:

$$x_{jt} = \frac{X_{jt}}{X_{mt}} = \left(\frac{\psi_j}{\psi_m}\right)^{\epsilon} \left(\frac{P_{jt}}{P_{mt}}\right)^{1-\epsilon} \tag{4}$$

where ψ_j is a parameter in the utility function, $\sum_{j=0}^{J} \psi_j = 1$, $\epsilon > 0$ is the elasticity of substitution across sectoral goods, P_{jt} is the price of sectoral good *j*, and P_{mt} is the price of manufacturing good *m*. Taking the logarithmic growth rate of equation (4), we obtain:

$$\hat{x}_{jt} = ln(x_{jt}) - ln(x_{jt-1}) = (1-\epsilon)(\hat{P}_{jt} - \hat{P}_{mt}) \quad (5)$$

where $\hat{x}_{jt}$ is logarithmic change in the ratio of the final uses expenditure on sectoral good *j* to the final uses expenditure on the manufacturing good *m*, $\hat{P}_{jt}$ is the logarithmic change in the price of sectoral good *j*, and $\hat{P}_{mt}$ is the logarithmic change in the price of manufacturing good *m*.

The methodology used to calculate $\mathbf{X}_t$ over time is somewhat complex. Berlingieri (2014) calibrates final uses to employment shares in 1948 using equation (3). He then calculates the final uses ratio for each sector using equation (4). Finally, he uses equation (5) to calculate changes in final uses ratios over time. To do this, Berlingieri sets the elasticity of substitution equal to 0.5 and uses BEA price indexes to calculate price growth rates.[16]

Berlingieri (2014) repeats the exercise presented in the first sub-section for both the gross output model and a basic value added model, allowing for changes in final uses shares over time.[17] When final uses shares were held constant over time, the value added model predicted no reallocation of workers across sectors. However, when final uses shares are allowed to change, Berlingieri provides a more meaningful appraisal of the empirical contribution of accounting for the I-O structure of the economy, as both models allow for the reallocation of workers across sectors.

With the elasticity of substitution set to 0.5, differences in the growth rates of prices across sectors prompt changes in final uses expenditure shares, as shown in equation (5).[18] In particular, prices increased more in services than in manufacturing or agriculture, leading to a reallocation of *nominal* final uses shares from manufacturing and agriculture to services and, in turn, to an increase in the employment share of services at the expense of the two other sectors.

In contrast to the first exercise in which the gross output model reacted only to changes in the composition of intermediate inputs, this model is now driven by both changes in the I-O structure *and* differences in the growth rates of prices across sectors. As a result, the predictions of this model improve dramatically, as shown in Table 3. Comparing the results of the value added and gross output models, it becomes evident that accounting for changes in the I-O

[16] Berlingieri (2014) uses BEA value added price indexes by industry for the value added model and final consumption expenditure prices for the gross output model. See Appendix A in Berlingieri (2014) for more information on the price indexes used in the report.

[17] In a value added model, the share of intermediate inputs in gross output $(1-\beta_j)$ is always equal to zero. Therefore, Ω_t^{-1} becomes an identity matrix and the sectoral employment shares are equal to final uses shares ($\mathbf{X}_t$).

[18] If the elasticity of substitution is less than one, then final uses expenditure shares expand in sectors with relatively high $\hat{P}_{jt}$. If the elasticity is larger than one, then final uses expenditure shares expand in sectors with relatively low $\hat{P}_{jt}$. Finally, if the elasticity is equal to one, then final uses expenditure shares are constant.

structure greatly improves the accuracy of the predictions, as the changes in employment shares predicted by the gross output model were much closer to the observed change.[19]

Table 3: Predicted versus Actual Changes in Sectoral Employment Shares, United States, 1948-2002

Sector	Actual Change (Percentage Points)	Gross Output Model		Value Added Model	
		Predicted Change (Percentage Points)	Share of Actual Change (Per Cent)	Predicted Change (Percentage Points)	Share of Actual Change (Per Cent)
	A	B	B/A*100	C	C/A*100
Agriculture	-3.99	-3.59	89.97	-2.82	70.68
Manufacturing	-18.28	-9.99	54.65	-5.44	29.76
Services	22.28	13.58	60.95	8.26	37.07

Note: The actual and predicted changes in the employment share are expressed as percentage points of total employment. The predicted changes are the results of both the gross output model and the value added model.
Source: Berlingieri (2014:21)

Berlingieri (2014) also repeats the four counterfactual exercises discussed in the previous sub-section, allowing for changes in final uses shares. The results of these simulations indicate that the contribution of outsourcing to sectoral reallocation is somewhat lower compared to the case when final uses shares are fixed over time (Table 2 and Table 4); however, outsourcing still appears to account for an important part of the change in sectoral employment shares in the United States between 1948 and 2002.

Table 4: Effect of Outsourcing on Manufacturing and Services Employment Shares, United States, 1948-2002

Counterfactual Exercise	Manufacturing			Services		
	Predicted Change (Percentage Points)	Difference with Baseline (Percentage Points)	Share of Actual Change (Per Cent)	Predicted Change (Percentage Points)	Difference with Baseline (Percentage Points)	Share of Actual Change (Per Cent)
	A_i	$B_i = -9.99 - A_i$	$B_i/-18.28*100$	C_i	$D_i = 13.58 - C_i$	$D_i/22.28*100$
Baseline Case	-9.99	0.00	...	13.58	0.00	...
First Counterfactual	-7.70	-2.29	12.53	9.40	4.18	18.76
Second Counterfactual	-7.54	-2.45	13.40	11.05	2.53	11.36
Third Counterfactual	-9.83	-0.16	0.88	13.41	0.17	0.76
Fourth Counterfactual	-9.97	-0.02	0.11	13.55	0.02	0.09

Note: The predicted change and the difference with respect to the baseline case are expressed in percentage points of total employment. The ratio to data is the prediction of the simulation expressed as percentage share of the actual change in the data.
Source: Berlingieri (2014:22)

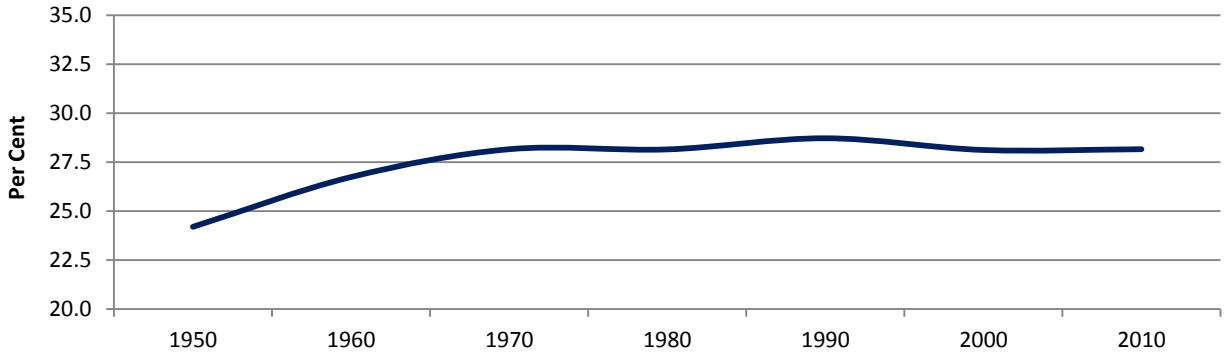
This report performs the aforementioned analysis for Canada for the 1976-2008 period. As previously mentioned, the major differences in methodology between this report and Berlingieri (2014) are related to data sources and levels of aggregation. The data sources and definitions used in this report are discussed in the following section.

[19] The predictions of these models are affected by the choice of both the elasticity of substitution and price indexes.

D. The Role of Outsourcing: Evidence from Occupational Data

Moving away from I-O analysis, Berlingieri (2014) employs aggregate occupational data to provide further evidence that outsourcing has driven changes in sectoral employment shares. In particular, Berlingieri uses occupational data to determine whether and to what extent the increase in employment in the PBS industry was due to workers within each occupation moving to the PBS industry (as opposed to workers within each industry moving to PBS occupations), as this would support the argument that outsourcing drove the increase in employment in the PBS industry as opposed to a widespread increase in demand for PBS.

Chart 1: Share of PBS Occupations in Total Employment, Per Cent, United States, 1950-2010



Source: Berlingieri (2014:23).

The share of workers in PBS occupations exhibited a small increase over the 1950-2010 period (Chart 1). Between 1950 and 2010, the share of PBS occupations in total employment increased slightly from 24.2 per cent in 1950 to 28.2 per cent in 2010, with the entire increase concentrated from 1950 to 1970.[20] In contrast, the PBS industry's share of total employment grew from 1947 to 2007, increasing 9.2 percentage points, accounting for roughly 40 per cent of the total growth of the service sector's employment share (Berlingieri, 2014:2). According to Berlingieri (2014:24), this suggests that "organizational change with a reallocation of activities across the boundaries of the firms" drove the increase in the PBS industry's share of total employment. Alternatively, if an increase in PBS activities within firms drove the increase in the PBS industry's share of total employment, then we would have observed a larger increase in the share of workers in PBS occupations.

To provide more proof of this assessment, Berlingieri (2014) decomposes the change in the share of the PBS industry in total employment (l_{pbs}) over the 1970-2010 period as follows:

[20] Berlingieri (2014) selects PBS occupations according to the share of workers within each occupation that are employed in the PBS industry. According to the baseline definition, PBS occupations are defined as occupations with 9 per cent or more of their workers employed in the PBS industry.

$$\Delta l_{pbs} = \underbrace{\sum_{o} \Delta w_{pbs}^{o} l_{1}^{o}}_{Within} + \underbrace{\sum_{o} w_{pbs,1}^{o} \Delta l^{o}}_{Between} + \underbrace{\sum_{o} \Delta w_{pbs}^{o} \Delta l^{o}}_{Cross} \quad (6)$$

where w_{pbs}^{o} is the share of workers employed in the PBS industry for a given occupation o, l^{o} is the share of a given occupation o in total employment, and the subscript 1 indicates quantities at the beginning of the period. In equation (6), the first term measures the part of the increase in employment in the PBS industry that is due to workers within each occupation moving to the PBS industry (the **within-occupation component**), the second term measures the part of the increase in employment in the PBS industry that is due to changes in the share of each occupation in total employment (the **between-occupation component**), and the third term is an interaction term (the **cross-occupation component**).

Table 5: Contributions to the Change in the Employment Share of the PBS Industry, United States, Percentage Points, 1970-2010

Occupational Category	Within	Between	Cross	Total
PBS Occupations	3.62	0.20	0.35	4.17
Managers	0.86	0.01	0.05	0.92
Professionals	1.04	0.16	0.17	1.36
Computer	0.11	0.27	0.38	0.76
Clerks	1.39	-0.16	-0.18	1.05
Technicians	0.17	-0.04	-0.03	0.10
Others	0.05	-0.05	-0.02	-0.02
Non-PBS Occupations	1.52	-0.01	-0.01	1.50
Total	5.14	0.19	0.34	**5.67**

Note: All figures are expressed in terms of percentage points of total employment. The grand total (5.67) is the increase in the PBS industry's employment share from 1970 to 2010. See Berlingieri (2014) for the complete list of PBS occupations.
Source: Berlingieri (2014:25)

Berlingieri (2014) shows that most of the increase in the employment share of the PBS in the United States can be attributed to the within-occupation component, while the between-occupation component contributed little to the increase (Table 5). This suggests that "the rise or fall of certain types of occupations does not account for much of the increase in PBS employment, which supports the idea that the underlying activities have remained roughly constant over time" (Berlingieri, 2014:25). Therefore, it is likely that the rise of the PBS industry was more closely related to an increase in outsourcing to the PBS industry rather than increased production of PBS within firms.

In this report, we will conduct the above-mentioned analysis using Canadian aggregate occupational data for the 1987-2014 period. However, it is important to note that the definitions of PBS occupations and the PBS industry used in this report differ from Berlingieri (2014).

III. Data Sources and Limitations

This section reviews the input-output (I-O) and employment data to be used in the analysis presented in the following section, highlighting its strengths and weaknesses. It is divided into five sub-sections. The first and second sub-sections concern the I-O and employment-by-industry estimates to be used in the following section. The third sub-section discusses the industry definitions in the I-O and employment-by-industry data. The fourth and fifth sub-sections examine the prices-by-industry and employment-by-occupation data to be used in the following section.

A. Input-Output Data

The national Input-Output tables in current prices are the primary data source in this report. The Input-Output tables represent the most comprehensive and detailed accounting of transactions involving the production of goods and services in the economy as well as the intermediate and final consumption of goods and services in the economy.

The Input-Output tables are produced at both the national level and the provincial level on an annual basis and are available about two-and-half years after the end of the reference year. At present, the national tables are available for the 1961-2011 period, while the provincial tables are available for the 1997-2011 period.

The Input-Output accounts are composed of three major tables: the output table, input table, and the final demand table.[21] These tables identify transactions by commodity, by industry, and by category of final demand. Information on these categories is provided below.

- **Commodity:** A neutral term that includes both: 1) goods and services, such as "grains" or "communications services"; and 2) types of transactions, such as "wages" or "indirect taxes". It is important to distinguish between the two types of commodities in the input table, as the former are intermediate inputs while the latter are elements of value added.

- **Industry:** A group of establishments that conduct activities involving market transactions, such as "crop and animal production" and "educational services". Establishments are categorized into industries according to their major activity.

- **Final demand (or final uses):** A category that identifies transactions that constitute final uses expenditure on (or final sales of) goods and services. Final demand is broken down by final user (*e.g.*, "government sector" or "non-government sector") and final use (*e.g.*, "personal expenditures" or "machinery and equipment investment").

[21] There is also a fourth Input-Output table that provides information on interprovincial transactions.

The input table provides information on the commodities used by industries as inputs. The output table provides information on the commodities produced by industries. The final demand table provides a breakdown of commodities by final demand category

The Input-Output tables are based on three classification systems: the Input-Output Industry Classification (IOIC) for industries, the Input-Output Commodity Classification (IOCC) for commodities, and the Input-Output Final Demand Classification (IOFDC) for final demand categories. The IOIC is based on the North American Industry Classification System (NAICS), with slight differences related to fictive industries and the non-business sector. Each classification system has four levels of aggregation: the worksheet (W) level, the historical-link (L) level, the medium (M) level, and the small (S) level.

Canada has excellent I-O tables, with current price estimates at the S, M and L levels produced annually from 1961 to 2011 at the national level (Table 6). These estimates are accessible on Statistics Canada's website through CANSIM. In particular, the following Input-Output tables were used in this report:

- Table 381-0013 – *Inputs and outputs, by industry and commodity, S-level aggregation and North American Industry Classification System (NAICS), annual (dollars)*: This table provides input and output data in current dollars for Canada and the provinces for the 1961-2008 period at the S-level aggregation.

- Table 381-0028 – *Provincial input-output tables, inputs and outputs, summary level, basic prices, annual (dollars)*: This table provides input and output data for Canada and the provinces for the 2007-2011 period at the S-level aggregation. Compared to table 381-0013, industries and commodities are at a slightly more disaggregated level, with 36 industries and 75 commodities. While the industries and commodities can easily be combined such that they correspond with the level of aggregation in table 381-0013, the two data sets are not perfectly comparable due to significant methodological changes.

Table 6: Levels of Aggregation in the I-O Series

Aggregation Level	Industries	Commodities	Final Demand Categories
Historical-link (L)	123	473	126
Medium (M)	64	114	42
Small (S)	26	62	22

Source: Statistics Canada. CANSIM table 381-0013.

A key characteristic of the Canadian input and output tables, which distinguish them from national tables in other countries, is their rectangular nature resulting from the fact that they are produced in an industry-by-commodity format where the number of commodities exceeds the number of industries. Nonetheless, symmetric industry-by-industry tables can easily be

calculated. This is required to carry out the analyses presented in the previous section. Appendix I discusses the technique used to convert from industry-by-commodity input and output tables to industry-by-industry total requirements tables.

B. Employment-by-Industry Data

This report also uses Labour Force Survey (LFS) employment-by-industry estimates. The LFS has employment-by-industry estimates starting in 1976, which are consistently defined according to the NAICS. The LFS is better than other sources of employment-by-industry data, as it is available for a long time period (unlike the Survey of Employment, Payrolls and Hours) and it has been historically revised to ensure that industries are consistently defined over time (unlike Census data). These estimates are accessible on Statistics Canada's website through CANSIM. In particular, the following table was used in this report:

- Table 282-0008 – *Labour force survey estimates (LFS), by North American Industry Classification System (NAICS), sex and age group, annual (persons unless otherwise noted)*: This table provides annual employment estimates by two-digit NAICS industry for Canada and the provinces for the 1976-2014 period.

In addition to the above-mentioned table, we also obtained LFS employment estimates at the four-digit NAICS level for the 1987-2012 period by special order. These highly-disaggregated data are needed to ensure that the employment-by-industry data correspond with the industry definitions in the Input-Output tables. Unfortunately, LFS employment estimates are unavailable below the two-digit NAICS level before 1987.

C. Industry Definitions

In the Canadian System of National Accounts (CSNA), industry statistics have been compiled according to a multitude of classification systems; this creates many problems related to the creation of consistent historical time series. Between 1961 and 1997, industry statistics were based on three variants of the Standard Industrial Classification (SIC). Starting in 1997, industry statistics were compiled according to three versions of the NAICS.[22]

The IOIC is based on the industrial standard of the day. As a result, the Input-Output tables were produced according to the SIC from 1961 to 1997, and according to the NAICS from 1997 onward. However, in order to maintain time series continuity, Statistics Canada published Input-Output tables for the 1961-1996 period according to the NAICS.[23]

[22] Starting in 2007, industry statistics were based on NAICS 2007. From 2002 to 2006, industry statistics were based on NAICS 2002. Between 1997 and 2001, industry statistics were based on NAICS 1997.

[23] Girard and Trau (2001) discuss the methodology used by Statistics Canada to implement a NAICS-based time series for the 1961-1996 period.

As previously mentioned, the IOIC is not identical to the NAICS. In particular, there are small but significant differences related to fictive industries and the non-business sector.[24] Most importantly, the non-business sector is treated differently in the IOIC compared to the NAICS, leading to the creation of two sectors: non-profit institutions serving households (IOIC code NP) and the government sector (IOIC code GS). These sectors consist of non-profit and government components of all other industries. For example, hospitals (NAICS code 622) from the health care and social assistance (NAICS code 62) industry is categorized in the government sector, and religious organizations (NAICS code 8131) from the other services (NAICS code 81) industry is categorized in the non-profit sector.

It is also important to note that the IOIC contains three "fictive" industries that are not defined according to the NAICS – namely, operating, office, cafeteria and laboratory supplies (IOIC code F1); travel, entertainment, advertising and promotion (IOIC code F2); and transportation margins (IOIC code F3). These three industries are not particularly important, as their outputs are entirely used as intermediate inputs, meaning that no value-added activity is directly associated with these industries. In addition, since fictive industries are not NAICS-defined, there are no employment estimates associated with these industries. Therefore, these industries are excluded from the analyses carried out in the following section of this report.

As previously mentioned, employment data are needed at the four-digit NAICS level in order to ensure that the employment-by-industry data (roughly) correspond with the industry definitions in the Input-Output tables. Since LFS employment data are unavailable below the two-digit NAICS level prior to 1987, we can only carry out the analyses discussed in the previous section at a detailed industry level for the 1987-2008 period despite the existence of high-quality I-O data starting in 1961. However, we are able to perform the analyses discussed in the previous section for broader industry groupings starting in 1976.

Appendix II summarizes the procedure used to obtain employment estimates that are reasonably consistent with the IOIC definitions in the Input-Output tables.

D. Price Indexes

As discussed in the previous section, this report models the evolution of final uses expenditure shares over time using price indexes by industry. Berlingieri (2014) used BEA value added price indexes by industry for the value added model and final consumption expenditure prices for the gross output model. In this report, we also use value added price indexes by industry for the value added model; however, we employ gross output price indexes by industry for the proposed gross output model. The value added price index is an implicit value added

[24] See Trau (2005) for a detailed breakdown of the NAICS-based industries that appear in the Input-Output tables used in this report.

deflator calculated by dividing an index of nominal value added by an index of real value added. Similarly, the gross output price index is an implicit gross output deflator calculated by dividing an index of nominal gross output by an index of real gross output.

Real and nominal estimates of gross output and value added are publicly available on Statistics Canada's website through CANSIM. In particular, the following table was used to calculate price indexes in this report:

- Table 383-0032 – *Multifactor productivity, gross output, value-added, capital, labour and intermediate inputs at a detailed industry level, by North American Industry Classification System (NAICS), annual (index, 2007=100 unless otherwise noted)*: This table provides annual estimates for real gross output, real value added, nominal gross output, and nominal value added, among other productivity-related variables. These estimates are available at the two-digit NAICS level for the 1961-2011 period.

