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Abstract

Under the flexible exchange rate regime, the Canadian economy is constantly affected by fluctuations in exchange rates. This paper focuses on the employment effect of the exchange rate in Canada. We find that appreciations of the Canadian dollar have significant effects on employment in manufacturing industries; such effects are mostly associated with the export-weighted exchange rate and not the import-weighted exchange rate. Meanwhile, the exchange rate has little effect on jobs in nonmanufacturing industries. Because the manufacturing sector accounts for only about 10% of the employment in Canada, the overall employment effect of the exchange rate is small. In addition, we quantify the loss of manufacturing employment associated with a boom in the commodity market during which the Canadian dollar tends to appreciate. Our estimates suggest that when commodity prices increase by 15.77% (one standard deviation of annual change in commodity price between 1994 and 2010), Canada's manufacturing employment decreases by 0.8%, about 0.08% of the total employment.

JEL classification codes: F1, F3, J2

Key words: exchange rate, employment in Canada

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1 Introduction

The current monetary policy regime in Canada is inflation targeting. Under this regime, the Bank of Canada adjusts the nominal interest rate to target inflation; the exchange rate is flexible, allowing the Bank to pursue an independent monetary policy tailored to the needs of the Canadian economy. Because Canada participates actively in the international markets as a small open economy, the Canadian dollar has experienced substantial fluctuations in its value relative to the other currencies.

The October 2010 issue of the Bank of Canada's Monetary Policy Report recognized the potential negative effects of a strong Canadian dollar: "A combination of disappointing productivity performance and persistent strength in the Canadian dollar could dampen the expected recovery of Canada's net exports. Heightened tensions in foreign exchange markets could inhibit necessary global adjustment and put additional pressure on freely floating currencies"(p.27). One concern is that a commodity boom typically leads to an appreciation of the Canadian dollar, which reduces the competitiveness of the Canadian manufacturing industries in the world market.

In this paper, we use data from 1982 to 2012 to assess the effects of the exchange rate on Canadian employment both within and outside of the manufacturing industries. We believe that these effects are important considerations for policy makers who want to assess the potential cost of the current monetary policy regime and determine whether Canada should restrict exchange rate movements.

Our main findings are as follows. First, the exchange rate affects employment in the manufacturing industries. Our estimate suggests that, for the average manufacturing industry, a 1% appreciation in the trade-weighted exchange rate reduces employment by 0.66%. When we distinguish between import-weighted and export-weighted exchange rates, we find that most of the effects on employment are associated with the export-weighted exchange rate, while the import-weighted exchange rate does not have significant partial effects on employment.

Second, appreciations in the Canadian dollar do not appear to have negative effects on employment in non-manufacturing industries. Because manufacturing accounts for only about 10% of total employment in Canada, the overall effect of the exchange rate on Canadian employment is relatively small.

Third, because commodity prices tend to commove positively with the value of the Canadian dollar, we also estimate the loss of manufacturing employment associated with a commodity boom. The estimates suggest that, if the commodity prices experience a one standard deviation positive shock (i.e., a 15.77% increase in the overall price of commodities produced in Canada), the manufacturing sector is predicted to lose 11,656 jobs. This amounts to a 0.8% decrease in manufacturing employment and a 0.08% decrease in the total employment of Canada.

Overall, our empirical results suggest that the employment effects of exchange rate appreciations are small in Canada. Therefore, in terms of employment, the flexible exchange rate regime does not appear to create an undue burden on the Canadian economy. Of course, we recognize that a commodity boom can have different regional impacts due to differences in industrial composition. For instance, Ontario and Quebec accounted for 44.8% and 28.7% of Canada's manufacturing employment in 2010, while Alberta accounted for 54.4% of employment in the industry of mining, quarrying, and oil and gas extraction. However, monetary policy is ill-suited to address regional issues. Recommending how to address the potential regional imbalances associated with a commodity boom is beyond the scope of this paper.

Our paper contributes to the literature of Dutch disease, and the broader literature on "resource curse" to which the Dutch disease literature belongs. The former literature focuses on the exchange rate channel. That is, a commodity boom may cause the currency to appreciate which could harm the manufacturing sector (more generally, the non-commodity tradable sector) in an open economy. The latter is much wider in the sense that it includes not only the exchange rate channel but also other mechanisms, such as rent-seeking, corruption, domestic conflict, and high volatility (i.e., topics that are typically discussed in the fields of development and economic growth). In particular, our paper adds to the literature regarding the existence of Dutch disease in Canada.