The NAICS industries included in this table correspond with IOIC definitions, as the estimates in this table were constructed using I-O data. However, this table only provides real and nominal estimates of gross output and value added for business sector industries. As a result, it does not contain price indexes for the non-profit and government sectors. Therefore, we assume that prices in the non-profit and government sectors grew in line with the average for the service sector as a whole.

E. Employment-by-Occupation Data

In the following section, we decompose aggregate occupational data to determine whether and to what extent outsourcing has driven changes in sectoral employment shares. To perform this analysis, we obtained LFS employment estimates by occupation by industry from Statistics Canada by special order. More specifically, these estimates provide a detailed breakdown of employment in two-digit NAICS industries by two-digit National Occupational Classification for Statistics (NOC-S) categories at the national level for the 1987-2014 period. LFS employment data broken down by NOC-S category are unavailable prior to 1987.

IV. Evidence for Canada

This section conducts an analysis similar to Berlingieri (2014) for Canada for the 1976-2008 period. In particular, we attempt to replicate the four core accounting exercises carried out in Berlingieri using Canadian data. The section is organized into four main sub-sections, with each sub-section corresponding to one of the four core exercises. The first sub-section estimates the extent to which the change in manufacturing's share in total employment was driven by changes in the I-O structure of the economy, holding final demand constant over time. The second sub-section estimates the contribution of outsourcing to the change in manufacturing's employment share by running several simulations in which the I-O coefficients for selected intermediates are held constant over time. The third sub-section allows final demand to evolve over time and compares the results to those of the first exercise. The fourth sub-section uses aggregate occupational data to provide further evidence regarding the effect of outsourcing on manufacturing's share of total employment. A brief summary of the results is also provided.

A. The Effect of Changes in the I-O Structure on Sectoral Allocation

This sub-section evaluates the impact of changes in the I-O structure of the economy on the reallocation of employment across industries in Canada using the methodology implemented in Berlingieri (2014). It also presents descriptive statistics on changes in the composition of intermediate inputs in the Canadian economy, with particular attention paid to PBS and financial services, which were the focus of Berlingieri (2014), as well as mining sector products, which account for a large share of the change in inter-industry transactions since 2000.

i. Descriptive Statistics

The share of finance, insurance and real estate services in gross output in manufacturing (IOIC code 3A) grew from 1.3 per cent in 1976 to 2.5 per cent in 2008; this increase was concentrated in the 1976-1987 period (1.1 percentage points), with only a small rise in the 1987-2008 period (0.1 percentage point) (Chart 2, Panel A). In contrast, the share of finance, insurance and real estate services in gross output in the total economy grew steadily from 3.1 per cent in 1976 to 5.3 per cent in 2002, before falling slightly to 5.2 per cent in 2005 and 2008.

The increase in the use of professional, scientific, technical, computer, administrative, support, and related services in manufacturing was much more dramatic: its share of gross output in manufacturing was stable over the 1976-1990 period before growing rapidly from 1.2 per cent in 1990 to 4.0 per cent in 2002, an increase of 2.8 percentage points (Chart 2, Panel B). Between 2002 and 2008, the share of professional, scientific, technical, computer, administrative, support, and related services in gross output in manufacturing fell to 3.5 per cent. While trends over time were similar in the total economy, the share of professional, scientific, technical, computer,

administrative, support, and related services in gross output in the total economy was consistently higher (by approximately 50 per cent) than in manufacturing.

The increase in the shares of finance, insurance and real estate services and professional, scientific, technical, computer, administrative, support and related services in gross output in manufacturing suggests that the direct requirement for these services in manufacturing has increased over the 1976-2011 period, which suggests that manufacturing establishments are increasingly outsourcing these services.

Metal ores and concentrates, mineral fuels, and non-metallic minerals accounted for a larger share of gross output in manufacturing than the other two intermediate inputs between 1976 and 2008 (Chart 2, Panel C). The relative importance of this intermediate input in manufacturing is primarily due to the fact that oil refineries are categorized within the manufacturing sector. As a result, an increase in the volume or price of crude oil refined in Canada is reflected in input tables as an increase in the use of metal ores and concentrates, mineral fuels, and non-metallic minerals in manufacturing. Unfortunately, this means that increases in the price of this intermediate input drives some of the results of the accounting exercises performed later in this section.[25]

Oil and gas refinery establishments are often considered part of the downstream sector of the oil and gas industry, providing processing services to oil and gas extractors. However, refinery establishments are classified within petroleum and coal products manufacturing under the NAICS. In petroleum and coal products manufacturing, the share of value added in gross output was extremely low between 1976 and 2008, ranging from -6.6 per cent to 7.4 per cent (Table 7), because refineries 'purchase' mineral fuels (an intermediate input) from oil and gas extractors in the mining and oil and gas extraction industry, with the value of those mineral fuels included in value added of the mining and oil and gas extraction industry instead of the petroleum and coal products manufacturing industry.[26]

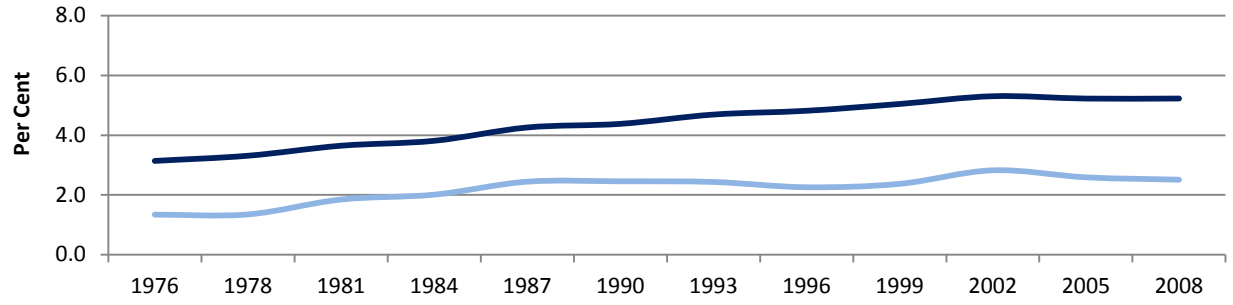
In manufacturing, the share of metal ores and concentrates, mineral fuels, and non-metallic minerals in gross output was extremely volatile over the 1976-2008 period, with large increases in this share in the late 1970s and 2000s and large declines in this share in the 1980s and 1990s (Chart 2, Panel C). The volatility in the gross output share of this intermediate input was largely driven by volatility in crude oil prices. In contrast to finance, insurance and real estate services and professional, scientific, technical, computer, administrative, support and related services, the share of metal ores and concentrates, mineral fuels, and non-metallic minerals in gross output in manufacturing was consistently higher than in the total economy.

[25] This issue is discussed in more detail later in the section.

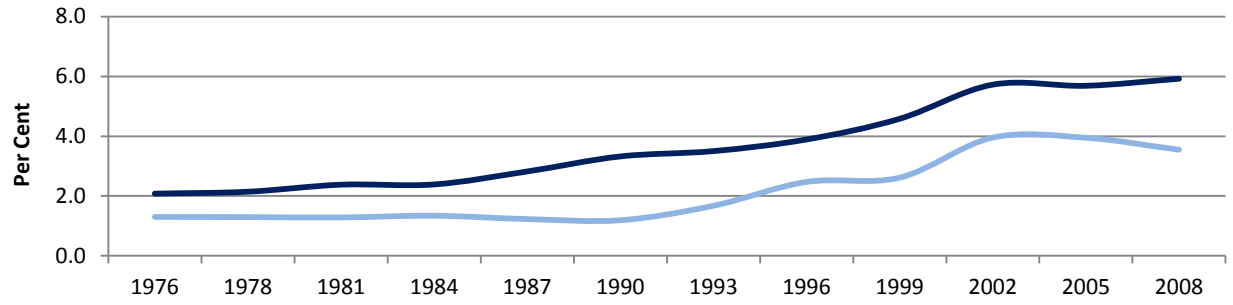
[26] It is important to note that refineries are often owned by the same firms that operate the oil and gas rigs from which refineries 'purchase' mineral fuels.

Chart 2: Shares of Selected Intermediate Inputs by Commodity in Gross Output for Manufacturing and All Industries, 1976-2008

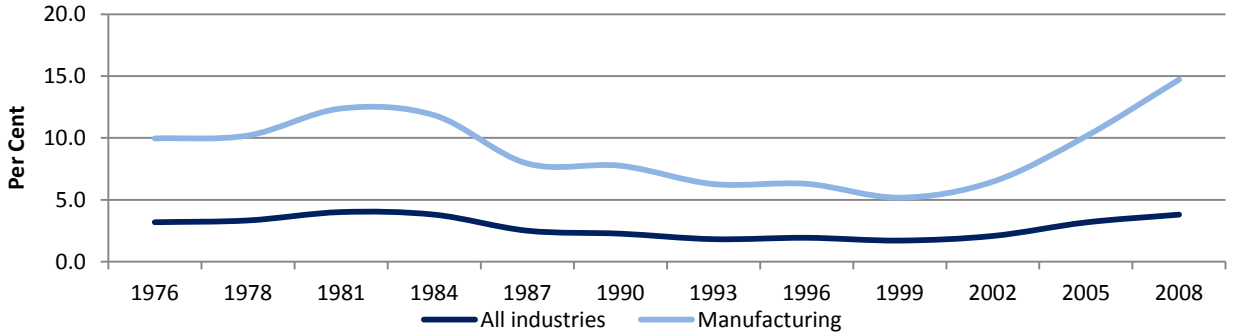
Panel A: Finance, Insurance, and Real Estate Services



Panel B: Professional, Scientific, Technical, Computer, Administrative, Support, and Related Services



Panel C: Metal Ores and Concentrates, Mineral Fuels, and Non-Metallic Minerals



Note: Finance, insurance and real estate services; professional, scientific, technical, computer, administrative, support and related services; and metal ores and concentrates, mineral fuels and non-metallic minerals are commodities. These commodities are produced within multiple industries and therefore do *not* perfectly correspond with finance, insurance, real estate and rental and leasing (IOIC code 5A), PBS (IOIC codes 54 and 56), and mining and oil and gas extraction (IOIC code 21), respectively.
Source: CSLS calculations based on Statistics Canada data. CANSIM table 381-0013.

Table 7 provides a breakdown of gross output in three-digit NAICS manufacturing industries between value added and intermediate inputs for 1976, 1987, 2000 and 2008. This table illustrates an important fact: the increase in the shares of finance, insurance and real estate services and professional, scientific, technical, computer, administrative, support and related services in gross output occurred in almost all manufacturing industries between 1976 and 2008. This suggests that the direct requirement for finance, insurance and real estate services and professional, scientific, technical, computer, administrative, support and related services increased in most manufacturing industries over the 1976-2011 period, supporting the notion that the outsourcing of these services has increased.

Table 7: Shares of Value Added and Selected Intermediate Inputs in Gross Output by Industry, Per Cent, 1976, 1987, 2000 and 2008

IOIC Codes	1976				1987				2000				2008			
	Value Added	Intermediates			Value Added	Intermediates			Value Added	Intermediates			Value Added	Intermediates		
		Total	FS	PBS		Total	FS	PBS		Total	FS	PBS		Total	FS	PBS
Total industries	53.1	46.9	3.1	2.1	52.0	48.0	4.3	2.8	48.0	52.0	5.1	5.3	50.1	49.9	5.2	5.9
Manufacturing [3A]	32.7	67.3	1.4	1.3	34.0	66.0	2.5	1.2	31.5	68.5	2.4	4.0	27.9	72.1	2.5	3.6
Food manufacturing	24.2	75.8	1.0	0.5	26.8	73.2	2.0	0.4	26.0	74.0	1.8	3.0	28.4	71.6	2.1	3.3
Beverage and tobacco product manufacturing	48.5	51.5	1.4	1.2	45.9	54.1	2.2	0.7	42.1	57.9	3.2	10.5	49.8	50.2	5.3	7.0
Textile and textile product mills	37.1	62.9	1.5	0.7	36.2	63.8	2.7	0.6	38.2	61.8	2.4	1.9	40.7	59.3	2.9	3.2
Clothing manufacturing	43.0	57.0	1.9	1.1	43.7	56.3	3.6	1.1	46.7	53.3	3.1	1.6	47.0	53.0	3.6	1.4
Leather and allied product manufacturing	42.6	57.4	2.0	0.8	41.5	58.5	2.9	0.5	43.1	56.9	2.2	4.0	42.5	57.5	4.1	3.4
Wood product manufacturing	38.3	61.7	1.1	0.6	38.0	62.0	1.9	0.5	36.5	63.5	1.7	1.8	33.1	66.9	2.2	2.7
Paper manufacturing	40.0	60.0	1.1	0.6	40.2	59.8	2.6	0.6	37.9	62.1	2.3	2.2	31.9	68.1	2.8	3.2
Printing and related support activities	62.6	37.4	2.3	0.8	45.9	54.1	3.1	1.2	46.8	53.2	2.9	2.5	51.0	49.0	3.0	2.6
Petroleum and coal products manufacturing	-6.6	106.6	1.3	0.6	7.4	92.6	2.3	0.7	7.4	92.6	2.3	2.2	7.1	92.9	0.9	1.4
Chemical manufacturing	36.9	63.1	2.1	1.5	38.2	61.8	3.0	1.0	32.0	68.0	3.3	4.1	25.0	75.0	3.6	3.7
Plastics and rubber products manufacturing	41.1	58.9	2.0	1.4	38.7	61.3	3.5	1.2	38.2	61.8	2.1	4.0	34.1	65.9	2.7	3.9
Non-metallic mineral product manufacturing	48.1	51.9	1.2	0.9	46.5	53.5	2.9	0.8	43.9	56.1	3.0	3.1	43.3	56.7	3.1	3.7
Primary metal manufacturing	28.0	72.0	0.9	0.6	32.6	67.4	1.8	0.7	30.2	69.8	1.9	1.6	24.0	76.0	1.4	2.5
Fabricated metal product manufacturing	43.0	57.0	1.4	0.9	43.6	56.4	2.9	0.9	43.8	56.2	2.4	1.8	40.4	59.6	2.5	2.1
Machinery manufacturing	44.9	55.1	1.4	1.3	41.6	58.4	3.5	1.2	44.2	55.8	2.1	2.4	40.3	59.7	2.2	2.7
Computer and electronic product manufacturing	48.6	51.4	3.3	1.7	46.4	53.6	3.3	1.8	29.3	70.7	3.4	8.2	38.5	61.5	4.0	9.8
Electrical equipment, appliance and component manufacturing	42.5	57.5	1.4	1.0	38.6	61.4	2.5	0.8	35.4	64.6	2.9	4.2	33.1	66.9	4.5	5.3
Transportation equipment manufacturing	27.6	72.4	1.0	3.9	25.7	74.3	1.7	3.7	24.5	75.5	2.6	6.2	20.7	79.3	3.3	6.0
Furniture and related product manufacturing	45.1	54.9	2.3	1.2	42.1	57.9	3.3	1.1	41.8	58.2	2.3	1.9	44.0	56.0	2.8	2.5
Miscellaneous manufacturing	50.6	49.4	2.4	1.7	35.2	64.8	3.1	1.2	43.8	56.2	2.5	2.4	45.7	54.3	3.0	3.1

Note: "FS" refers to the commodity "Finance, insurance, and real estate services". "PBS" refers to the commodity "Professional, scientific, technical, computer, administrative, support, and related services".
Source: CSLS calculations based on Statistics Canada data. CANSIM table 381-0014.

The coefficients in the industry-by-industry total requirements tables provide further information on changes in the composition of intermediate inputs. The total requirements table shows the value of gross output in the industry at the beginning of the row that is required per dollar of final uses expenditure (or final demand) in the industry at the top of the column. The diagonal coefficients are typically greater than one, while the off-diagonal coefficients are always less than one. Larger coefficients indicate that more gross output is needed in the industry at the beginning of the row in order to meet a dollar of final demand in the industry at the top of the column. In other words, larger coefficients indicate that the industry at the beginning of the row is a more important intermediate input for the industry at the top of the column. It is important to note that these coefficients include both the *direct* and *indirect* requirements.

According to the BEA (2009:15), the horizontal sums of the coefficients in the total requirements table measure the "relative strength of final demand on output" (the **backward linkage**), while the vertical sums measure the "strength of the particular industry's tie to final-demand changes" (the **forward linkage**). The forward linkage is most important for the purposes of this report, as it measures "the interconnection of a sector to all other sectors through the supply of intermediate inputs" (Berlingieri, 2014:4). Thus, intensification in the use of PBS as an intermediate input would be reflected in an increase in the forward linkage of the PBS industry.

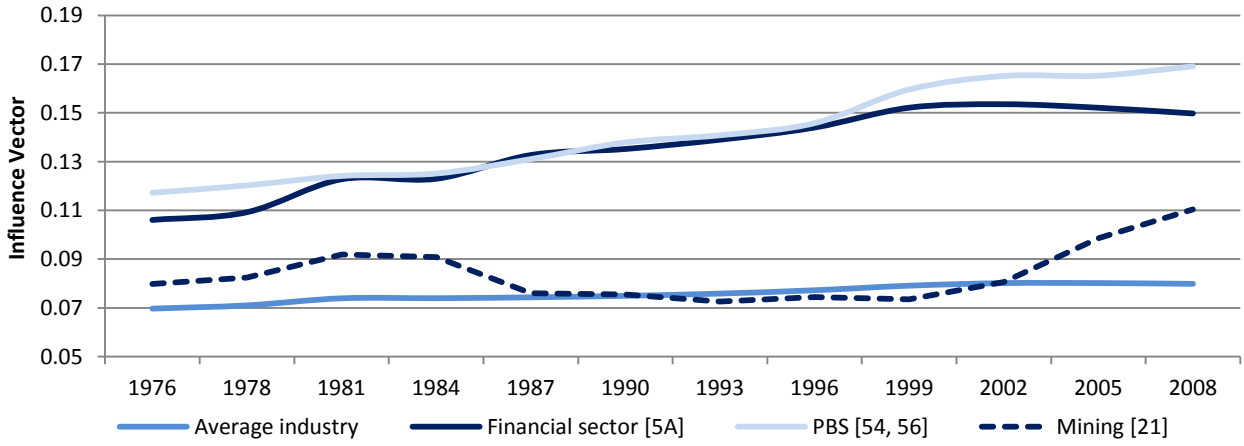
Berlingieri (2014) measures the strength of forward linkages using the influence vector. The influence vector is simply the unweighted arithmetic average of the forward linkage – that is, the horizontal sum of the coefficients in the total requirements table divided by the number of industries. In other words, the influence vector measures the intensity with which all industries in the economy use a given industry's output as an intermediate input.

Table 8 presents influence vectors for each industry for selected years between 1976 and 2008, and Chart 3 simply visualizes this data for selected industries. As in Berlingieri (2014), PBS has become an industry with one of the biggest influence on the Canadian economy. Between 1976 and 2008, PBS (IOIC codes 54 and 56) experienced the largest absolute increase in its influence vector (0.5 points), followed by finance, insurance, real estate and rental and leasing (IOIC code 5A) (0.4 points), mining and oil and gas extraction (IOIC code 21) (0.3 points), and manufacturing (0.3 points).[27] Unsurprisingly, the changes in the influence vectors of these industries are quite similar to the trends seen in Chart 2, with PBS seeing a steady increase in its vector from 1987 to 2008, finance, insurance, real estate and rental and leasing exhibiting increases from 1976 to 2002, and mining and oil and gas extraction seeing increases in the late seventies and twenty-first century. Other industries saw negligible absolute changes in their influence vectors between 1976 and 2008.

[27] PBS is defined as the aggregate of professional, scientific and technical services (IOIC code 54) and administrative and support, waste management and remediation services (IOIC code 56). Finance, insurance, real estate and rental and leasing is a special aggregate that consists of finance and insurance (IOIC code 52), real estate and rental and leasing (IOIC code 53), and management of companies and enterprises (IOIC code 55).

In 2008, manufacturing had the highest influence vector (0.24), followed by PBS (0.17), finance, insurance, real estate and rental and leasing (0.15), and mining and oil and gas extraction (0.11). The influence vectors of these industries were much higher than the average across all industries (0.08) and the average across all other industries (0.06).

Chart 3: Influence Vector by Selected Industry, 1976-2008



Source: CSLS calculations based on Statistics Canada data. CANSIM table 381-0013.

Table 9 presents the total requirements coefficients for manufacturing for the 1976-2008 period. More specially, it shows the coefficients in the manufacturing column of the industry-by-industry total requirements table for selected years between 1976 and 2008. The results are quite similar to those presented in Table 8 and Chart 3. In particular, PBS exhibited the largest absolute increase in its coefficient (0.5 points), followed by finance, insurance, real estate and rental and leasing (0.4 points), mining and oil and gas extraction (0.3 points) and manufacturing (0.3 points). However, mining and oil and gas extraction had the second highest coefficient (0.27) in 2008, followed by PBS (0.09) and finance, insurance, real estate and rental and leasing (0.09). The increase in the coefficient for mining and oil and gas extraction was isolated to the 2002-2008 period, when it increased an impressive 0.15 points. This coincided with a massive increase in the value of metal ores and concentrates, mineral fuels, and non-metallic minerals inputs in the manufacturing sector from $38 billion in 2002 to $92 billion in 2008 (Table 10).

Table 11 presents the shares of intermediate inputs by commodity in gross output for manufacturing for the 1976-2008 period. This table illustrates the *direct* requirements per dollar of gross output for manufacturing in terms of commodity inputs. It shows that metal ores and concentrates, mineral fuels, and non-metallic minerals exhibited the largest increase in its share in gross output for manufacturing (4.8 percentage points), followed by machinery and motor vehicles, other transport equipment and parts (2.3 percentage points) and professional, scientific, technical, computer, administrative, support, and related services (2.3 percentage points), chemicals, pharmaceuticals, chemical and other manufactured products (1.8 percentage points), and finance, insurance and real estate services (1.2 percentage points).

Table 8: Influence Vector by Industry, 1976-2008

IOIC Codes	Influence Vector												
	1976	1978	1981	1984	1987	1990	1993	1996	1999	2002	2005	2008	Δ76-08
Crop and animal production [1A]	0.06	0.07	0.08	0.08	0.07	0.07	0.07	0.08	0.08	0.07	0.07	0.07	0.01
Forestry and logging [1B]	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.00
Fishing, hunting and trapping [1C]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.00
Support activities for agriculture and forestry [1D]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.00
Mining and oil and gas extraction [21]	0.08	0.08	0.09	0.09	0.08	0.08	0.07	0.07	0.07	0.08	0.10	0.11	0.03
Utilities [22]	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.00
Construction [23]	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06	-0.01
Manufacturing [3A]	0.21	0.22	0.24	0.24	0.23	0.23	0.23	0.24	0.25	0.26	0.25	0.24	0.03
Wholesale trade [41]	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.01
Retail trade [4A]	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.00
Transportation and warehousing [4B]	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.01
Information and cultural industries [51]	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.01
Finance, insurance, real estate and rental and leasing [5A]	0.11	0.11	0.12	0.12	0.13	0.14	0.14	0.14	0.15	0.15	0.15	0.15	0.04
Professional and business services (PBS)	0.11	0.12	0.13	0.13	0.13	0.14	0.14	0.15	0.16	0.17	0.17	0.17	0.05
Professional, scientific and technical services [54]	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.10	0.10	0.10	0.04
Administrative and support, waste management and remediation services [56]	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.01
Educational services [61]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.00
Health care and social assistance [62]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.00
Arts, entertainment and recreation [71]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.00
Accommodation and food services [72]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.00
Other services (except public administration) [81]	0.06	0.06	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.00
Non-profit institutions serving households [NP]	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.12	0.13	0.12	0.11	0.10	0.01
Government sector [GS]	0.08	0.08	0.08	0.08	0.08	0.09	0.08	0.08	0.09	0.09	0.09	0.08	0.01

Note: The influence vector of an industry is defined as the unweighted arithmetic average of the entries in that industry's row in the total requirements table.
Source: CSLS calculations based on Statistics Canada data. CANSIM table 381-0013.

Table 9: Total Requirements Coefficients by Industry for Manufacturing, 1976-2008

IOIC Codes	Total Requirements Coefficients												
	1976	1978	1981	1984	1987	1990	1993	1996	1999	2002	2005	2008	Δ76-08
Crop and animal production [1A]	0.09	0.10	0.11	0.10	0.08	0.08	0.08	0.08	0.07	0.07	0.06	0.06	-0.03
Forestry and logging [1B]	0.04	0.04	0.03	0.04	0.04	0.04	0.04	0.05	0.04	0.03	0.03	0.02	-0.02
Fishing, hunting and trapping [1C]	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Support activities for agriculture and forestry [1D]	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Mining and oil and gas extraction [21]	0.17	0.17	0.21	0.20	0.13	0.13	0.11	0.12	0.10	0.12	0.19	0.27	0.10
Utilities [22]	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.01
Construction [23]	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	-0.01
Manufacturing [3A]	1.59	1.60	1.61	1.62	1.63	1.63	1.68	1.70	1.72	1.71	1.68	1.62	0.03
Wholesale trade [41]	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.02
Retail trade [4A]	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
Transportation and warehousing [4B]	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.00
Information and cultural industries [51]	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.01
Finance, insurance, real estate and rental and leasing [5A]	0.04	0.05	0.06	0.06	0.07	0.07	0.08	0.08	0.09	0.10	0.09	0.09	0.04
Professional and business services (PBS)	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.06	0.07	0.09	0.09	0.09	0.05
Professional, scientific and technical services [54]	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.06	0.06	0.04
Administrative and support, waste management and remediation services [56]	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.01
Educational services [61]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Health care and social assistance [62]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Arts, entertainment and recreation [71]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00
Accommodation and food services [72]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other services (except public administration) [81]	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
Non-profit institutions serving households [NP]	0.06	0.06	0.07	0.06	0.06	0.07	0.07	0.07	0.07	0.08	0.06	0.05	-0.01
Government sector [GS]	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.00

Note: This table shows the I-O coefficients in manufacturing's column in the total requirements table. The sum of each column provides the backward linkage of manufacturing.
Source: CSLS calculations based on Statistics Canada data. CANSIM table 381-0013.

Table 10: Intermediate Inputs by Commodity for Manufacturing, Millions of Current Dollars, 1976-2008

Commodity Group	Millions of Current Dollars											
	1976	1978	1981	1984	1987	1990	1993	1996	1999	2002	2005	2008
Value added	33,015	41,883	60,015	73,668	93,326	103,839	103,578	135,748	171,214	183,241	185,305	173,705
Intermediate inputs (total)	69,207	88,965	139,452	164,022	184,586	206,505	215,245	288,400	344,482	406,232	450,687	454,029
Agricultural products	5,696	7,190	10,423	11,063	11,255	11,363	11,715	14,606	15,469	17,986	18,348	20,293
Forestry products	2,249	3,073	3,812	4,382	5,434	5,962	7,202	9,743	10,294	10,010	10,852	7,516
Fish, seafood and trapping products	379	656	798	711	1,374	1,211	1,209	1,258	1,468	1,195	1,187	1,373
Metal ores and concentrates, mineral fuels, and non-metallic minerals	10,179	13,340	24,697	28,143	22,034	24,045	19,966	26,643	26,637	38,064	64,458	92,423
Food, alcohol and tobacco products	3,329	4,184	6,276	7,345	7,396	7,855	8,563	10,302	11,268	15,794	15,548	17,537
Leather, rubber, plastic, textile and clothing products	3,782	4,525	6,364	7,432	9,687	9,886	9,681	12,158	13,988	16,111	12,898	9,625
Wood, pulp and paper products	4,042	4,559	8,045	9,344	12,807	14,047	13,103	17,904	21,062	25,334	23,703	20,151
Primary and fabricated metal products	8,757	10,874	16,688	17,414	21,421	22,958	22,168	30,280	36,550	40,957	49,042	49,914
Machinery and motor vehicles, other transport equipment and parts	6,745	9,649	11,894	18,469	21,868	27,375	35,976	51,591	70,300	67,661	72,643	55,604
Electrical, electronic and communications products	1,432	1,693	2,903	3,718	5,129	7,912	7,884	10,914	13,563	14,075	11,137	9,622
Non-metallic mineral, petroleum and coal products	2,180	3,058	5,790	6,384	5,700	5,933	6,179	7,738	8,658	11,248	15,712	20,864
Chemicals, pharmaceuticals, chemical and other manufactured products	4,247	5,794	10,003	11,748	14,648	16,234	16,971	22,783	27,159	34,717	38,042	37,179
Construction	430	513	880	905	932	1,297	1,170	1,101	1,563	1,391	1,232	1,152
Transportation and storage	2,810	3,479	4,725	5,658	6,645	6,580	6,660	8,009	9,258	11,225	14,092	14,933
Communications services and other utilities	1,481	2,137	3,548	4,914	5,792	6,692	7,832	9,019	10,564	11,456	13,089	12,505
Wholesaling and retailing margins and services	2,598	2,981	4,492	5,266	6,358	7,695	7,747	11,048	12,800	16,579	18,644	19,010
Retailing margins and services	22	25	20	25	29	34	39	46	451	812	1,060	976
Finance, insurance and real estate services	1,374	1,769	3,688	4,781	6,796	7,628	7,763	9,582	12,365	16,654	16,479	15,764
Professional, scientific, technical, computer, administrative, support, and related services	1,325	1,689	2,551	3,180	3,405	3,683	5,325	10,469	13,601	23,297	25,083	22,245
Education tuition and other fees	..	..	..	..	..	..	..	47	21	10	9	16
Health care and social assistance services	..	..	..	..	..	..	..	..	..	..	..	..
Accommodation and miscellaneous services	1,399	1,771	2,235	2,688	3,556	4,012	3,932	5,121	6,776	6,712	7,793	7,260
Other intermediates	4,751	6,006	9,620	10,452	12,320	14,103	14,160	18,038	20,667	24,944	19,636	18,067

Source: CSLS calculations based on Statistics Canada data. CANSIM table 381-0013.

Table 11: Shares of Intermediate Inputs by Commodity in Gross Output for Manufacturing, Per Cent, 1976-2008

Commodity Group	Shares in Gross Output for Manufacturing (Per Cent)												
	1976	1978	1981	1984	1987	1990	1993	1996	1999	2002	2005	2008	Δ76-08
Value added	32.30	32.01	30.09	30.99	33.58	33.46	32.49	32.00	33.20	31.09	29.14	27.67	-4.63
Intermediate inputs (total)	67.70	67.99	69.91	69.01	66.42	66.54	67.51	68.00	66.80	68.91	70.86	72.33	4.63
Agricultural products	5.57	5.49	5.23	4.65	4.05	3.66	3.67	3.44	3.00	3.05	2.88	3.23	-2.34
Forestry products	2.20	2.35	1.91	1.84	1.96	1.92	2.26	2.30	2.00	1.70	1.71	1.20	-1.00
Fish, seafood and trapping products	0.37	0.50	0.40	0.30	0.49	0.39	0.38	0.30	0.28	0.20	0.19	0.22	-0.15
Metal ores and concentrates, mineral fuels, and non-metallic minerals	9.96	10.20	12.38	11.84	7.93	7.75	6.26	6.28	5.17	6.46	10.14	14.72	4.77
Food, alcohol and tobacco products	3.26	3.20	3.15	3.09	2.66	2.53	2.69	2.43	2.19	2.68	2.44	2.79	-0.46
Leather, rubber, plastic, textile and clothing products	3.70	3.46	3.19	3.13	3.49	3.19	3.04	2.87	2.71	2.73	2.03	1.53	-2.17
Wood, pulp and paper products	3.95	3.48	4.03	3.93	4.61	4.53	4.11	4.22	4.08	4.30	3.73	3.21	-0.74
Primary and fabricated metal products	8.57	8.31	8.37	7.33	7.71	7.40	6.95	7.14	7.09	6.95	7.71	7.95	-0.62
Machinery and motor vehicles, other transport equipment and parts	6.60	7.37	5.96	7.77	7.87	8.82	11.28	12.16	13.63	11.48	11.42	8.86	2.26
Electrical, electronic and communications products	1.40	1.29	1.46	1.56	1.85	2.55	2.47	2.57	2.63	2.39	1.75	1.53	0.13
Non-metallic mineral, petroleum and coal products	2.13	2.34	2.90	2.69	2.05	1.91	1.94	1.82	1.68	1.91	2.47	3.32	1.19
Chemicals, pharmaceuticals, chemical and other manufactured products	4.15	4.43	5.01	4.94	5.27	5.23	5.32	5.37	5.27	5.89	5.98	5.92	1.77
Construction	0.42	0.39	0.44	0.38	0.34	0.42	0.37	0.26	0.30	0.24	0.19	0.18	-0.24
Transportation and storage	2.75	2.66	2.37	2.38	2.39	2.12	2.09	1.89	1.80	1.90	2.22	2.38	-0.37
Communications services and other utilities	1.45	1.63	1.78	2.07	2.08	2.16	2.46	2.13	2.05	1.94	2.06	1.99	0.54
Wholesaling and retailing margins and services	2.54	2.28	2.25	2.22	2.29	2.48	2.43	2.60	2.48	2.81	2.93	3.03	0.49
Retailing margins and services	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.09	0.14	0.17	0.16	0.13
Finance, insurance and real estate services	1.34	1.35	1.85	2.01	2.45	2.46	2.43	2.26	2.40	2.83	2.59	2.51	1.17
Professional, scientific, technical, computer, administrative, support, and related services	1.30	1.29	1.28	1.34	1.23	1.19	1.67	2.47	2.64	3.95	3.94	3.54	2.25
Education tuition and other fees	..	..	..	..	..	..	..	0.01	0.00	0.00	0.00	0.00	…
Health care and social assistance services	..	..	..	..	..	..	..	..	..	..	..	..	…
Accommodation and miscellaneous services	1.37	1.35	1.12	1.13	1.28	1.29	1.23	1.21	1.31	1.14	1.23	1.16	-0.21
Other intermediates	4.65	4.59	4.82	4.40	4.43	4.54	4.44	4.25	4.01	4.23	3.09	2.88	-1.77

Source: CSLS calculations based on Statistics Canada data. CANSIM table 381-0013.

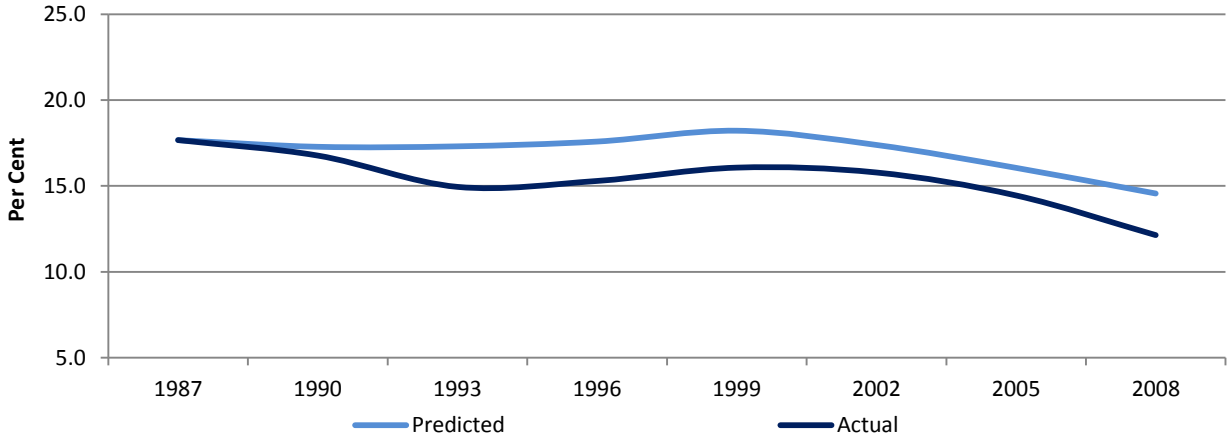
ii. Baseline Results for the 1987-2008 Period

The major contribution of Berlingieri (2014) was to quantify the impact of changes in the I-O structure of the economy (*i.e.*, total requirements coefficients and shares of value added in gross output) on the employment shares of agriculture, manufacturing and services. To do this, he developed a gross output model in which employment shares are determined by final demand shares, I-O coefficients and shares of value added in gross output. Therefore, when final demand shares are held constant, changes in the I-O structure produce a reallocation of employment across sectors. We will now perform this exercise for Canada for the 1987-2008 period, with final demand shares fixed to their 1987 level. However, unlike Berlingieri (2014), who aggregated up to three major broad sectors, the analysis presented in this section uses data for twenty-two IOIC industries. The results of this exercise are summarized in Table 12.

Between 1987 and 2008, the share of manufacturing in total employment fell 5.6 percentage points from 17.7 per cent to 12.1 per cent, while the model predicts a 3.1 percentage point drop from 17.7 per cent in 1987 to 14.6 per cent in 2008, accounting for 56.0 per cent of the actual change in the manufacturing employment share. In contrast, Berlingieri (2014) found that changes in the I-O structure accounted for 25.3 per cent of the actual decrease in the employment share of manufacturing in the United States from 1948 to 2002.

Both the observed and predicted decreases in manufacturing's employment share were concentrated between 1999 and 2008 (Chart 4). In addition, both the actual and predicted employment shares increased from 1993 to 1999. Conversely, the actual employment share of manufacturing fell markedly (2.7 percentage points) from 1987 to 1993, while the gross output model predicted a negligible decrease of 0.4 percentage point.

Chart 4: Predicted vs Actual Changes in the Manufacturing Employment Share, Baseline Case, 1987-2008



Source: CSLS calculations based on Statistics Canada data.

It is important to note the substantial growth in the predicted employment share of mining and oil and gas extraction from 1.6 per cent in 1987 to 5.4 per cent in 2008, well above the observed increase of 0.06 percentage point (Table 12). Given that both the increase in the predicted employment share of mining and oil and gas extraction and the decrease in the predicted employment share of manufacturing were concentrated in the 1999-2008 period, it is likely both of these trends were driven by the considerable increase in the total requirements coefficient for mining and oil and gas extraction in manufacturing between 1999 and 2008 (Table 9). This issue will be addressed formally in the following sub-section.

With regard to the service sector, the gross output model predicts a 1.0 percentage-point increase, accounting for only 16.2 per cent of the observed increase of 6.2 percentage points. This is quite different from Berlingieri's (2014) finding that changes in the I-O structure accounted for 8.1 percentage points (or 36.2 per cent) of the observed increase in the employment share of services in the United States from 1948 to 2002.

Of the total observed increase in the share of services in total employment from 1987 to 2008 (6.2 percentage points), 5.0 percentage points (or 80.1 per cent) was due to PBS and a negligible 0.02 percentage point (or 0.3 per cent) was due to finance, insurance, real estate and rental and leasing. In contrast, the gross output model predicted a 2.2 percentage-point increase in the employment share of PBS, accounting for 44.2 per cent of the actual change, and a 1.4 percentage-point increase in the employment share of finance, insurance, real estate and rental and leasing, well above the actual change.

Overall, the predicted changes in employment shares according to the gross output model are quite different from the observed changes, as illustrated by the final column in Table 12. This suggests that the explanatory power of the proposed gross output model is weak for Canada, at least with the selected data sources and specification.