In the literature on Dutch disease in Canada, our paper is most closely related to Shakeri, Gray and Leonard (2012). They adopted a two-step approach to estimate first the relationship between the real Canada-US exchange rate and commodity prices, and then the effect of the exchange rate on the output of the manufacturing industries. In the exchange rate equation, they established that both energy and non-energy commodities play important roles in explaining the exchange rate, especially during the post 2004 period. Regarding industrial output, they found that only 25 out of 80 manufacturing industries experienced Dutch disease (i.e., experienced a drop in output associated with appreciations). In particular, labour-intensive industries such as textiles, apparel and leather products were affected the most, followed by petroleum and coal, electronic equipment and appliances, furniture, food and beverage, and transportation equipment.

The empirical approach and regression specification of our paper differ from Shakeri et al. (2012) in a number of ways: (1) we focus on the impact of exchange rate on employment rather than on output; (2) we not only study the manufacturing sector at a disaggregate level, but also expand the scope of study beyond manufacturing by examining the manufacturing and non-manufacturing industries together at a higher level of aggregation; (3) in our analysis of the manufacturing industries, we construct trade weighted industry-specific exchange rates to exploit industry heterogeneity in exposure to exchange rate, while Shakeri et al. (2012) rely on the real bilateral exchange rate between Canada and the United States; and (4) when estimating the employment effect, our models allow industry-specific trade and input-output characteristics - the imported input share, the import penetration ratio, the export orientation ratio, and the fraction of output sold to commodity industries - to influence the effects of exchange rate on jobs. Moreover, in terms of findings, we find evidence that, while the manufacturing industries suffer a mild case of Dutch disease, the other industries are not affected negatively by the appreciation of the Canadian dollar.

Beine, Bos and Coulombe (2012) argued that an important driver of the bilateral Canadian-US dollar exchange rate is the weakness of the US dollar, which has little to do with the evolution of commodity prices. After accounting for changes in the strength of the US dollar, they still found that a stronger Canadian dollar was associated with a decrease in the Canadian industry employment. However, their list of industries prone to Dutch disease is somewhat different from Shakeri et al. (2012). Specifically, in Beine, Bos and Coulombe (2012), industries most affected by Dutch disease were textile mills, machinery, and computer and electronics, followed by plastics and rubber, furniture, printing, paper, primary metal, and transportation equipment. Industries such as food, beverage and tobacco, textile product, leather and allied product, petroleum and coal, non-metallic mineral, and electronic equipment were not affected by exchange rate fluctuations .

Another branch of the literature on Dutch disease relies on the analysis of time-series of national data. Hutchison (1994) applied cointegration analysis and the vector correction model to data from the UK, Norway, and the Netherlands. They did not find evidence of Dutch disease, because there was little trade-off between the development of the energy sector and the development of the manufacturing sector in these countries, especially in the long-run. Similarly, Bjϕrnland (1998) used a structural VAR model to study Dutch disease in Norway and the UK and found at best weak support for the Dutch disease. In Norway, manufacturing output actually benefited from energy booms according to their analysis. There was some weak evidence of a Dutch disease in the U.K. in the long-run, although the economy responded positively in the short term.

Other papers extend the empirical study of Dutch disease to Saudi Arabia (Looney, 1990), Russia (Oomes and Kalcheva, 2007), and Kazakhstan (Egert and Leonard, 2008). The overall evidence is mixed. Many industries in Saudi Arabia, especially those produce mostly tradable goods, suffered from Dutch disease (Looney, 1990). In Russia, however, there was no clear evidence that the resource boom hurt the country's manufacturing output (Oomes and Kalcheva, 2007). In Kazakhstan, the economy had been largely spared Dutch disease because the exchange rate mechanism was absent. The real exchange rate of the non-oil open sector was simply not linked to real oil prices (Egert and Leonard, 2008).