Table 12: Predicted versus Actual Changes in the Employment Shares by Industry, Baseline Case, 1987-2008

IOIC Codes	Actual			Predicted			Ratio		
	1987	2008	Δ87-08	1987	2008	Δ87-08	1987	2008	Δ87-08
	A	B	C=B-A	D	E	F=D-E	D/A*100	E/B*100	F/C*100
Primary	5.93	4.03	-1.90	5.93	8.82	2.89	100.0	218.9	-152.3
Crop and animal production [1A]	3.38	1.82	-1.56	3.38	2.99	-0.39	100.0	164.2	25.0
Forestry and logging [1B]	0.46	0.21	-0.25	0.46	0.20	-0.26	100.0	96.2	103.2
Fishing, hunting and trapping [1C]	0.30	0.13	-0.16	0.30	0.13	-0.16	100.0	100.5	99.6
Support activities for agriculture and forestry [1D]	0.20	0.20	0.01	0.20	0.11	-0.08	100.0	55.7	-925.9
Mining and oil and gas extraction [21]	1.60	1.66	0.06	1.60	5.38	3.78	100.0	324.1	6,010.3
Secondary	24.96	20.67	-4.29	24.96	21.07	-3.89	100.0	101.9	90.8
Utilities [22]	0.99	0.94	-0.06	0.99	0.68	-0.31	100.0	73.1	535.2
Construction [23]	6.29	7.61	1.31	6.29	5.82	-0.48	100.0	76.5	-36.2
Manufacturing [3A]	17.67	12.13	-5.55	17.67	14.57	-3.11	100.0	120.1	56.0
Tertiary	69.11	75.30	6.19	69.11	70.11	1.00	100.0	93.1	16.2
Wholesale trade [41]	3.61	3.91	0.29	3.61	3.60	-0.02	100.0	92.2	-5.3
Retail trade [4A]	13.55	12.68	-0.86	13.55	12.50	-1.05	100.0	98.5	121.6
Transportation and warehousing [4B]	5.49	5.25	-0.24	5.49	5.05	-0.44	100.0	96.2	181.7
Information and cultural industries [51]	2.88	2.44	-0.44	2.88	2.96	0.07	100.0	121.0	-16.9
Finance, insurance, real estate and rental and leasing [5A]	6.66	6.68	0.02	6.66	8.04	1.38	100.0	120.4	6,901.3
Professional and business services (PBS)	6.57	11.54	4.96	6.57	8.76	2.19	100.0	75.9	44.2
Professional, scientific and technical services [54]	4.24	7.35	3.11	4.24	5.71	1.47	100.0	77.7	47.4
Administrative and support, waste management and remediation services [56]	2.33	4.19	1.85	2.33	3.05	0.72	100.0	72.9	38.9
Educational services [61]	0.37	0.67	0.30	0.37	0.67	0.30	100.0	99.5	98.9
Health care and social assistance [62]	3.36	4.88	1.53	3.36	3.40	0.04	100.0	69.6	2.7
Arts, entertainment and recreation [71]	1.54	2.24	0.70	1.54	1.51	-0.03	100.0	67.3	-4.7
Accommodation and food services [72]	6.21	6.68	0.47	6.21	5.64	-0.56	100.0	84.5	-119.8
Other services (except public administration) [81]	4.79	4.20	-0.59	4.79	4.40	-0.39	100.0	104.8	66.0
Non-profit institutions serving households [NP]	2.65	3.14	0.49	2.65	2.85	0.20	100.0	90.9	41.3
Government sector [GS]	11.42	10.99	-0.43	11.42	10.73	-0.69	100.0	97.6	160.6

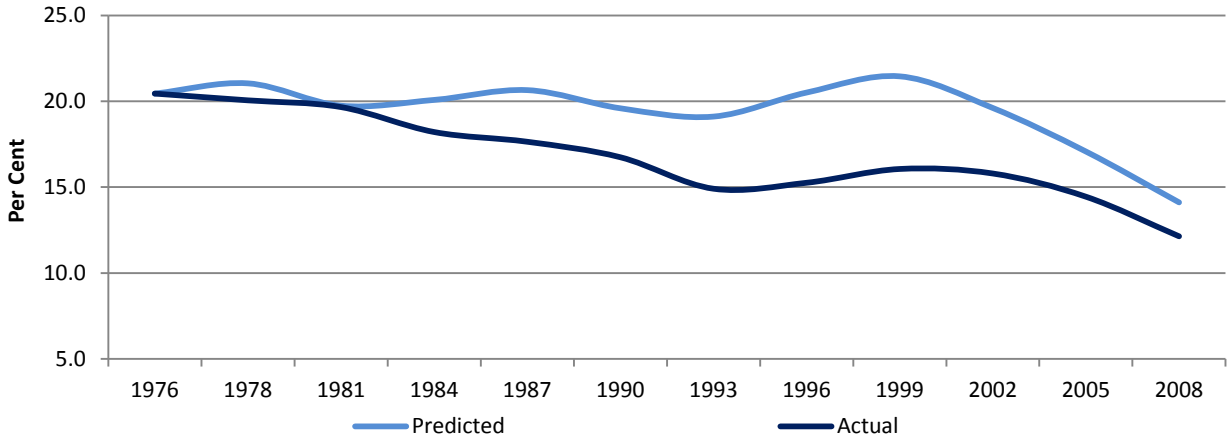
Source: CSLS calculations based on Statistics Canada data.

iii. Baseline Results for the 1976-2008 Period

The previous exercise will now be repeated for the longer 1976-2008 period at a higher level of aggregation, with only eleven industries included in the model compared to twenty-two for the shorter 1987-2008 period. Final demand shares are fixed at their 1976 level over time. The results of this exercise are summarized in Table 13.

Between 1976 and 2008, manufacturing's share of total employment fell 8.3 percentage points from 20.4 per cent to 12.1 per cent, while the gross output model predicts a 6.3 percentage point drop from 20.4 per cent in 1987 to 14.1 per cent in 2008, accounting for 76.3 per cent of the actual change in the manufacturing employment share compared to 56.0 per cent for previous exercise covering the shorter 1987-2008 period. As we saw in the previous exercise, both the observed and predicted employment shares of manufacturing exhibited significant increases from 1993 to 1999 and large declines between 1999 and 2008 (Chart 5). However, while the actual employment share of manufacturing fell steadily from 20.4 per cent in 1976 to 14.9 per cent in 1993, the gross output model predicted a small and uneven decrease of 1.3 percentage points.

Chart 5: Predicted vs Actual Changes in the Manufacturing Employment Share, Baseline Case, 1976-2008



Source: CSLS calculations based on Statistics Canada data.

While it appears that the movement of the predicted and actual employment shares of manufacturing are correlated over the 1976-2008 period, this does not necessarily mean that the gross output model's predictions are useful. Indeed, the correlation between the model's predictions and observed changes may be spurious. Between 1999 and 2008, the predicted decline in the manufacturing employment share was largely driven by increases in the value of intermediates purchased from mining and oil and gas extraction as suggested earlier. This also led to a large increase in the predicted employment share of mining and oil and gas extraction. However, the actual decrease in manufacturing's share of total employment was probably more closely linked to the perfect storm that ravaged the sector in the 2000s than to the increased

importance of intermediates produced in mining and oil and gas extraction.[28] More specifically, the decline in manufacturing after 2000 was almost certainly connected to the slowdown in economic growth in the United States, the emergence of low-cost foreign competitors, and appreciation of the Canadian dollar linked to soaring crude oil prices and other factors.

With regard to services, the model predicts a 5.0 percentage-point increase in the employment share between 1976 and 2008 when final demand shares are held constant, accounting for only 40.6 per cent of the observed increase of 12.2 percentage points. Hence the model appears to have more explanatory power for the longer 1976-2008 period than for the shorter 1987-2008, when it only accounted for 16.2 per cent of the rise in the service sector's share of total employment.

Of the actual increase in the service sector's share of total employment between 1976 and 2008 (12.2 percentage points), 4.6 percentage points was due to professional, scientific and technical services (IOIC code 54) and 3.3 percentage points was due to financial, business, building and other support services.[29] In contrast, the gross output model predicted a 5.9 percentage-point increase in the employment share of financial, business, building and other support services, accounting for 176.4 per cent of the actual change, and a 2.7 percentage-point increase in the employment share of professional, scientific and technical services, explaining 59.8 per cent of the actual change.

[28] If the decrease in manufacturing's share of total employment was linked to the increased demand for intermediates produced in mining and oil and gas extraction, then we should have observed a larger increase in the employment share of mining and oil and gas extraction, *ceteris paribus*.

[29] For the longer 1976-2008, administrative and support, waste management and remediation services (IOIC code 56) is aggregated along with finance, insurance, real estate and rental and leasing IOIC code 5A) to create financial, business, building and other support services. This aggregation was performed to maintain compatibility between industry definitions in the employment estimates and the I-O data.

Table 13: Predicted versus Actual Changes in the Employment Shares by Industry, Baseline Case, 1976-2008

IOIC Codes	Actual			Predicted			Ratio		
	1976	2008	Δ76-08	1976	2008	Δ76-08	1976	2008	Δ76-08
	A	B	C=B-A	D	E	F=D-E	D/A*100	E/B*100	F/C*100
Primary industries [1A, 1B, 1C, 1D, 21]	7.90	4.13	-3.76	7.90	10.26	2.36	100.0	248.1	-62.8
Secondary industries	29.14	20.70	-8.44	29.14	21.82	-7.32	100.0	105.4	86.7
Utilities [22]	1.21	0.94	-0.27	1.21	1.62	0.41	100.0	172.7	-153.4
Construction [23]	7.49	7.62	0.13	7.49	6.09	-1.39	100.0	80.0	-1,082.3
Manufacturing [3A]	20.44	12.14	-8.30	20.44	14.11	-6.33	100.0	116.2	76.3
Tertiary industries	62.97	75.17	12.20	62.97	67.92	4.95	100.0	90.4	40.6
Trade [41, 4A]	17.26	16.61	-0.65	17.26	16.00	-1.27	100.0	96.3	194.2
Transportation and warehousing [4B]	6.19	5.25	-0.93	6.19	5.48	-0.71	100.0	104.3	75.7
Information, culture and recreation [51, 71]	3.81	4.69	0.88	3.81	4.42	0.62	100.0	94.3	69.7
Financial, business, building and other support services [5A, 56]	7.55	10.88	3.33	7.55	13.43	5.87	100.0	123.4	176.4
Professional, scientific and technical services [54]	2.78	7.36	4.58	2.77	5.51	2.74	100.0	74.9	59.8
Accommodation and food services [72]	4.54	6.69	2.15	4.54	3.48	-1.06	100.0	52.0	-49.6
Other tertiary industries [61, 62, 81, NP, GS]	20.84	23.68	2.84	20.84	19.60	-1.24	100.0	82.8	-43.7

Source: CSLS calculations based on Statistics Canada data.

Overall, the gross output model's predictions were unable to explain much (if any) of the actual change in employment shares for most industries. However, the model's predictions appear to be more accurate for the longer 1976-2008 period than for the shorter 1987-2008 period, which may be due to differences in the level of aggregation between these exercises.

The poor explanatory power of the model has three possible explanations: 1) final demand channels, which were held constant in this exercise, are more important for certain industries; 2) there are certain weaknesses with the model (*e.g.*, its assumptions, specification, etc.), making it incapable of accurately explaining changes in sectoral employment shares; or 3) the use of current dollar data leads to major distortions resulting from changes in relative prices, such as the growth in the relative price of crude oil between 1999 and 2008.

The first possible explanation will be addressed later in this section. In particular, we will allow final demand shares to shift over time, and look at how the predictions of the gross output model under these conditions compare to the predictions of the current exercise.

The second possible explanation is more difficult to address. The model may have been unable to explain much of the actual changes in employment shares in Canada due to the choice of data, the assumptions of the model, the level of aggregation, or other factors. In particular, the model assumes that there is no capital in the economy, and the predicted employment shares are not directly affected by differential labour productivity growth rates across industries. However, these assumptions simplify the exercise to a great extent. In addition, the model may be more appropriate at higher levels of aggregation or for longer time periods, which may explain why the model's predictions were more accurate for the 1976-2008 period compared to the 1987-2008 period.

It would also be interesting to see the extent to which the inaccuracy of the model is due to the use of current dollar data as opposed to constant (or chained) dollar data. Constant (or chained) dollar data allows price changes (*e.g.*, an increase in the relative price of mineral fuels) to affect the evolution of I-O coefficients over time. Unfortunately, we do not attempt to use constant (or chained) dollar data in this report, as only current dollar data are publically available for Canada for the 1976-2008 period.

B. The Effect of Outsourcing on Sectoral Allocation

Manufacturing's employment share is affected by changes in intermediate demand in two main ways: 1) an increase (decrease) in manufacturing's demand for intermediates from industry *j* leads to a decrease (increase) in the employment share of manufacturing and an increase (decrease) in the employment share of industry *j*; 2) an increase (decrease) in the intermediate demand for manufacturing's output from industry *j* leads to an increase (decrease) in the employment share of manufacturing and a decrease (increase) in the employment share of industry *j*. In other words, both manufacturing's demand for other industries' intermediates and other industries demand for manufacturing's intermediates matter.

Berlingieri (2014) performed four simulations to quantify the contribution of different sorts of outsourcing to changes in employment shares in the United States. These exercises involved holding manufacturing's demand for intermediates from selected industries constant over time in order to estimate the contribution of various types of outsourcing to the decline in manufacturing's share of total employment. To do this, Berlingieri held the coefficients in the direct requirements matrix for selected intermediate inputs in manufacturing constant over time. In this sub-section, we will perform similar simulations for Canada for both the shorter 1987-2008 period and the longer 1976-2008 period. Table 14 briefly describes these simulations.

Table 14: Description of the Counterfactual Exercises

Period	Simulations	Description
1987-2008	All Coefficients	This exercise estimates the contribution of all types of outsourcing to the decline in the manufacturing employment share by fixing the direct requirements coefficients for all intermediates in manufacturing at their 1987 level.
	PBS Coefficient	This exercise estimates the contribution of PBS outsourcing to the decline in the manufacturing employment share by fixing the direct requirements coefficient for intermediates purchased from the PBS industry in manufacturing at its 1987 level.
	FS Coefficient	This exercise estimates the contribution of financial services (FS) outsourcing to the decline in the manufacturing employment share by fixing the direct requirements coefficient for intermediates purchased from finance, insurance, real estate and rental and leasing in manufacturing at its 1987 level.
	Mining Coefficient	This exercise estimates the contribution of 'outsourcing' of mining products to the decline in the manufacturing employment share by fixing the direct requirements coefficient for intermediates purchased from mining and oil and gas extraction in manufacturing at its 1987 level.
1976-2008	All Coefficients	This exercise estimates the contribution of all types of outsourcing to the decline in the manufacturing employment share by fixing the direct requirements coefficients for all intermediates in manufacturing at their 1976 level.
	FS/PBS Coefficient	This exercise estimates the contribution of PBS and FS outsourcing to the decline in the manufacturing employment share by fixing the direct requirements coefficients for intermediates purchased from the PBS industry and finance, insurance, real estate and rental and leasing in manufacturing at their 1976 level.
	Primary Coefficient	This exercise estimates the contribution of the 'outsourcing' of primary products to the decline in the manufacturing employment share by fixing the direct requirements coefficient for intermediates purchased from primary industries – an aggregate that includes agricultural, forestry, mining, and oil and gas industries – in manufacturing at its 1976 level.

i. Simulation Results for the 1987-2008 Period

Table 15 presents the key results of the simulations performed for the 1987-2008 period.

Table 15: Effect of Simulations on the Predicted Manufacturing Employment Share, 1987-2008

Counterfactual Exercise	Predicted Change (Percentage Points)	Difference with Baseline (Percentage Points)	Share of Predicted Change (Per Cent)	Share of Actual Change (Per Cent)
	A_i	$B_i = -3.11 - A_i$	$B_i / -3.11 * 100$	$B_i / -5.55 * 100$
Baseline Case	-3.11	0.00	...	...
1: All Coefficients	-2.53	-0.58	18.72	10.49
2: PBS Coefficient	-2.99	-0.11	3.68	2.06
3: FS Coefficient	-3.10	0.00	0.13	0.07
4: Mining Coefficient	-2.64	-0.47	15.16	8.50

Note: The predicted change and the difference with respect to the baseline case are expressed in percentage points of total employment. The ratio to data is the prediction of the simulation expressed as percentage share of the actual change in the data.
Source: CSLS calculations based on Statistics Canada data.

Identical to Berlingieri (2014), the first exercise estimates the contribution of all types of outsourcing to the decline in manufacturing's employment share by fixing the demand for intermediate inputs in manufacturing over time. To do this, the coefficients in the direct requirements matrix for all intermediates in manufacturing are fixed at their 1987 level.

While the baseline case of the model (which was presented in the previous sub-section) predicted a 3.1 percentage-point decline in the employment share of manufacturing, this exercise predicts a decline of only 2.5 percentage points, which indicates that outsourcing could explain 18.7 per cent of the baseline prediction and 10.5 per cent of the actual change between 1987 and 2008. However, this rests on the assumption "that the entire observed change in the shares of intermediate use was coming from outsourcing" (Berlingieri, 2014:16). Similarly, Berlingieri found that changes in the demand for intermediates in manufacturing accounted for 59.5 per cent of the baseline case and for 15.0 per cent of the observed decrease between 1948 and 2002.

The second exercise estimates the effect of PBS outsourcing on manufacturing's employment share by keeping the demand for PBS intermediates in manufacturing fixed over time, as in Berlingieri (2014). This involves fixing the coefficients in the direct requirements matrix for PBS intermediates in manufacturing at their 1987 level.

This simulation predicts a decline of 2.5 percentage points in manufacturing's employment share compared to the baseline prediction of a 3.1 percentage-point decline; this suggests that PBS outsourcing can explain 3.7 per cent of the baseline prediction and 2.1 per cent of the actual change from 1987 to 2008. Berlingieri's (2014) findings indicate that PBS outsourcing was a more important driver of the decline in the manufacturing employment share

in the United States, accounting for 63.9 per cent of the baseline prediction and for 16.1 per cent of the observed change.

The results of this exercise do not account for the nature of outsourcing, but merely ascribe an increase (decrease) in the use of PBS intermediates in manufacturing to an increase (decrease) in outsourcing from manufacturing to PBS. In other words, it does not matter why firms started using more PBS. Berlingieri (2014:13) summarizes this point succinctly:

> "PBS are intrinsically very substitutable: for instance, a firm always has the option to employ an accountant or an engineer in-house instead of buying accounting and engineering services from specialized firms. Despite the option of internal production the firm decided to purchase the input from the market, so whatever the fundamental reason behind this choice may be, what is key in order to calculate the impact of outsourcing on the reallocation of labor across sectors is primarily to identify market transactions correctly."

In contrast to Berlingieri (2014), the definition of PBS in this report excludes management of companies and enterprises (NAICS code 55), the NAICS industry where the internal production of services is concentrated. This means that the results of this exercise correspond to the external production of PBS, which in turn means that the increased use of PBS intermediates in manufacturing was driven by outsourcing rather than "a simple progressive shift towards service activity both inside and outside the firm" (Berlingieri, 2014:12).

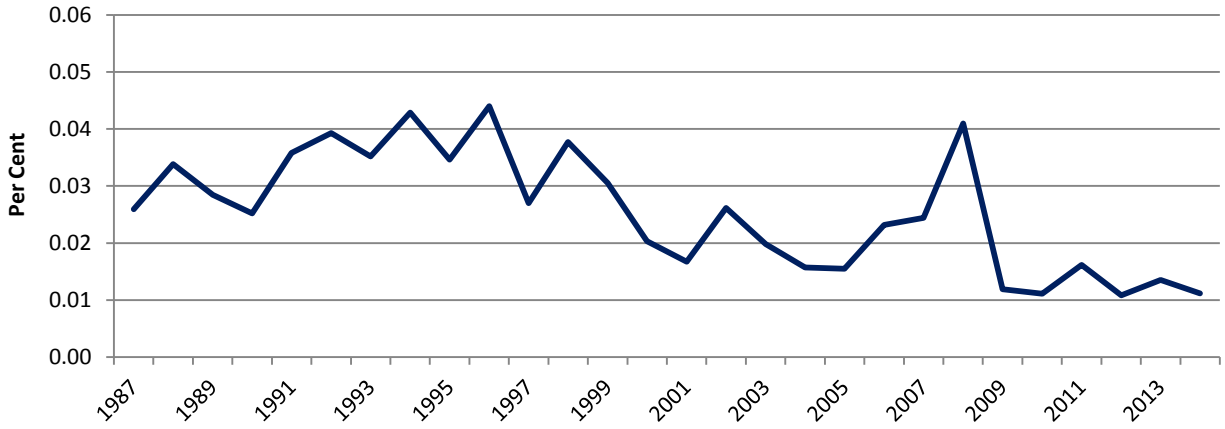
Similar to Berlingieri (2014), the third exercise measures the contribution of financial services (FS) outsourcing to the decline in manufacturing's employment share by keeping the demand for FS intermediates in manufacturing fixed over time. In particular, the coefficients in the direct requirements matrix for intermediates purchased from finance, insurance, real estate and rental and leasing in manufacturing are fixed to their 1987 level.

The results of this exercise indicate that FS outsourcing was not a significant determinant of the decline in manufacturing's employment share from 1987 to 2008, as it only accounted for 0.13 per cent of the baseline case and 0.07 per cent of the actual change. Similarly, Berlingieri (2014) shows that FS outsourcing only explains 1.1 per cent of the decline in the manufacturing employment share in the United States from 1948 to 2002.

Unlike Berlingieri (2014), we cannot distinguish between the internal and external production of services, as management of companies and enterprises is aggregated with finance, insurance, real estate and rental and leasing in Canadian I-O data. Thus, the results of this exercise may be affected by changes in the internal production of services. However, Chart 6 shows that the employment share of management of companies and enterprises was insignificant over the 1987-2012 period, suggesting that the rise in the employment share of finance,

insurance, real estate and rental and leasing was not driven by an increase in the production of services within firms.[30]

Chart 6: Employment Share of Management of Companies and Enterprises, Per Cent, Canada, 1987-2012



Source: CSLS calculations based on Statistics Canada data. Labour Force Survey. Special order.

The fourth exercise estimates the effect of changes in I-O coefficients for intermediates purchased from mining and oil and gas extraction in manufacturing on manufacturing's employment share. To do this, the direct requirements coefficients for mining and oil and gas extraction intermediates in manufacturing are fixed at their 1987 level.

While the baseline case predicted a 3.1 percentage-point decline in the employment share of manufacturing, this exercise predicts a decline of only 2.6 percentage points, indicating that the increase in the demand for mining and oil and gas extraction intermediates in manufacturing accounted for 15.2 per cent of the baseline prediction and 8.5 per cent of the actual change between 1987 and 2008. These results suggest that the increase in the value of mineral fuels processed by the manufacturing sector accounts for up to 8.5 per cent of the predicted decline in manufacturing's employment share according to the baseline case of the gross output model. Unlike the results of previous simulations, this should not be interpreted as the impact of mining outsourcing on manufacturing's employment share but rather as an artifact of the data. As previously stated, the massive increase in the relative price of intermediates produced by mining and oil and gas extraction has a substantial effect on the predictions of the model.

ii. Simulation Results for the 1976-2008 Period

We will now present the results of the simulations for the longer 1976-2008 period. Given that a higher level of aggregation was used for this period, the scope of the simulation is broader than before. In particular, the second and third exercises are combined in order to

[30] The significant year-to-year variation in Chart 6 is largely attributable to sampling variability, as management of companies and enterprises is a very small industry with few observations.

quantify the contribution of both PBS and FS outsourcing to the decline in the proportion of manufacturing in total employment, and the fourth exercise is broadened to include all primary industries rather than just mining and oil and gas extraction. Table 16 presents the key results of the simulations conducted for the 1976-2008 period.

Table 16: Effect of Simulations on the Predicted Manufacturing Employment Share, 1976-2008

Counterfactual Exercise	Predicted Change (Percentage Points)	Difference with Baseline (Percentage Points)	Share of Predicted Change (Per Cent)	Share of Actual Change (Per Cent)
	A_i	$B_i = -6.33 - A_i$	$B_i / -6.33 * 100$	$B_i / -8.30 * 100$
Baseline Case	-6.33	0.00	...	...
1: All Coefficients	-4.58	-1.75	27.69	21.13
2: PBS/FS Coefficient	-6.05	-0.29	4.53	3.45
3: Primary Coefficient	-6.06	-0.28	4.35	3.32

Note: The predicted change and the difference with respect to the baseline case are expressed in percentage points of total employment. The ratio to data is the prediction of the simulation expressed as percentage share of the actual change in the data.
Source: CSLS calculations based on Statistics Canada data.

In the previous sub-section, the baseline case predicted a 6.3 percentage-point drop in the share of manufacturing in total employment in Canada between 1976 and 2008. According to the first simulation, in which the I-O coefficients for all intermediates in manufacturing are fixed at their 1976 level, outsourcing accounted for 27.7 per cent of the predicted fall in manufacturing's employment share according to the baseline case and for 21.1 per cent of the observed decline in manufacturing's employment share. According to these results, the contribution of outsourcing to the decline in manufacturing's employment share for the longer 1987-2008 period was double its contribution for the shorter 1987-2008 period; this may be due to differences in the level of aggregation or indicate that a great deal of outsourcing occurred between 1976 and 1986.

In contrast, the results of the second exercise, in which the I-O coefficients for PBS and FS intermediates in manufacturing are fixed at their 1976 level, are similar to what we found for the 1987-2008 period. In particular, PBS and FS outsourcing can explain 4.5 per cent of the baseline prediction and 3.5 per cent of the actual change for the 1976-2008 period.

The third exercise holds the demand for intermediate inputs purchased from primary industries – an aggregate that includes agricultural, forestry, mining, and oil and gas industries – in manufacturing constant at their 1976 level. The results of this simulation suggest that changes in the I-O coefficients for primary industries account for 4.4 per cent of the baseline prediction and 3.3 per cent of the actual change for the 1976-2008 period. However, the role of mining and oil and gas extraction was almost certainly much higher than reported, as the contribution of agricultural and forestry industries were probably negative given that the total requirements coefficients for theses industries in manufacturing declined from 1976 to 2008.

Given that the necessary data are not readily available, this report cannot estimate the contribution of PBS offshoring to the decline in manufacturing's employment share as in Berlingieri (2014). However, the share of imports in total professional, scientific, technical, computer, administrative, support, and related services inputs decreased 6.3 percentage points from 15.2 per cent in 1976 to 8.8 per cent in 2008, indicating that PBS offshoring was a less important determinant of the change in manufacturing's employment share than domestic PBS outsourcing (Table 17). In contrast, the share of imports in total finance, insurance, and real estate services inputs increased significantly from 7.5 per cent in 1976 to 13.3 per cent in 2008. Thus, FS offshoring may be driving some (or all) of the predictions of both the baseline case and the simulations.

Table 17: Share of Imports in Intermediate Inputs by Commodity for the Total Economy, Per Cent, 1976, 1987, 2000 and 2008

Intermediate Commodities	Share of International Imports in Total Inputs (Per Cent)				
	1976	1987	2000	2008	Δ76-08
Total	12.90	14.17	20.40	17.78	4.87
FS	7.53	10.05	12.25	13.28	5.75
PBS	15.16	13.95	12.87	8.83	-6.34

Note: "FS" refers to the commodity "Finance, insurance, and real estate services". "PBS" refers to the commodity "Professional, scientific, technical, computer, administrative, support, and related services".
Source: CSLS calculations based on Statistics Canada data. CANSIM tables 381-0011 and 381-0014.

C. The Effect of Changes in Final Demand on Sectoral Allocation

In this sub-section, final uses expenditure shares are allowed to evolve over time. The purpose of this exercise is to determine whether the contribution of changes in the I-O structure, and of outsourcing in particular, to the decline in manufacturing's employment share still matters when final demand channels are present. More specifically, this sub-section repeats the exercises presented in the first sub-section for both the gross output model and a value added model, allowing for changes in final demand shares over time. [31]

As in Berlingieri (2014:17), we model the evolution of final demand shares over time using a consumer optimization framework in which consumers are assumed to be utility-maximizing agents with "homothetic preferences with a less than unitary elasticity of substitution between goods." With a less-than-unitary elasticity of substitution, this framework predicts that differences in the growth rates of prices across sectors prompt changes in final uses expenditure shares. In particular, nominal final demand shares shift away from industries with relatively low price growth toward industries with relatively high price growth. In this report, we use value added price indexes by industry for the value added model and gross output price

[31] In the value added model, the share of intermediate inputs in gross output $(1-\beta_j)$ is always equal to zero. Consequently, the total requirements matrix (Ω_t^{-1}) becomes an identity matrix and the employment shares are equal to final demand shares ($\mathbf{X}_t$). Therefore, the value added model would have predicted no changes in employment shares in the first sub-section when final demand shares were held constant over time.

indexes by industry for the gross output model, and the elasticity of substitution is set to 0.5 as in Berlingieri (2014).[32]

i. Baseline Results for the 1987-2008 Period

Table 18 presents the key results of this exercise for the value added and gross output models for Canada for the shorter 1987-2008 period. In contrast to the results of the first sub-section in which the gross output model reacted only to changes in the I-O structure, the model is now driven by both changes in the I-O structure *and* differences in the growth rates of prices across industries. Similar to Berlingieri (2014), this significantly improved the explanatory power of the model. In particular, the gross output model can explain 5.4 percentage points (or 97.9 per cent) of the decline in manufacturing over the 1987-2008 period when final demand shares are allowed to change, compared to 3.1 percentage points (or 56.0 per cent) when final demand shares are held constant.

Table 18: Predicted versus Actual Changes in the Manufacturing Employment Share, 1987-2008

Year	Actual Share	Gross Output Model				Value Added Model			
		Constant Xt		Changing Xt		Constant Xt		Changing Xt	
		Predicted Share	Ratio to Actual Share	Predicted Share	Ratio to Actual Share	Predicted Share	Ratio to Actual Share	Predicted Share	Ratio to Actual Share
	A	B	B/A*100	C	C/A*100	D	D/A*100	E	E/A*100
1987	17.67	17.67	100.0	17.67	100.0	17.67	100.0	17.67	100.0
2008	12.13	14.57	120.1	12.25	101.0	17.67	145.7	11.93	98.4
Δ87-08	-5.55	-3.11	56.0	-5.43	97.9	0.00	0.0	-5.74	103.6

Note: The actual and predicted changes in the employment share are expressed as percentage points of total employment. The predicted changes are the results of both the gross output model and the value added model.
Source: CSLS calculations based on Statistics Canada data.

The results of this exercise for twenty-two industries for the gross output model and the value added model for the 1987-2008 period are shown in Table 19 and Table 20, respectively.

Comparing Table 19 and Table 20, the gross output model appears to explain more of the observed changes in employment shares than the value added model for the 1987-2008 period. Specifically, the predicted changes according to the gross output model are closer to actual changes for fourteen of twenty-two industries. This suggests that changes in the I-O structure of the economy are an important determinant of changes in employment shares.

While permitting final uses shares to evolve over time improved the explanatory power of the gross output model for manufacturing, this was not the case for all industries (Table 19).

[32] It is important to note that the predictions of these models are affected by the value of the elasticity of substitution as well as the choice of price indexes.

For instance, predicted changes in employment shares were further from the actual changes for sixteen of twenty-two industries after allowing for changes in final demand shares. However, in addition to manufacturing, allowing final uses shares to evolve over time improved the accuracy of the model for PBS, finance, insurance, real estate and rental and leasing, crop and animal production (IOIC code 1A), health care and social assistance (IOIC code 62), and arts, entertainment and recreation (IOIC code 71).

Given that the framework used to model changes in final demand shares is driven by differential prices growth rates, the results of this exercise are greatly affected by dramatic price changes in certain industries. Most importantly, the gross output model predicts an 8.4 percentage-point rise in the employment share of mining and oil and gas extraction when final demand shares are allowed to change compared to the 3.8 percentage-point increase when final demand shares are held constant and the observed change of 0.1 percentage point. The results were also markedly different for support activities for agriculture and forestry (IOIC code 1D). Since these two industries experienced significantly above-average price growth between 1987 and 2008, the gross output model predicted exceedingly large increases in their final demand shares, which in turn drove massive increases in their predicted employment shares.

Largely due to the fact that final demand channels amplify the effect of relative price changes on employment shares, the significant increase in the relative price of gross output in mining and oil and gas extraction (which in turn led to an even greater increase in its employment share) resulted in a predicted decline in the employment share of the service sector from 69.1 per cent in 1987 to 67.1 per cent in 2008 compared to the predicted 1.0 percentage-point increase when final uses shares are fixed. In reality, the service sector experienced a 6.2 percentage-point increase in its share of total employment over this period.

Next, we will repeat the analysis presented in the first sub-section for the longer 1976-2008, allowing for changes in final demand shares over time.

Table 19: Predicted versus Actual Changes in Employment Shares by Industry, Baseline Case, Gross Output Model, 1987-2008

IOIC Codes	Actual			Predicted			Ratio		
	1987	2008	Δ87-08	1987	2008	Δ87-08	1987	2008	Δ87-08
	A	B	C=B-A	D	E	F=D-E	D/A*100	E/B*100	F/C*100
Primary	5.93	4.03	-1.90	5.93	13.45	7.52	100.0	333.8	-396.3
Crop and animal production [1A]	3.38	1.82	-1.56	3.38	2.25	-1.13	100.0	123.5	72.6
Forestry and logging [1B]	0.46	0.21	-0.25	0.46	0.35	-0.11	100.0	166.3	44.0
Fishing, hunting and trapping [1C]	0.30	0.13	-0.16	0.30	-0.55	-0.84	100.0	-409.2	517.7
Support activities for agriculture and forestry [1D]	0.20	0.20	0.01	0.20	1.40	1.21	100.0	685.4	13,662.3
Mining and oil and gas extraction [21]	1.60	1.66	0.06	1.60	10.00	8.40	100.0	602.4	13,349.0
Secondary	24.96	20.67	-4.29	24.96	19.40	-5.56	100.0	93.9	129.6
Utilities [22]	0.99	0.94	-0.06	0.99	1.65	0.65	100.0	175.9	-1125.9
Construction [23]	6.29	7.61	1.31	6.29	5.51	-0.78	100.0	72.4	-59.5
Manufacturing [3A]	17.67	12.13	-5.55	17.67	12.25	-5.43	100.0	101.0	97.9
Tertiary	69.11	75.30	6.19	69.11	67.14	-1.97	100.0	89.2	-31.8
Wholesale trade [41]	3.61	3.91	0.29	3.61	2.54	-1.07	100.0	65.1	-368.7
Retail trade [4A]	13.55	12.68	-0.86	13.55	9.56	-3.99	100.0	75.3	462.5
Transportation and warehousing [4B]	5.49	5.25	-0.24	5.49	4.34	-1.15	100.0	82.8	468.4
Information and cultural industries [51]	2.88	2.44	-0.44	2.88	1.83	-1.06	100.0	74.8	240.2
Finance, insurance, real estate and rental and leasing [5A]	6.66	6.68	0.02	6.66	8.42	1.76	100.0	126.1	8,803.4
Professional and business services (PBS)	6.57	11.54	4.96	6.57	9.72	3.14	100.0	84.2	63.3
Professional, scientific and technical services [54]	4.24	7.35	3.11	4.24	5.85	1.60	100.0	79.5	51.6
Administrative and support, waste management and remediation services [56]	2.33	4.19	1.85	2.33	3.87	1.54	100.0	92.5	83.1
Educational services [61]	0.37	0.67	0.30	0.37	0.94	0.57	100.0	140.4	189.9
Health care and social assistance [62]	3.36	4.88	1.53	3.36	4.40	1.05	100.0	90.2	68.7
Arts, entertainment and recreation [71]	1.54	2.24	0.70	1.54	2.56	1.02	100.0	114.0	144.9
Accommodation and food services [72]	6.21	6.68	0.47	6.21	5.22	-0.99	100.0	78.2	-209.7
Other services (except public administration) [81]	4.79	4.20	-0.59	4.79	4.45	-0.34	100.0	106.0	57.5
Non-profit institutions serving households [NP]	2.65	3.14	0.49	2.65	3.82	1.16	100.0	121.6	239.8
Government sector [GS]	11.42	10.99	-0.43	11.42	9.34	-2.08	100.0	85.0	484.1

Source: CSLS calculations based on Statistics Canada data.

Table 20: Predicted versus Actual Changes in the Employment Shares by Industry, Value Added Model, 1987-2008

IOIC Codes	Actual			Predicted			Ratio		
	1987	2008	Δ87-08	1987	2008	Δ87-08	1987	2008	Δ87-08
	A	B	C=B-A	D	E	F=D-E	D/A*100	E/B*100	F/C*100
Primary	5.93	4.03	-1.90	5.93	12.75	6.82	100.0	316.3	-359.0
Crop and animal production [1A]	3.38	1.82	-1.56	3.38	1.76	-1.61	100.0	96.9	103.7
Forestry and logging [1B]	0.46	0.21	-0.25	0.46	0.40	-0.06	100.0	191.6	22.6
Fishing, hunting and trapping [1C]	0.30	0.13	-0.16	0.30	-1.03	-1.33	100.0	-773.2	816.4
Support activities for agriculture and forestry [1D]	0.20	0.20	0.01	0.20	3.77	3.58	100.0	1,844.7	40,518.2
Mining and oil and gas extraction [21]	1.60	1.66	0.06	1.60	7.84	6.24	100.0	472.2	9,914.6
Secondary	24.96	20.67	-4.29	24.96	20.86	-4.10	100.0	100.9	95.6
Utilities [22]	0.99	0.94	-0.06	0.99	2.09	1.10	100.0	2,23.5	-1,894.9
Construction [23]	6.29	7.61	1.31	6.29	6.84	0.55	100.0	89.9	41.5
Manufacturing [3A]	17.67	12.13	-5.55	17.67	11.93	-5.74	100.0	98.4	103.6
Tertiary	69.11	75.30	6.19	69.11	66.39	-2.72	100.0	88.2	-43.9
Wholesale trade [41]	3.61	3.91	0.29	3.61	1.99	-1.62	100.0	50.9	-558.8
Retail trade [4A]	13.55	12.68	-0.86	13.55	9.07	-4.47	100.0	71.5	518.3
Transportation and warehousing [4B]	5.49	5.25	-0.24	5.49	4.16	-1.33	100.0	79.2	545.5
Information and cultural industries [51]	2.88	2.44	-0.44	2.88	1.22	-1.66	100.0	50.0	377.8
Finance, insurance, real estate and rental and leasing [5A]	6.66	6.68	0.02	6.66	5.73	-0.92	100.0	85.9	-4,619.1
Professional and business services (PBS)	6.57	11.54	4.96	6.57	9.15	2.58	100.0	79.3	52.0
Professional, scientific and technical services [54]	4.24	7.35	3.11	4.24	5.05	0.81	100.0	68.8	26.2
Administrative and support, waste management and remediation services [56]	2.33	4.19	1.85	2.33	4.10	1.77	100.0	98.0	95.5
Educational services [61]	0.37	0.67	0.30	0.37	1.19	0.82	100.0	178.1	273.6
Health care and social assistance [62]	3.36	4.88	1.53	3.36	5.19	1.84	100.0	106.3	120.3
Arts, entertainment and recreation [71]	1.54	2.24	0.70	1.54	4.60	3.05	100.0	204.9	435.9
Accommodation and food services [72]	6.21	6.68	0.47	6.21	6.24	0.03	100.0	93.4	6.6
Other services (except public administration) [81]	4.79	4.20	-0.59	4.79	5.39	0.60	100.0	128.2	-101.1
Non-profit institutions serving households [NP]	2.65	3.14	0.49	2.65	3.27	0.61	100.0	104.1	126.2
Government sector [GS]	11.42	10.99	-0.43	11.42	9.19	-2.24	100.0	83.6	520.9

Source: CSLS calculations based on Statistics Canada data.

ii. Baseline Results for the 1976-2008 Period

Table 21 presents the key results of this exercise for the value added and gross output models for Canada for the 1976-2008 period. In contrast to what was shown for the 1987-2008 period, the explanatory power of the gross output model was only marginally improved for the 1976-2008 period after allowing for changes in final uses expenditure shares. In particular, the gross output model accounts for 79.3 per cent of the observed decline in manufacturing over the 1976-2008 period when final uses shares evolve over time, compared to 76.3 per cent when final uses shares are fixed at their 1976 level.

Table 21: Predicted versus Actual Changes in the Manufacturing Employment Share, 1976-2008

Year	Actual Share	Gross Output Model				Value Added Model			
		Constant Xt		Changing Xt		Constant Xt		Changing Xt	
		Predicted Share	Ratio to Actual Share	Predicted Share	Ratio to Actual Share	Predicted Share	Ratio to Actual Share	Predicted Share	Ratio to Actual Share
	A	B	B/A*100	C	C/A*100	D	D/A*100	E	E/A*100
1976	20.44	20.44	100.0	20.44	100.0	20.44	100.0	20.44	100.0
2008	12.14	14.11	116.2	13.86	114.2	20.44	168.4	16.40	135.1
Δ76-08	-8.30	-6.33	76.3	-6.58	79.3	0.00	0.0	-4.05	48.7

Note: The actual and predicted changes in the employment share are expressed as percentage points of total employment. The predicted changes are the results of both the gross output model and the value added model.
Source: CSLS calculations based on Statistics Canada data.

Table 22 and Table 23 present the results of this exercise for eleven industries for the longer 1976-2008 period for the gross output model and the value added model, respectively.

Generally speaking, the results of the gross output model are significantly better than those of the value added model, as the predicted changes according to the gross output model are closer to actual changes for eight of eleven industries. With respect to manufacturing, the value added model accounts for only 48.7 per cent of the observed decline in manufacturing compared to 79.3 per cent for the gross output model. The relative performance of these models indicates that, by accounting for changes in the composition of intermediates inputs, the predictive power is strengthened.

Unlike manufacturing, allowing for changes in final demand shares worsened the predictive power of the gross output model for seven of eleven industries. However, in addition to manufacturing, allowing final uses shares to evolve over time improved the accuracy of the model for transportation and warehousing (IOIC code 4B), professional, scientific and technical service, and accommodation and food services (IOIC code 72).

The results of this exercise are quite different from those in Berlingieri (2014). In particular, prices increased more in the primary sector than in either the secondary or service

sector in Canada between 1976 and 2008, largely owing to significant price increases in mining and oil and gas extraction (and, in particular, oil and gas extraction) after 2000.[33] As a result, the predicted increase in the employment share of primary industries was heighted after permitting changes in final demand shares, while the predicted change in the employment share of the service sector was lowered.[34] More specifically, the gross output model predicted changes of 2.4, -7.3 and 5.0 percentage points (respectively) for the primary, secondary and tertiary sectors when final uses shares were fixed, while it predicted changes of 3.8, -6.6 and 2.8 percentage points (respectively) when final uses shares were allowed to evolve over time.

Regardless of whether final demand shares are held constant over time, the predicted changes in the employment share of the primary sector were well above the actual *decrease* of 3.8 percentage points between 1976 and 2008, while the predicted changes in the employment shares of the secondary and tertiary sectors were well below the observed changes (-8.4 percentage points and 12.2 percentage points, respectively).

In contrast, Berlingieri (2014) found that prices increased more in services than in manufacturing or agriculture, leading to a reallocation of final demand shares from manufacturing and agriculture toward services and, in turn, to an increase in the employment share of services at the expense of agriculture and manufacturing.

[33] It is important to remember that Berlingieri's (2014) analysis only covered the 1948-2002, and therefore was not affected by the increase in crude oil prices from 2002 to 2008. Furthermore, Berlingieri categorized mining within the manufacturing sector, not within the agricultural sector.

[34] The predicted decrease in the employment share of the secondary sector is somewhat smaller when allowing for changes in final demand shares, as price growth in this sector was higher than in the service sector. However, this was not the case for manufacturing, a component of the secondary sector.

Table 22: Predicted versus Actual Changes in the Employment Shares by Industry, Baseline Case, Gross Output Model, 1976-2008

IOIC Codes	Actual			Predicted			Ratio		
	1976	2008	Δ76-08	1976	2008	Δ76-08	1976	2008	Δ76-08
	A	B	C=B-A	D	E	F=D-E	D/A*100	E/B*100	F/C*100
Primary industries [1A, 1B, 1C, 1D, 21]	7.90	4.13	-3.76	7.90	11.72	3.83	100.0	283.6	-101.8
Secondary industries	29.14	20.70	-8.44	29.14	22.54	-6.60	100.0	108.9	78.2
Utilities [22]	1.21	0.94	-0.27	1.21	2.63	1.42	100.0	280.6	-529.8
Construction [23]	7.49	7.62	0.13	7.49	6.05	-1.44	100.0	79.4	-1,116.8
Manufacturing [3A]	20.44	12.14	-8.30	20.44	13.86	-6.58	100.0	114.1	79.3
Tertiary industries	62.97	75.17	12.20	62.97	65.73	2.77	100.0	87.5	22.7
Trade [41, 4A]	17.26	16.61	-0.65	17.26	14.83	-2.43	100.0	89.3	373.0
Transportation and warehousing [4B]	6.19	5.25	-0.93	6.19	5.14	-1.05	100.0	97.8	112.4
Information, culture and recreation [51, 71]	3.81	4.69	0.88	3.81	3.66	-0.15	100.0	78.1	-16.5
Financial, business, building and other support services [5A, 56]	7.55	10.88	3.33	7.55	13.64	6.09	100.0	125.3	182.8
Professional, scientific and technical services [54]	2.78	7.36	4.58	2.78	5.60	2.82	100.0	76.1	61.6
Accommodation and food services [72]	4.54	6.69	2.15	4.54	3.74	-0.80	100.0	55.9	-37.3
Other tertiary industries [61, 62, 81, NP, GS]	20.84	23.68	2.84	20.84	19.13	-1.72	100.0	80.8	-60.4

Source: CSLS calculations based on Statistics Canada data.

Table 23: Predicted versus Actual Changes in the Employment Shares by Industry, Value Added Model, 1976-2008

IOIC Codes	Actual			Predicted			Ratio		
	1976	2008	Δ76-08	1976	2008	Δ76-08	1976	2008	Δ76-08
	A	B	C=B-A	D	E	F=D-E	D/A*100	E/B*100	F/C*100
Primary industries [1A, 1B, 1C, 1D, 21]	7.90	4.13	-3.76	7.90	12.47	4.57	100.0	301.6	-121.6
Secondary industries	29.14	20.70	-8.44	29.14	30.01	0.87	100.0	145.0	-10.3
Utilities [22]	1.21	0.94	-0.27	1.21	5.42	4.22	100.0	578.4	-1,568.2
Construction [23]	7.49	7.62	0.13	7.49	8.19	0.70	100.0	107.5	541.1
Manufacturing [3A]	20.44	12.14	-8.30	20.44	16.40	-4.05	100.0	135.0	48.8
Tertiary industries	62.97	75.17	12.20	62.97	57.53	-5.44	100.0	76.5	-44.6
Trade [41, 4A]	17.26	16.61	-0.65	17.26	12.43	-4.83	100.0	74.8	741.6
Transportation and warehousing [4B]	6.19	5.25	-0.93	6.19	4.00	-2.18	100.0	76.2	233.7
Information, culture and recreation [51, 71]	3.81	4.69	0.88	3.81	0.99	-2.82	100.0	21.1	-318.7
Financial, business, building and other support services [5A, 56]	7.55	10.88	3.33	7.55	7.97	0.42	100.0	73.3	12.6
Professional, scientific and technical services [54]	2.78	7.36	4.58	2.78	4.51	1.74	100.0	61.3	37.9
Accommodation and food services [72]	4.54	6.69	2.15	4.54	6.91	2.37	100.0	103.3	110.3
Other tertiary industries [61, 62, 81, NP, GS]	20.84	23.68	2.84	20.84	20.71	-0.14	100.0	87.4	-4.8

Source: CSLS calculations based on Statistics Canada data.

iii. Simulation Results for the 1987-2008 Period

As in Berlingieri (2014), we will now repeat the simulations performed in the second sub-section, allowing final demand shares to evolve over time. Generally speaking, the results of these simulations indicate that the contribution of outsourcing to the decline in manufacturing's employment share is somewhat lower compared to the case when final uses shares are fixed over time; however, outsourcing still appears to account for a small part of the change manufacturing's employment share in Canada.

Parallel to Table 15, the key results of the simulations performed for the longer 1987-2008 period are summarized in Table 24. According to the results of the first exercise, when final demand shares are allowed to change over time, outsourcing from manufacturing to other industries is able to explain up to 7.6 per cent of the observed decline in the manufacturing employment share from 1987 to 2008. In contrast, when final uses shares are held constant, it could explain up to 10.5 per cent of the decline in manufacturing's employment share. Similarly, the contributions of PBS outsourcing (exercise 2) and FS outsourcing (exercise 3) to the decline in manufacturing's employment share are slightly lower when final demand shares are allowed to change, at 1.4 per cent and 0.04 per cent, respectively.

The results of the fourth exercise, in which the I-O coefficients for mining and oil and gas extraction intermediates in manufacturing are fixed, are significantly lower than in Table 15, which may explain why the results of the first exercise are so much lower when final demand shares are allowed to change over time. In particular, when final demand shares change over time, changes in demand for mining and oil and gas extraction intermediates in manufacturing accounted for 5.8 per cent of the decline in manufacturing. However, when final uses shares are held constant, they account for 8.5 per cent of the decline in manufacturing's employment share.

Table 24: Effect of Simulations on the Predicted Manufacturing Employment Share, 1987-2008

Counterfactual Exercise	Predicted Change (Percentage Points)	Difference with Baseline (Percentage Points)	Share of Predicted Change (Per Cent)	Share of Actual Change (Per Cent)
	A_i	$B_i = -5.43 - A_i$	$B_i / -5.43 * 100$	$B_i / -5.55 * 100$
Baseline Case	-5.43	..	...	...
1: All Coefficients	-5.01	-0.42	7.78	7.62
2: PBS Coefficient	-5.35	-0.08	1.44	1.41
3: FS Coefficient	-5.43	0.00	0.04	0.04
4: Mining Coefficient	-5.11	-0.32	5.89	5.76

Note: The predicted change and the difference with respect to the baseline case are expressed in percentage points of total employment. The ratio to data is the prediction of the simulation expressed as percentage share of the actual change in the data.
Source: CSLS calculations based on Statistics Canada data.

iv. Simulation Results for the 1976-2008 Period

Similar to Table 16, the main results of the exercises performed for the longer 1976-2008 period are presented in Table 25. Unlike the 1987-2008 period, the results of the first exercise are quite similar regardless of whether we permit changes in final demand shares over time: the contribution of changes in the manufacturing sector's demand for intermediates accounts for 21.1 per cent of the decline in manufacturing according to Table 16, while it accounts for 20.6 per cent of the decline in manufacturing according to Table 25. This is also true for the results of the third exercise, in which the demand for intermediates purchased from primary industries in manufacturing is fixed. However, the contribution of PBS and FS outsourcing (exercise 2) to the decline in the share of manufacturing in total employment is significantly lower when final demand shares change over time (0.6 per cent versus 3.5 per cent).

Table 25: Effect of Simulations on the Predicted Manufacturing Employment Share, 1976-2008

Counterfactual Exercise	Predicted Change (Percentage Points)	Difference with Baseline (Percentage Points)	Share of Predicted Change (Per Cent)	Share of Actual Change (Per Cent)
	A_i	B_i = -6.58 - A_i	B_i / -6.58 * 100	B_i / -8.30 * 100
Baseline Case	-6.58	..	...	...
1: All Coefficients	-4.87	-1.71	25.95	20.58
2: PBS/FS Coefficient	-6.53	-0.05	0.77	0.61
3: Primary Coefficient	-6.32	-0.26	3.94	3.13

Note: The predicted change and the difference with respect to the baseline case are expressed in percentage points of total employment. The ratio to data is the prediction of the simulation expressed as percentage share of the actual change in the data.
Source: CSLS calculations based on Statistics Canada data.

D. The Role of Outsourcing: Evidence from Occupational Data

This sub-section uses aggregate industry-by-occupation employment data to provide further evidence regarding the role of outsourcing in the reallocation of employment across industries. In particular, we will present descriptive statistics and perform a decomposition of the growth in the proportion of selected industries in total employment.

i. Descriptive Statistics

The share of PBS occupations[35] in total employment increased steadily over the 1987-2014 period from 39.9 per cent in 1987 to 43.4 per cent in 2014 (Chart 7).[36] This suggests that

[35] Box 2 discusses the definitions of PBS, FS and manufacturing occupations used in this report. It is important to note that occupations may be classified in more than one of the three occupational groupings. As a result, there is some overlap in terms of the occupations included in the occupational groupings. The list of occupations included in the PBS, FS and manufacturing occupational groupings are listed in Table 26, Table 27 and Table 28, respectively.
[36] In contrast, Berlingieri (2014) found that the share of workers in PBS occupations increased slightly from 24.2 per cent to 28.2 per cent in 2010, with the entire increase concentrated from 1950 to 1970. However, it is important to note that the definition of PBS occupations used in this report differs from Berlingieri (2014).

the relative importance of PBS has increased in the Canadian economy, although it is unclear whether this increased importance is related to increased production of PBS in only the PBS industry (NAICS codes 54-56) (which indicates an increase in PBS outsourcing) or increased production of PBS in all industries (which indicates increased in-house production of PBS and thus increased final demand for PBS).[37] This issue is addressed later in this sub-section.

Box 2: What are PBS, FS and Manufacturing Occupations?

Similar to Berlingieri (2014), we select PBS occupations according to the share of workers within each occupation that are employed in the PBS industry (NAICS codes 54-56).[1] According to his baseline definition, PBS occupations are defined as occupations with 9 per cent or more of their workers employed in the PBS industry. In this report, PBS occupations are defined as occupations for which the share of workers located in the PBS industry was larger than the PBS industry's share of total employment in 1987. Given that the PBS industry accounted for 6.1 per cent of total employment in 1987, PBS occupations are defined as occupations with more than 6.1 per cent of their workers in the PBS industry. The occupations included in the PBS occupational grouping are listed in Table 26.

Financial services (FS) occupations are defined as occupations for which the share of workers located in finance, insurance, real estate and leasing (NAICS codes 52-53) was larger than finance, insurance, real estate and leasing's share of total employment in 1987. Given that finance, insurance, real estate and leasing accounted for 6.2 per cent of total employment in 1987, FS occupations are defined as occupations with more than 6.2 per cent of their workers in finance, insurance, real estate and leasing. FS occupations are listed in Table 27.

Manufacturing occupations are defined as occupations for which the share of workers located in manufacturing (NAICS codes 31-33) was larger than manufacturing's share of total employment in 1987. Given that manufacturing accounted for 16.7 per cent of total employment in 1987, financial services occupations are defined as occupations with more than 16.7 per cent of their workers in manufacturing. Manufacturing occupations are listed in Table 28.

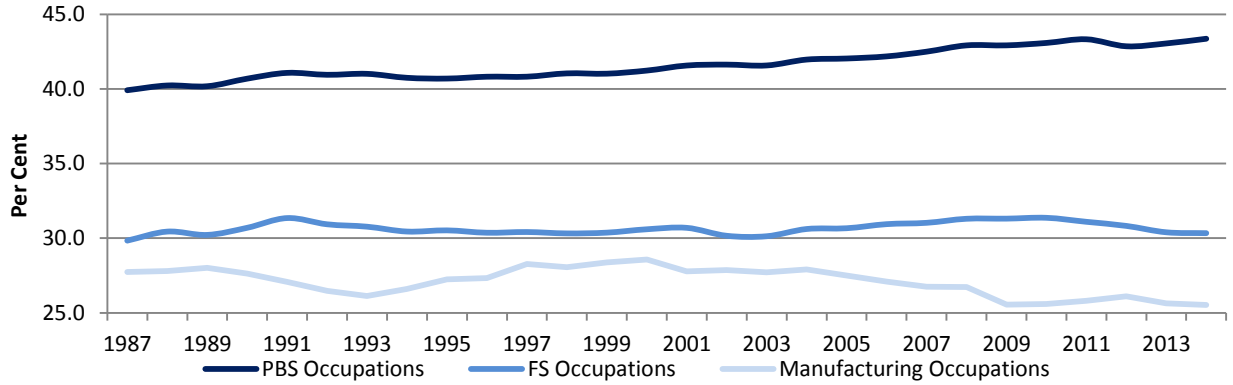
[1] In contrast to previous sections of this report, management of companies and enterprises (NAICS code 55) is now categorized within the PBS industry rather than finance, insurance, real estate and leasing.

Unlike PBS occupations, the share of financial services (FS) occupations in total employment was stable at about 30 per cent, while the share of manufacturing occupations in total employment fell from 27.7 per cent in 1987 to 25.5 per cent in 2014 (Chart 7). This indicates that the relative importance of FS in the Canadian economy has remained stable, while

[37] In contrast to previous sections of this report, management of companies and enterprises (NAICS code 55) is now categorized within the PBS industry rather than finance, insurance, real estate and leasing.

the relative importance of manufacturing has decreased. Generally speaking, trends in the shares of workers in FS and manufacturing occupations evolved in line with trends in the shares of finance, insurance, real estate and leasing (NAICS codes 52-53) and manufacturing (NAICS codes 31-33) in total employment, respectively. For example, both the manufacturing sector's share of total employment and the share of workers in manufacturing occupations fell from 1987 to 1993, recovered from 1993 to 2000, and declined again from 2000 to 2014.

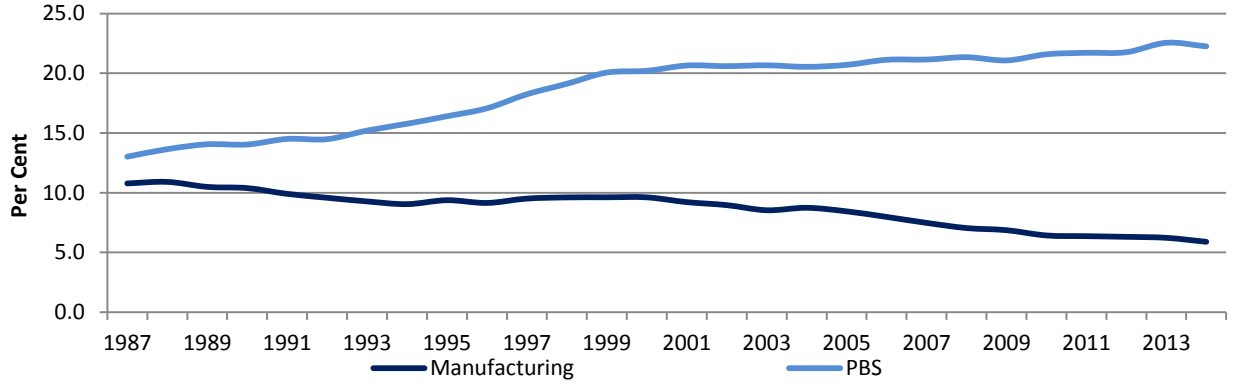
Chart 7: Shares of PBS, FS and Manufacturing Occupations in Total Employment, Per Cent, 1987-2014



Source: CSLS calculations based on Statistics Canada data. Labour Force Survey. Special order.

The PBS industry's share of PBS workers (that is, workers in PBS occupations) increased from 13.0 per cent in 1987 to 22.3 per cent in 2014, while the manufacturing sector's share fell from 10.8 per cent to 5.9 per cent over this period (Chart 8). Trends in the shares of PBS workers evolved in line with trends in the shares of the PBS industry and manufacturing in total employment, suggesting that changes in the former were driven by changes in the latter. This is consistent with Chart 9, which shows that the relative importance of PBS workers was relatively stable in both the PBS industry and manufacturing over the 1987-2014 period. Between 1987 and 2014, PBS workers accounted for roughly 83 per cent of total employment in the PBS industry and for roughly 26 per cent of total employment in the manufacturing sector.

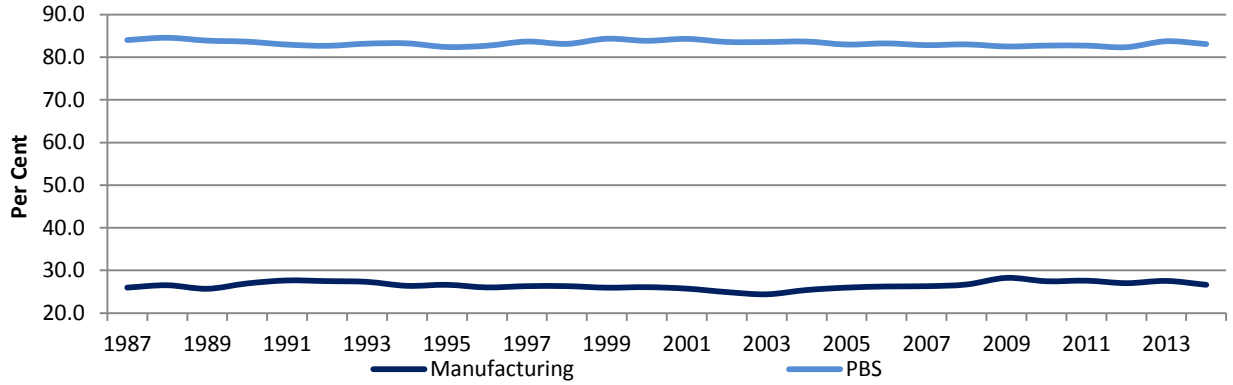
Chart 8: Shares of Total Employment in PBS Occupations by Industry, Manufacturing and the PBS Industry, Per Cent, 1987-2014



Source: CSLS calculations based on Statistics Canada data. Labour Force Survey. Special order.

If an increase in PBS outsourcing drove the decline in manufacturing employment, then we would expect the share of PBS occupations in total employment in manufacturing to fall over time.[38] However, according to Chart 9, PBS occupations accounted for roughly 26 per cent of total employment in the manufacturing sector over the entire 1987-2014 period. Nevertheless, it is important to note we would only expect this share to decline if the increase in PBS outsourcing was predominately in the form of the substitution of intermediates purchased from the PBS industry for intermediates produced in-house. If the increase in PBS outsourcing took the form of an increase in the purchase of *new* intermediates from the market, then we would not expect the share of PBS occupations in total employment in manufacturing to decline over time.

Chart 9: Shares of PBS Occupations in Total Employment for Manufacturing and the PBS Industry, Per Cent, 1987-2014



Source: CSLS calculations based on Statistics Canada data. Labour Force Survey. Special order.

ii. Decompositions

Berlingieri (2014) decomposes the change in the employment share of the PBS industry into the part of the increase that is due to workers within each occupation moving to the PBS industry (the **within-occupation component**), the part of the increase that is due to changes in the share of each occupation in total employment (the **between-occupation component**), and an interaction term (the **cross-occupation component**). He shows that most of the increase in the share of the PBS industry in total employment in the United States was due to the within-occupation component, while the between-occupation component did not account for much of the increase. This suggests that the rise of the PBS industry was largely related to outsourcing rather than increased in-house production of PBS.

In this sub-section, we conduct the aforementioned decomposition for Canada for the 1987-2014 period. Unlike Berlingieri (2014), the decomposition will be performed for three industries: the PBS industry, finance, insurance, real estate and leasing, and manufacturing.

[38] Appendix Table 3 provides a detailed occupational breakdown of manufacturing employment in Canada; it presents employment levels and employment shares in manufacturing by NOC-S occupations for 1987 and 2014.

Table 26 presents the key results of the decomposition performed for the PBS industry. Similar to Berlingieri (2014), most of the increase in the share of the PBS industry in total employment between 1987 and 2014 was due to the within-occupation component, while the between-occupation component contributed little to this increase. In particular, of the total increase in the PBS industry's share of total employment (5.5 percentage points), 4.1 percentages points (or 73.6 per cent) were due to the within-occupation component and 1.1 percentage points (or 20.4 per cent) were due to the between-occupation component.

The relative importance of the within-occupation component indicates that the rise of the employment share of the PBS industry was primarily driven by a reallocation of workers within occupations toward the PBS industry as opposed to a reallocation of workers toward PBS occupations. Therefore, the increase in the employment share of the PBS industry appears to have been more closely linked to outsourcing rather than increased in-house production of PBS. Nonetheless, the latter channel appears to have been important, as the between-occupation component accounted for one-fifth of the increase in the employment share of the PBS industry.

Table 26: Decomposition of Growth in the Employment Share of the PBS Industry, 1987-2014

NOC-S Occupation	Within	Between	Cross	Total
PBS Occupations	2.93	1.09	0.46	4.46
Senior Management Occupations	0.04	-0.02	-0.02	0.00
Specialist Managers	0.29	0.00	0.00	0.29
Professional Occupations in Business and Finance	0.09	0.35	0.05	0.50
Finance and Insurance Administrative Occupations	0.13	0.00	0.00	0.14
Secretaries	0.08	-0.47	-0.06	-0.46
Administrative and Regulatory Occupations	0.07	0.09	0.04	0.20
Clerical Occupations	0.56	-0.12	-0.10	0.34
Professional Occupations in Natural and Applied Sciences	0.57	0.51	0.45	1.54
Technical Occupations Related to Natural and Applied Sciences	0.31	0.12	0.09	0.51
Judges, Lawyers, Psychologists, Social Workers, Ministers of Religion, and Policy and Program Officers	-0.02	0.32	-0.02	0.28
Technical Occupations in Art, Culture, Recreation and Sport	0.06	0.14	0.03	0.23
Sales and Service Supervisors	-0.01	0.11	-0.02	0.08
Occupations in Protective Services	0.17	-0.02	-0.01	0.14
Occupations in Travel and Accommodation Including Attendants in Recreation and Sport	-0.04	0.04	-0.01	-0.01
Sales & Service Occupations N.E.C.	0.50	0.02	0.02	0.55
Primary Production Labourers	0.14	0.00	0.01	0.15
Non-PBS Occupations	1.14	0.04	-0.12	1.07
Total	4.07	1.13	0.34	**5.53**

Note: All figures are expressed in terms of percentage points of total employment. The grand total is the increase in the PBS industry's share of total employment from 1987 to 2014. The PBS occupations are listed.
Source: CSLS calculations based on Statistics Canada data. Labour Force Survey. Special order.

Table 27 presents the key results of the decomposition performed for finance, insurance, real estate and leasing. Between 1987 and 2014, the employment share of finance, insurance, real estate and leasing fell by 0.13 percentage point. While the between-occupation component positively contributed 0.40 percentage point to the change in the employment share of finance, insurance, real estate and leasing, the negative contribution of the within-occupation component (-0.65 percentage point) completely offset the between-occupation component, leading to a decrease in the employment share. Therefore, there is no evidence of a link between the decline in manufacturing and outsourcing to finance, insurance, real estate and leasing, as the within-occupation component (which is associated with outsourcing) was negative.

Table 27: Decomposition of Growth in the Employment Share of Finance, Insurance, Real Estate and Leasing, 1987-2014

NOC-S Occupation	Within	Between	Cross	Total
FS Occupations	-0.67	0.28	0.21	-0.17
Senior Management Occupations	0.02	-0.03	-0.01	-0.02
Specialist Managers	0.03	0.00	0.00	0.03
Other Managers N.E.C.	-0.12	0.07	-0.02	-0.07
Professional Occupations in Business and Finance	0.18	0.29	0.11	0.57
Finance and Insurance Administrative Occupations	0.15	0.01	0.00	0.17
Secretaries	-0.25	-0.35	0.19	-0.41
Administrative and Regulatory Occupations	-0.14	0.21	-0.08	-0.01
Clerical Supervisors	-0.02	0.09	-0.01	0.06
Clerical Occupations	-0.34	-0.31	0.06	-0.59
Professional Occupations in Natural and Applied Sciences	0.00	0.12	0.00	0.12
Wholesale, Technical, Insurance, Real Estate Sales Specialists, and Retail, Wholesale and Grain Buyers	-0.19	0.18	-0.04	-0.04
Non-FS Occupations	0.02	0.12	-0.09	0.04
Total	-0.65	0.40	0.12	**-0.13**

Note: All figures are expressed in terms of percentage points of total employment. The grand total is the increase in the PBS industry's share of total employment from 1987 to 2014. The FS occupations are listed.
Source: CSLS calculations based on Statistics Canada data. Labour Force Survey. Special order.

Table 28 presents the key results of the decomposition performed for manufacturing. The within- and between-occupation components both contributed a great deal to the decline in manufacturing's employment share between 1987 and 2014; however, the contribution of the within-occupation component was somewhat larger. Of the total decrease in manufacturing's employment share (7.0 percentage points), 4.1 percentages points (or 57.9 per cent) were due to the within-occupation component and 3.1 percentage points (or 43.4 per cent) were due to the between-occupation component.

The importance of the within-occupation component suggests that outsourcing accounts for a significant part of the decline in manufacturing's employment share. However, the between-occupation component was also very important, indicating that the decline in

manufacturing over the 1987-2014 period was also related to a decline in the relative importance of manufacturing occupations and activities.

Furthermore, PBS occupations contributed -2.0 percentage points (or 49.8 per cent) to the within-occupation component and only 0.3 percentage point (or -11.2 per cent) to the between-occupation component. Therefore, it appears that the reallocation of PBS workers from manufacturing to the other industries accounted for 28.8 per cent of the decline in the manufacturing sector's share of total employment, while the increase in the share of PBS occupations offset the decline in manufacturing by 4.9 per cent.

Table 28: Decomposition of Growth in the Employment Share of Manufacturing, 1987-2014

NOC-S Occupation	Within	Between	Cross	Total
Manufacturing Occupations	-2.08	-2.93	-0.06	-5.07
Senior Management Occupations	-0.08	-0.06	0.04	-0.10
Specialist Managers	-0.26	0.00	0.00	-0.26
Other Managers N.E.C.	-0.28	0.09	-0.04	-0.23
Professional Occupations in Natural and Applied Sciences	-0.24	0.40	-0.19	-0.03
Technical Occupations Related to Natural and Applied Sciences	-0.18	0.15	-0.05	-0.07
Stationary Engineers, Power Station Operators and Electrical Trades and Telecommunications Occupations	-0.12	-0.03	0.01	-0.14
Machinists, Metal Forming, Shaping and Erecting Occupations	-0.17	-0.26	0.05	-0.39
Mechanics	-0.25	-0.18	0.06	-0.37
Other Trades N.E.C.	-0.28	-0.13	0.08	-0.32
Heavy Equipment and Crane Operators Including Drillers	-0.08	-0.01	0.01	-0.09
Trades Helpers, Construction, and Transportation Labourers and Related Occupations	-0.22	-0.05	0.02	-0.25
Supervisors in Manufacturing	-0.03	0.02	0.00	-0.01
Machine Operators in Manufacturing	0.00	-1.64	0.00	-1.64
Assemblers in Manufacturing	0.09	-0.61	-0.03	-0.56
Labourers in Processing, Manufacturing and Utilities	0.03	-0.63	-0.01	-0.61
Non-manufacturing Occupations	-1.99	-0.12	0.15	-1.96
Total	-4.07	-3.05	0.09	**-7.03**

Note: All figures are expressed in terms of percentage points of total employment. The grand total is the increase in the PBS industry's share of total employment from 1987 to 2014. The manufacturing occupations are listed.
Source: CSLS calculations based on Statistics Canada data. Labour Force Survey. Special order.

It is important to note that the definition of PBS occupations in this report is quite broad, and therefore, the results of this exercise may overstate the effect on PBS outsourcing on manufacturing's employment share. For example, if PBS occupations are defined twice as strictly, then PBS occupations contributed -0.9 percentage points (or 22.9 per cent) to the within-

occupation component, suggesting that the reallocation of PBS workers from manufacturing to other industries accounted for only 13.2 per cent of the decline in manufacturing.[39]

Another problem is that the occupational categories used in this report are quite broad. If these broad occupational categories are composed of occupations that are more or less closely linked to certain industries, then the reallocation of workers between occupations within a given broad occupational category may have shown up as a reallocation of workers between industries for that broad occupational category. In other words, the results of the exercise may overestimate the within-occupation component and underestimate the between-occupation component. Therefore, the within-occupation component may have been less important if we used more detailed occupational data.

E. Summary of the Results

The main results of the analyses carried out in this section are briefly summarized below.

i. The Effect of Changes in the I-O Structure on Sectoral Allocation

First, we estimated the extent to which the change in manufacturing's employment share was driven by changes in the composition of intermediate inputs, holding final demand shares constant over time. To do this, we employed the gross output model created in Berlingieri (2014) in which employment shares are determined by changes in final demand shares and by changes in the I-O structure of the economy (which is embodied by I-O coefficients and shares of value added in gross output). This analysis was carried out for the 1976-2008 period and, at a much more disaggregated level, for the 1987-2008 period.

The gross output model predicted a 6.3 percentage-point decline in the manufacturing employment share from 20.4 per cent in 1987 to 14.1 per cent in 2008 (the **baseline case**), accounting for 76.3 per cent of the actual decline of 8.3 percentage points. In contrast, Berlingieri (2014) found that changes in the composition of intermediate inputs accounted for 25.3 per cent of the fall in the employment share of manufacturing over the 1948-2002 period.

Both the actual and predicted employment shares of manufacturing exhibited significant increases from 1993 to 1999 and large declines between 1999 and 2008. However, while actual employment share of manufacturing fell steadily from 20.4 per cent in 1976 to 14.9 per cent in 1993, the gross output model predicted a small and unsteady decrease of 1.3 percentage points.

[39] PBS occupations are now defined as occupational categories with more than 12.2 per cent of their workers in the PBS industry (or double the PBS industry's share of total employment) in 1987.

While the predicted and actual employment shares for manufacturing were correlated over the 1993-2008 period, this does not necessarily mean that the gross output model's predictions are useful. Indeed, the correlation between the model's predictions and observed changes may be spurious. Between 1999 and 2008, the predicted decline in the manufacturing employment share was largely driven by an increase in the I-O coefficient for mining and oil and gas extraction, reflecting an increase in the value of intermediates purchased from mining and oil and gas extraction.[40] This also led to an unrealistically large increase in the predicted employment share of mining and oil and gas extraction. However, the decline in manufacturing's employment share after 2000 was probably more closely linked to the slowdown in economic growth in the United States, the emergence of low-cost foreign competitors, and appreciation of the Canadian dollar linked to soaring crude oil prices and other factors.

Overall, the gross output model's predictions were unable to explain much (if any) of the actual change in employment shares for most industries. However, the model's predictions appear to be more accurate for the longer 1976-2008 period than for the shorter 1987-2008 period, which may be due to differences in the level of aggregation between these exercises.

ii. The Effect of Outsourcing on Sectoral Allocation

Second, we estimated the contribution of outsourcing to the change in manufacturing's employment share by running several simulations in which the demand for selected intermediates was held constant over time. As before, these exercises were conducted for both the 1987-2008 period and the 1976-2008 period.

The first exercise estimated the contribution of all types of outsourcing to the decline in manufacturing's employment share by fixing the demand for intermediate inputs in manufacturing over time. To do this, the coefficients in the direct requirements matrix for all intermediates in manufacturing are fixed at their 1976 level. The results of this exercise indicate that outsourcing accounted for 27.7 per cent of the predicted fall in manufacturing's employment and for 21.1 per cent of the actual decline in manufacturing's employment share. However, it is not clear whether the entire contribution can be interpreted as outsourcing. Berlingieri (2014) found that changes in the demand for intermediates in manufacturing accounted for 59.5 per cent of the baseline case and for 15.0 per cent of the actual decrease between 1948 and 2002.

The second exercise was identical to the first but for the fact that only the I-O coefficients for PBS and financial services (FS) intermediates in manufacturing were fixed over time. PBS and FS outsourcing could explain 4.5 per cent of the baseline prediction and 3.5 per cent of the actual decline in manufacturing's employment share for the 1976-2008 period.

[40] The increase in the value of intermediates purchased by manufacturing from mining and oil and gas extraction was largely associated with an increase in the volume and price of mineral fuels refined in Canada.

For the 1987-2008 period, we were able to look at the effect of PBS outsourcing and FS outsourcing separately. The simulation for PBS outsourcing suggested that PBS outsourcing could explain 3.5 per cent of the baseline prediction and 2.1 per cent of the actual change from 1987 to 2008. In contrast, Berlingieri (2014) found that PBS outsourcing was a more important driver of the decline in the manufacturing employment share in the United States, accounting for 63.9 per cent of the baseline prediction and for 16.1 per cent of the observed change. The simulation for FS outsourcing indicated that FS outsourcing was had a negligible effect on manufacturing's employment share from 1987 to 2008, accounting for 0.12 per cent of the baseline case and 0.07 per cent of the actual change. Similarly, Berlingieri showed that FS outsourcing only explained 1.1 per cent of the decline in the manufacturing employment share in the United States from 1948 to 2002.

The third exercise holds the demand for intermediate inputs purchased from primary industries – an aggregate includes agricultural, forestry, mining, and oil and gas industries – in manufacturing constant at their 1976 level. The results of this simulation suggest that changes in the I-O coefficients for primary industries account for 4.4 per cent of the baseline prediction and 3.3 per cent of the actual change for the 1976-2008 period. Again, this reflects the major increase in the value of intermediates purchased from mining and oil and gas extraction. However, the role of mining and oil and gas extraction was almost certainly much higher than reported, as the contributions of agricultural and forestry industries must have been negative since the I-O coefficients for these industries in manufacturing fell from 1976 to 2008.

iii. The Effect of Changes in Final Demand on Sectoral Allocation

Third, we allowed final demand shares to evolve over time and compared the results to those of the first exercise. The explanatory power of the gross output model was only marginally improved for the 1976-2008 period after allowing for changes in final demand expenditure shares. In particular, the gross output model accounted for 79.3 per cent of the observed decline in manufacturing when final uses shares evolved over time, compared to 76.3 per cent when final uses shares were fixed at their 1976 level. Unlike manufacturing, allowing for changes in final demand shares worsened the predictive power of the model for seven of eleven industries.

iv. The Role of Outsourcing: Evidence from Occupational Data

Fourth, we carried out decompositions using aggregate occupational data to provide further evidence regarding the role of PBS outsourcing in the evolution in the manufacturing employment share. In particular, we decomposed the change in the employment share of the PBS industry into the part of the increase that is due to workers within each occupation moving to the PBS industry (the **within-occupation component**), the part of the increase that is due to changes in the share of each occupation in total employment (the **between-occupation component**), and an interaction term (the **cross-occupation component**).

Similar to Berlingieri (2014), we showed that most of the increase in the PBS industry's employment share from 1987 to 2014 was due to the within-occupation component, while the between-occupation component did not account for much of the increase. In particular, 73.6 per cent of the increase in the PBS industry's employment share was due to the within-occupation component and 20.4 per cent was due to the between-occupation component. The relative importance of the within-occupation component indicates that the rise of the PBS industry was primarily driven by a reallocation of workers within occupations toward the PBS industry as opposed to a reallocation of workers toward PBS occupations. Therefore, the increase in the employment share of the PBS industry appears to have been more closely linked to an increase PBS outsourcing rather than an increase in the final demand for PBS (and an associated increase in the in-house production of PBS).

After applying the same techniques to the decline in manufacturing's employment share, we found that both the within- and between-occupation components both contributed a great deal to the decline in manufacturing's employment share between 1987 and 2014. Of total decrease in manufacturing's employment share, 57.9 per cent was due to the within-occupation component and 43.4 per cent was due to the between-occupation component. The importance of the within-occupation component suggests that outsourcing accounts for a significant part of the decline in manufacturing's employment share.

Furthermore, PBS occupations accounted for 49.8 per cent of the within-occupation component for manufacturing, indicating that the reallocation of PBS workers from manufacturing to the other industries accounted for 28.8 per cent of the decline in manufacturing's employment share. If PBS occupations are defined twice as strictly, then the reallocation of PBS workers from manufacturing to the other industries accounted for 13.2 per cent of the decline in manufacturing's employment share.

V. Conclusion

The report examined the impact of outsourcing on manufacturing's employment share in Canada. Using the methodologies implemented in Berlingieri (2014), the report attempted to quantify the contribution of intermediate demand channels and outsourcing to the decline in manufacturing's share of total employment in Canada between 1976 and 2008, with particular attention paid to the role of professional and business services (PBS) outsourcing.

Two approaches were used to determine the contribution of outsourcing to the evolution in manufacturing's employment share in this report. The first approach used input-output (I-O) analysis to estimate the impact of changes in the I-O structure of the economy on employment shares by industry. The second approach used aggregate industry-by-occupation employment data to decompose changes in employment shares by industry in various ways. The results of these analyses are mixed; however, they seem to suggest that an increase in outsourcing accounts for a small but significant portion of the decline in the manufacturing employment share.

Input-Output Analysis

The principal analysis in the report involved estimating employment shares using a gross output model in which employment shares are determined by changes in final demand shares and by changes in the I-O structure of the economy. This analysis was carried out for the 1976-2008 period and at a more disaggregated level for the 1987-2008 period.

In Canada, the evolution of the I-O structure of the economy, which captures changes in the composition of intermediate inputs for all industries, accounted for 76.3 per cent of the fall in the employment share of manufacturing over the 1976-2008 period. To look more closely at the role of outsourcing in the decline in manufacturing's employment share, the report held manufacturing's direct requirements for all intermediate inputs constant over time to provide an upper-bound for the contribution of outsourcing to the decline in manufacturing's employment share. The results of this exercise indicate that outsourcing accounted for 21.1 per cent of the decline in manufacturing's employment share. The report also estimated the contribution of PBS and FS outsourcing to the decline in manufacturing's employment share. The results indicate that an increase in PBS and FS outsourcing together accounted for only 3.5 per cent of the decline in manufacturing's employment share between 1976 and 2008.

In contrast, Berlingieri (2014) found that changes in the composition of intermediate inputs for all industries accounted for only 25.3 per cent of the fall in manufacturing's share of total employment in the United States over the 1948-2002 period, well below the result in this report (76.3 per cent). He found that changes in manufacturing's direct requirements for intermediate inputs accounted for 15.0 per cent of the decline in manufacturing's employment

share in the United States between 1948 and 2002, similar to what was found in this report (21.1 per cent). However, Berlingieri also found that PBS outsourcing accounted for 16.1 per cent of the fall in manufacturing's employment share, well above the result in this report (3.5 per cent).

There are two reasons to doubt the predictive power of the gross output model for Canada. First, a significant portion of the predicted decline in the manufacturing employment share was driven by an increase in the direct requirements for mining and oil and gas extraction, which largely reflected an increase in the value of mineral fuels refined in Canada. This also led to an unrealistically large increase in the predicted employment share of mining and oil and gas extraction. Second, the model was unable to explain much (if any) of the actual change in employment shares for most of the industries included in the analysis.

The poor explanatory power of the gross output model has two possible explanations: 1) there may be certain weaknesses with the model (*e.g.*, its assumptions, specification, etc.), making it incapable of accurately explaining changes in sectoral employment shares; and 2) the use of current dollar data leads to major distortions resulting from changes in relative prices, such as the growth in the relative price of crude oil in the 2000s.

The first explanation is difficult to address. The model may have been unable to explain much of the actual changes in employment shares in Canada due to the data, the assumptions of the model, the level of aggregation, or other factors. In particular, the model assumes that there is no capital in the economy, and the predicted employment shares are not directly affected by differential labour productivity growth rates across industries. It is also possible that the model is more appropriate at higher levels of aggregation or for longer periods as in Berlingieri (2014), which may explain why the model's predictions were more accurate for the 1976-2008 period compared to the 1987-2008 period.

Another issue is the uncertainty regarding the extent to which the inaccuracy of the model is due to the use of current dollar data as opposed to constant (or chained) dollar data. Constant dollar data allows price changes (such as an increase in crude oil prices) to affect the evolution of I-O coefficients over time. Unfortunately, we do not attempt to use constant dollar data in this report, as only current dollar data are publically available in a consistent time series for Canada for the 1976-2008 period. Further research is needed to determine whether and to what extent the results of the report are affected by the use of constant dollar I-O data.

Occupational Analysis

The report also performed a decomposition of the decline in manufacturing's employment share using aggregate occupational data. We found that 57.9 per cent of the decrease was due to workers within each occupation moving from manufacturing to other industries, while 43.4 per cent was due to changes in the share of each occupation in total

employment. Furthermore, we found that the reallocation of PBS workers from manufacturing to other industries accounted for 13 to 29 per cent (depending on the definition of PBS occupations) of the decline in manufacturing's employment share. This suggests that outsourcing accounted for a significant part of the decline in manufacturing's employment share, contradicting the results of the analysis based on I-O data. However, it is likely that these results overestimate the actual contribution of outsourcing to the decline in manufacturing's employment share because the occupational categories employed in this report were overly broad. For that reason, it would be interesting to redo this analysis using more detailed industry-by-occupation employment data.

Implications

Generally speaking, whether the decline in manufacturing's employment share is an issue depends primarily on the quality of the new jobs. If the quality of the new jobs is worse than the quality of those lost, then the decline in manufacturing's employment share should be considered an issue. According to Hirshhorn (2013), the decline in manufacturing's employment share may have implications for the quality of the workplace, as the service sector jobs that have increased in relative terms are quite different from manufacturing jobs. For instance, service sector jobs tend to "have a higher incidence of part-time and temporary workers, rely more on unpaid overtime and make greater use of flexible work arrangements" (Hirshhorn, 2013). In contrast, if the new jobs are created in innovative industries that require high-skill workers, then it is likely that the living standards of Canadians will improve.

Service sector jobs, which will continue to account for an increasingly large share of total employment, tend to require higher levels of educational attainment than manufacturing jobs. Therefore, it will be important for policymakers to continue to promote an improvement in educational attainment among Canadians. It will also be important for policymakers to help retrain workers who have lost jobs in industries with falling employment like manufacturing so that they can be redeployed into industries with expanding employment.

Furthermore, policymakers must pay attention to the role of outsourcing on productivity growth. As PBS outsourcing continues to increase, the PBS industry will increasingly influence the productivity performance of other industries. Several researchers have shown that domestic outsourcing and offshoring have significant effects on productivity growth (Tang and do Livramento, 2008; Cheung, Rossiter, Zheng, 2008; Houseman and Mandel, 2015). It is imperative for policymakers to understand the drivers of productivity growth, as it is the primary determinant of living standards in the long run.

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Appendices

Appendix I: Deriving Industry-by-Industry Total Requirements

A. Input-Output Requirements Tables

There are four requirements tables in the input-output (I-O) accounts. The first table – a direct requirements table – shows the relationship between commodity inputs and gross output. The remaining tables – total requirements tables – show the relationship between gross output and final uses expenditure (Horowitz and Planting, 2009: 12-7). More detailed is provided below.

- The **direct requirements** table shows the amount of the commodity at the top of the column that is needed to produce a dollar of the gross output in the industry at the beginning of the row. In other words, it shows the share of each commodity input in total gross output in a given industry.

- The **commodity-by-commodity total requirements** table shows the amount of gross output of the commodity at the beginning of each row that is required per dollar of final uses expenditure on the commodity at the top of the column.

- The **industry-by-commodity total requirements** table shows the amount of gross output in the industry at the beginning of the row that is required per dollar of final uses expenditure on the commodity at the top of the column.

- The **industry-by-industry total requirements** table shows the amount of gross output in the industry at the beginning of the row that is required per dollar of final uses expenditure in the industry at the top of the column.

In order to perform the analyses in Berlingieri (2014), we have to derive industry-by-industry total requirements tables, as only industry-by-commodity input, output and final demand tables are publicly available in Canada. To do this, we derive industry-by-industry total requirements tables from industry-by-commodity input and output tables using the procedure outlined in Horowitz and Planting (2009) and United Nations (1999). In particular, we employ the industry-technology assumption despite its drawbacks, as it makes the derivation of the industry-by-industry total requirements table straightforward and it allows for the number of commodities to differ from the number of industries in the input and output tables.

B. Deriving the Requirements Tables from the Input and Output Tables

I will now discuss the procedure used to derive industry-by-industry total requirements tables from industry-by-commodity input and output tables.[41] The procedure will be based on the following notations and definitions:

q:	A $c \times 1$ matrix that shows the total gross output of each commodity where c is the number of commodities.
g:	A $j \times 1$ matrix that shows the total gross output of each industry where j is the number of industries.
U:	The intermediate portion of the input (or the "use") matrix in which each column shows the total amount of each commodity that is used by a given industry. This is a $c \times j$ commodity-by-industry matrix.
V:	The output (or the "make") matrix in which each column shows the gross output in each industry of a given commodity. This is a $j \times c$ industry-by-commodity matrix.
^:	When this symbol is placed over a vector, it signifies a square $(n \times n)$ matrix in which the entries of the vector appear on the main diagonal and there are zeros everywhere else.
I:	An identity matrix.

There are four steps in the derivation of industry-by-industry total requirements tables from industry-by-commodity input and output tables. The first step is the calculation of a commodity-by-industry direct requirements table (*B*) as follows:

$$B = U\hat{g}^{-1} \tag{1}$$

where *B* is a $c \times j$ commodity-by-industry matrix in which each column shows how much of each commodity is required per dollar of gross output in a given industry.

The second step is to calculate an industry-by-commodity market shares or transformation matrix (*D*) using the following equation:

$$D = V\hat{q}^{-1} \tag{2}$$

where *D* is a $j \times c$ industry-by-commodity matrix in which each column shows the share of the total gross output of a given commodity that is produced in each industry. According to the BEA

[41] This section is based on the notation and definitions in the Appendix to Chapter 12 in Horowitz and Planting (2009). For more information on the derivation of requirements tables, see Horowitz and Planting (2009) and United Nations (1999).

(2009:12-22), the use of the market shares matrix to generate the total requirements table involves the assumption that "each commodity is produced by the various industries in fixed proportions," known as the industry-technology assumption.

The third step is the conversion of the commodity-by-industry direct requirements table (*B*) into a $j \times j$ industry-by-industry direct requirements matrix (*DB*) by multiplying the transformation matrix (*D*) by the commodity-by-industry direct requirements matrix (*B*).

The final step is to derive a $j \times j$ industry-by-industry total requirements matrix (Ω_t^{-1}) from the industry-by-industry direct requirements matrix (*DB*). In particular, the industry-by-industry direct requirements matrix (*DB*) is subtracted from the identity matrix (I) and then the inverse of this difference is taken, as represented by:

$$\Omega_t^{-1} = (I - DB)^{-1} \tag{3}$$

where Ω_t^{-1} is the industry-by-industry total requirements matrix, also known as the Leontief inverse matrix, which shows the amount of gross output required in each industry per dollar final uses expenditure in a given industry.[42]

C. Technology Assumptions

A symmetric I-O matrix – that is, matrix *A* in the Leontief model – is required for I-O analysis, as only a symmetric matrix can be inverted to obtain the Leontief inverse matrix. However, many national statistical offices only publish rectangular I-O tables – that is, industry-by-commodity tables. For instance, the number of commodities is greater than the number of industries in the Canadian I-O tables. In these cases, a symmetric I-O table must be derived.

There are two main procedures for deriving a symmetric I-O matrix from rectangular input (the intermediates portion of "use") tables and output (or "make") tables. Although these approaches are quite similar, they are based on very different assumptions about the input structure of the economy – namely, the industry-technology assumption and the commodity-technology assumption.

[42] The term Leontief inverse matrix comes from the Leontief model in which a industry gross output is equal to the Leontief inverse matrix, a measure of inter-industry linkages through the use of intermediate inputs, multiplied by a industry final demand or value added as follows:

$$x = (1 - A)^{-1} y \tag{4}$$

where *y* is a vector of industry final demand or value added, *x* is a vector of industry gross output, and $(1 - A)^{-1}$ is the Leontief inverse matrix.

Under the industry-technology assumption, "inputs are consumed in the same proportions by every product produced by a given industry, which means that principal and secondary products are all produced using the same technology, i.e. the same input structure" (United Nations, 1999:86). This means, for example, that the inputs used by the agricultural industry to produce wheat are assumed to be same as the inputs used to produce all products in the agricultural industry. In other words, the input structure of an industry acts as a proxy for the input structure of all of the commodities produced by that industry.

According to the United Nations (1999), there are two principal advantages of the industry-technology approach: 1) this approach always generates symmetric I-O tables with positive entries; 2) this approach allows for the use of rectangular input-output to generate symmetric I-O tables.[43] However, this assumption breaks "the fundamental economic rule that products with different prices at a given moment must reflect different costs or different technology" (United Nations, 1999:86).

Under the commodity-technology assumption, "the input structure of the technology that produces a given product is the same no matter where it is produced" (United Nations, 1999:87). This means, for example, that the inputs used by the agricultural industry to produce wheat are assumed to be same as the inputs used in the wheat industry. In other words, the input structure of a given commodity is assumed to be the same in all industries. While this assumption is reasonable than the industry-technology assumption, it frequently generates *negative* symmetric I-O tables and it only works if the input and output tables are square (*i.e.*, the number of industries must equal the number of commodities).[44] As a result, further adjustments are required to produce usable Leontief matrix under this assumption.

In this report, the industry-technology assumption is used to derive symmetric industry-by-industry total requirements tables from the Canadian I-O tables. A detailed description of the two approaches as well as a discussion of their respective advantages and disadvantages is available in United Nations (1999).

[43] The matrix *A* in the Leontief model is always positive because the matrix *B* and the matrix *D* are both always positive, and the matrix *B* and the matrix *D* can both be rectangular and the matrix *A* will still be symmetric.
[44] In order to use this approach, it is necessary to either have square I-O tables or to aggregate commodities and/or industries such that the number of commodities equals the number of industries.

Appendix II: Industry Definitions

Appendix Table 1 describes the aggregation required to ensure that the industry definitions in the I-O tables closely correspond with the industry definitions in the LFS for the shorter 1987-2008 period. In particular, the left column lists the IOIC industries in the Input-Output tables at the S level of aggregation, and the right column shows the aggregation of NAICS industries in the LFS employment data performed to match up with the IOIC industries in the Input-Output tables.

Appendix Table 2 describes the aggregation required to ensure that the industry definitions in the I-O tables correspond to the industry definitions in the LFS for the longer 1976-2008 period. The left column lists the NAICS industries available in LFS employment data for the entire 1976-2008 period. The middle column shows the aggregation of NAICS industries in LFS employment data required in order to achieve correspondence with IOIC industries in the Input-Output tables. The right column shows the aggregation of IOIC industries in the Input-Output tables needed to match up with the broad sectors in the middle column. As previously mentioned, a much higher level of aggregation is required for the 1976-2008 period because LFS employment data are not available at a granular level prior to 1987.

It is important to note that the aggregation procedures presented in Appendix Table 1 and Appendix Table 2 are not perfect. Even with LFS employment data at the four-digit NAICS level, it is impossible to attain perfect correspondence between NAICS industries in the LFS employment data and IOIC industries in the Input-Output tables. This is the case because the non-profit and government sectors in the IOIC are made up of certain portions of NAICS industries that are not available in a standard NAICS breakdown. See Trau (2005) for a detailed breakdown of the IOIC.

Appendix Table 1: Procedure to Obtain Consistent Industry Definitions for the 1987-2008 Period

Available IOIC Codes (I-O Tables)	Corresponding NAICS Codes (Employment Estimates)
All industries	All industries - Farming [110] - Public administration [91] + Defence services [9111]
Crop and animal production [1A]	Crop production [111] + Animal production [112]
Forestry and logging [1B]	Forestry and logging [113]
Fishing, hunting and trapping [1C]	Fishing, hunting and trapping [114]
Support activities for agriculture and forestry [1D]	Support activities for agriculture and forestry [115]
Mining and oil and gas extraction [21]	Mining and oil and gas extraction [21]
Utilities [22]	Utilities [22]
Construction [23]	Construction [23]
Manufacturing [3A]	Manufacturing [31] + Manufacturing [32] + Manufacturing [33]
Wholesale trade [41]	Wholesale trade [41]
Retail trade [4A]	Retail trade [44] + Retail trade [45]
Transportation and warehousing [4B]	Transportation and warehousing [48] + Transportation and warehousing [49]
Information and cultural industries [51]	Information and cultural industries [51]
Finance, insurance, real estate and rental and leasing [5A]	Finance and insurance [52] + real estate and rental and leasing [53] + management of companies and enterprises [55]
Professional, scientific and technical services [54]	Professional, scientific and technical services [54]
Administrative and support, waste management and remediation services [56]	Administrative and support, waste management and remediation services [56]
Educational services [61]	Educational services [61] - Elementary and secondary schools [6111] - Community colleges and C.E.G.E.P.s [6112] - Universities [6113]
Health care and social assistance [62]	Health care and social assistance [62] - Hospitals [622] - Social assistance [624]
Arts, entertainment and recreation [71]	Arts, entertainment and recreation [71]
Accommodation and food services [72]	Accommodation and food services [72]
Other services (except public administration) [81]	Other services (except public administration) [81] - Religious organizations [8131]
Operating, office, cafeteria, and laboratory supplies [F1]	n.a.
Travel and entertainment, advertising and promotion [F2]	n.a.
Transportation margins [F3]	n.a.
Non-profit institutions serving households [NP]	Social assistance [624] + Religious organizations [8131]
Government sector [GS]	Elementary and secondary schools [6111] + Community colleges and C.E.G.E.P.s [6112] + Universities [6113] + Hospitals [622] + Defence services [9111]

Appendix Table 2: Procedure to Obtain Consistent Industry Definitions for the 1976-2008 Period

Available NAICS Codes (Employment Estimates)	Aggregation of NAICS Codes	Corresponding IOIC Codes (I-O Tables)
All industries	All industries - Public administration [91]	All industries
Agriculture [110, 111, 112, 1151, 1152] Forestry, fishing, mining, quarrying, oil and gas [113, 114, 1153, 21]	Primary industries	Crop and animal production [1A] + Forestry and logging [1B] + Fishing, hunting and trapping [1C] + Support activities for agriculture and forestry [1D] + Mining and oil and gas extraction [21]
Utilities [22]	Utilities	Utilities [22]
Construction [23]	Construction	Construction [23]
Manufacturing [31, 32, 33]	Manufacturing	Manufacturing [3A]
Trade [41, 44, 45]	Trade	Wholesale trade [41] + Retail trade [4A]
Transportation and warehousing [48, 49]	Transportation and warehousing	Transportation and warehousing [4B]
Information, culture and recreation [51, 71]	Information, culture and recreation	Information and cultural industries [51] + Arts, entertainment and recreation [71]
Finance, insurance, real estate and leasing [52, 53] Business, building and other support services [55, 56]	Financial, business, building and other support services	Finance, insurance, real estate and rental and leasing [5A] + Administrative and support, waste management and remediation services [56]
Professional, scientific and technical services [54]	Professional, scientific and technical services	Professional, scientific and technical services [54]
Accommodation and food services [72]	Accommodation and food services	Accommodation and food services [72]
Educational services [61] Health care and social assistance [62] Other services [81]	Other tertiary industries	Educational services [61] + Health care and social assistance [62] + Other services (except public administration) [81] + Non-profit institutions serving households [NP] + Government sector [GS]
Public administration [91]	n.a.	n.a.

Appendix III: Appendix Tables

Appendix Table 3: Occupational Breakdown of Employment in Manufacturing, 1987 and 2014

NOC-S Codes	Employment Level ('000s)		Δ1987-2014		Share of Total (Per Cent)		Δ1987-2014	
	1987	2014	Absolute	Per Cent	1987	2014	Percentage Points	Per Cent
All Occupations	2,041	1,711	-330	-16.17	100.00	100.00	0.00	0.00
Senior Management Occupations	15	5	-11	-69.93	0.75	0.27	-0.48	-64.14
Specialist Managers	58	39	-19	-32.88	2.86	2.29	-0.57	-19.93
Managers in Retail Trade, Food and Accommodation Services	0	3	3	…	0.00	0.18	0.18	…
Other Managers N.E.C.	78	72	-5	-6.94	3.81	4.23	0.42	11.01
Professional Occupations in Business and Finance	24	24	1	2.13	1.15	1.40	0.25	21.82
Finance and Insurance Administrative Occupations	12	8	-4	-32.17	0.56	0.46	-0.11	-19.09
Secretaries	48	4	-44	-92.26	2.34	0.22	-2.13	-90.77
Administrative and Regulatory Occupations	27	37	10	37.59	1.30	2.14	0.84	64.13
Clerical Supervisors	12	20	8	72.17	0.56	1.16	0.59	105.38
Clerical Occupations	147	120	-27	-18.21	7.21	7.04	-0.18	-2.43
Professional Occupations in Natural and Applied Sciences	62	86	23	37.62	3.05	5.00	1.96	64.16
Technical Occupations Related to Natural and Applied Sciences	67	84	17	25.49	3.27	4.89	1.62	49.69
Professional Occupations in Health	0	0	0	…	0.00	0.00	0.00	…
Nurse Supervisors and Registered Nurses	2	0	-2	-100.00	0.08	0.00	-0.08	-100.00
Technical and Related Occupations in Health	7	7	0	-5.80	0.34	0.38	0.04	12.37
Assisting Occupations in Support of Health Services	0	0	0	…	0.00	0.00	0.00	…
Judges, Lawyers, Psychologists, Social Workers, Ministers of Religion, and Policy and Program Officers	4	5	2	54.29	0.17	0.32	0.14	84.04
Teachers and Professors	0	2	2	…	0.00	0.10	0.10	…
Paralegals, Social Services Workers and Occupations in Education and Religion, N.E.C.	0	0	0	…	0.00	0.00	0.00	…
Professional Occupations in Art and Culture	4	5	1	11.90	0.21	0.27	0.07	33.49
Technical Occupations in Art, Culture, Recreation and Sport	13	13	-1	-5.97	0.66	0.74	0.08	12.17
Sales and Service Supervisors	2	3	1	81.25	0.08	0.17	0.09	116.21
Wholesale, Technical, Insurance, Real Estate Sales Specialists, and Retail, Wholesale and Grain Buyers	33	54	21	63.25	1.63	3.17	1.54	94.74

Source: CSLS calculations based on Statistics Canada data. Labour Force Survey. Special order.

Appendix Table 3: Occupational Breakdown of Employment in Manufacturing, 1987 and 2014 (continued)

NOC-S Codes	Employment Level ('000s)		Δ1987-2014		Share of Total (Per Cent)		Δ1987-2014	
	1987	2014	Absolute	Per Cent	1987	2014	Percentage Points	Per Cent
All Occupations	2,041	1,711	-330	-16.17	100.00	100.00	0.00	0.00
Retail Salespersons and Sales Clerks	15	6	-9	-60.40	0.73	0.34	-0.39	-52.77
Cashiers	3	2	-1	-28.00	0.12	0.11	-0.02	-14.11
Chefs and Cooks	0	4	4	…	0.00	0.24	0.24	…
Occupations in Food and Beverage Service	0	0	0	…	0.00	0.00	0.00	…
Occupations in Protective Services	5	3	-3	-52.83	0.26	0.15	-0.11	-43.73
Occupations in Travel and Accommodation Including Attendants in Recreation and Sport	0	0	0	…	0.00	0.00	0.00	…
Childcare and Home Support Workers	0	0	0	…	0.00	0.00	0.00	…
Sales & Service Occupations N.E.C.	47	27	-21	-43.62	2.30	1.55	-0.75	-32.74
Contractors and Supervisors in Trades and Transportation	28	19	-10	-34.16	1.38	1.08	-0.30	-21.47
Construction Trades	40	24	-16	-39.85	1.95	1.40	-0.55	-28.25
Stationary Engineers, Power Station Operators and Electrical Trades and Telecommunications Occupations	32	22	-10	-32.08	1.56	1.26	-0.30	-18.97
Machinists, Metal Forming, Shaping and Erecting Occupations	118	103	-15	-13.02	5.80	6.01	0.22	3.76
Mechanics	88	63	-25	-28.68	4.32	3.68	-0.65	-14.93
Other Trades N.E.C.	53	20	-33	-62.10	2.61	1.18	-1.43	-54.79
Heavy Equipment and Crane Operators Including Drillers	17	9	-8	-47.88	0.81	0.50	-0.31	-37.83
Transportation Equipment Operators and Related Workers, Excluding Labourers	51	33	-18	-35.29	2.50	1.93	-0.57	-22.81
Trades Helpers, Construction, and Transportation Labourers and Related Occupations	59	41	-18	-30.39	2.89	2.40	-0.49	-16.96
Occupations Unique to Agriculture Excluding Labourers	0	0	0	…	0.00	0.00	0.00	…
Occupations Unique to Forestry Operations, Mining, Oil and Gas Extraction, and Fishing, Excluding Labourers	8	0	-8	-100.00	0.37	0.00	-0.37	-100.00
Primary Production Labourers	0	0	0	…	0.00	0.00	0.00	…
Supervisors in Manufacturing	88	125	37	42.29	4.29	7.28	2.99	69.73
Machine Operators in Manufacturing	412	308	-105	-25.35	20.20	17.98	-2.21	-10.95
Assemblers in Manufacturing	191	178	-13	-6.92	9.34	10.37	1.03	11.03
Labourers in Processing, Manufacturing and Utilities	167	135	-33	-19.49	8.20	7.87	-0.32	-3.96

Source: CSLS calculations based on Statistics Canada data. Labour Force Survey. Special order.