Leung and Yuen (2007) used data on three-digit manufacturing industries coded in the Standard Industrial Classification (SIC) system from 1981 to 1997 and examined the exchange rate effects on employment and wage in Canada. They found that appreciations reduce manufacturing employment, but have little impact on wage. Coulombe (2008) used provincial data on a subset of three-digit manufacturing industries in the North American Industry Classification System (NAICS) from 1987 to 2006 and studied the exchange rate effects on employment in Canada. They found a significant negative effect of the exchange rate on manufacturing employment, especially in provinces with the large manufacturing bases such as Ontario and Quebec.

A number of papers have examined the effects of the exchange rate on other aspects of the Canadian economy, such as firm performance and survival (Baggs et al., 2009; Tomlin, 2010) and labour productivity (Tang, 2010). There is also a well-established body of literature that focuses on the effects of the US dollar exchange rate on the labour market, particularly employment, in the United States. Papers based on data up to the 1990's (Campa and Goldberg, 2001; Klein, Schuh and Triest, 2003) find that the exchange rate has a very small effect on employment in manufacturing industries with the exchange rate elasticity of employment being no greater than 0.1 in magnitude. Based on city-level data in the 2000s, Huang and Tang (2013) find that the exchange rate has significant effects on both manufacturing and nonmanufacturing employment in US cities.

Relative to existing studies on the employment effects of the exchange rate in Canada, our paper offers a number of contributions. First, we examine the effects of the exchange rate on the overall economy, beyond the manufacturing industries. Second, we exploit differences in trade partners across industries to construct industry-specific exchange rates. From this, we are able to utilize cross-sectional variation in the exchange rates in addition to time-series variation in the exchange rates that is traditionally used in the literature. Third, our work suggests that the decrease in manufacturing employment is mostly associated with the appreciations in the export-weighted exchange rate, not the appreciations in the import-weighted exchange rate. Fourth, we provide an assessment of loss of manufacturing employment associated with a commodity boom via the exchange rate channel.

The remainder of the paper proceeds as follows. Section 2 describes the general trends of exchange rate and employment in Canada. Section 3 and Section 4 present the analysis of the exchange rate effect on employment in the manufacturing industries and in all industries, respectively. Section 5 estimates the relationship between commodity prices and exchange rates, and quantifies the potential job loss following appreciations led by a commodity boom. Conclusions follow.

2 Exchange Rate and Employment Trends in Canada

In this section, we discuss the general trends of employment in the major industries in Canada and the movements in the exchange rate between 1982 and 2012. During this period, total employment in Canada, including both full-time and part-time workers, grew from 10.9 million in 1982 to 17.5 million in 2012.[1] Meanwhile, the Canadian population

[1] The employment data are from CANSIM Table 282-0008.

increased from 25.1 million to 34.8 million.[2] Because the growth in total employment (60%) is higher than the growth in population (38.4%), the overall employment picture of Canada looks healthy over the entire period, notwithstanding the 2008-09 recession during the worldwide financial and economic crisis.

We next examine employment trends by major industry groups. From the first two rows of Table 1, we can see that service industries employ far more workers than goods industries, and the share of service industries in total employment has increased over time. In the following rows, we tabulate statistics for five main goods industries (two-digit NAICS codes in parentheses): agriculture, forestry, fishing and hunting (11), mining, quarrying and oil and gas extraction (21), utilities (22), construction (23), and manufacturing (31-33). Note that data for industries 11 and 21 are not available before 1987. Instead, we use data for the agriculture industry (111-112) and the forestry, fishing, mining, quarrying, and oil and gas industry (113-114, 21) for 1982. Overall, the share of goods industries in total employment has declined substantially. Even though the share of employment in the mining, quarrying, and oil and gas industry and in the construction industry have increased, they are not large enough to offset the declines in the other goods industries, most of which took place in manufacturing.

The decline in manufacturing employment is concentrated in Ontario and Quebec. Between 1982 and 2012, the share of employment in the manufacturing industries decreased by 6.9% across Canada. Ontario alone accounts for 57.4% of this loss and Quebec accounts for another 27.0%. On average, Ontario and Quebec accounted for 47.7% and 28.3% of Canada's manufacturing employment during the period of 1982-2012. These numbers suggests that Ontario bared a disproportionately large loss in manufacturing employment.

In the upper panel of Figure 1, we plot the employment of the goods industries, the employment of the services industries, and the real Canadian-dollar effective exchange rate

[2]The population data are from CANSIM Table 051-0001.

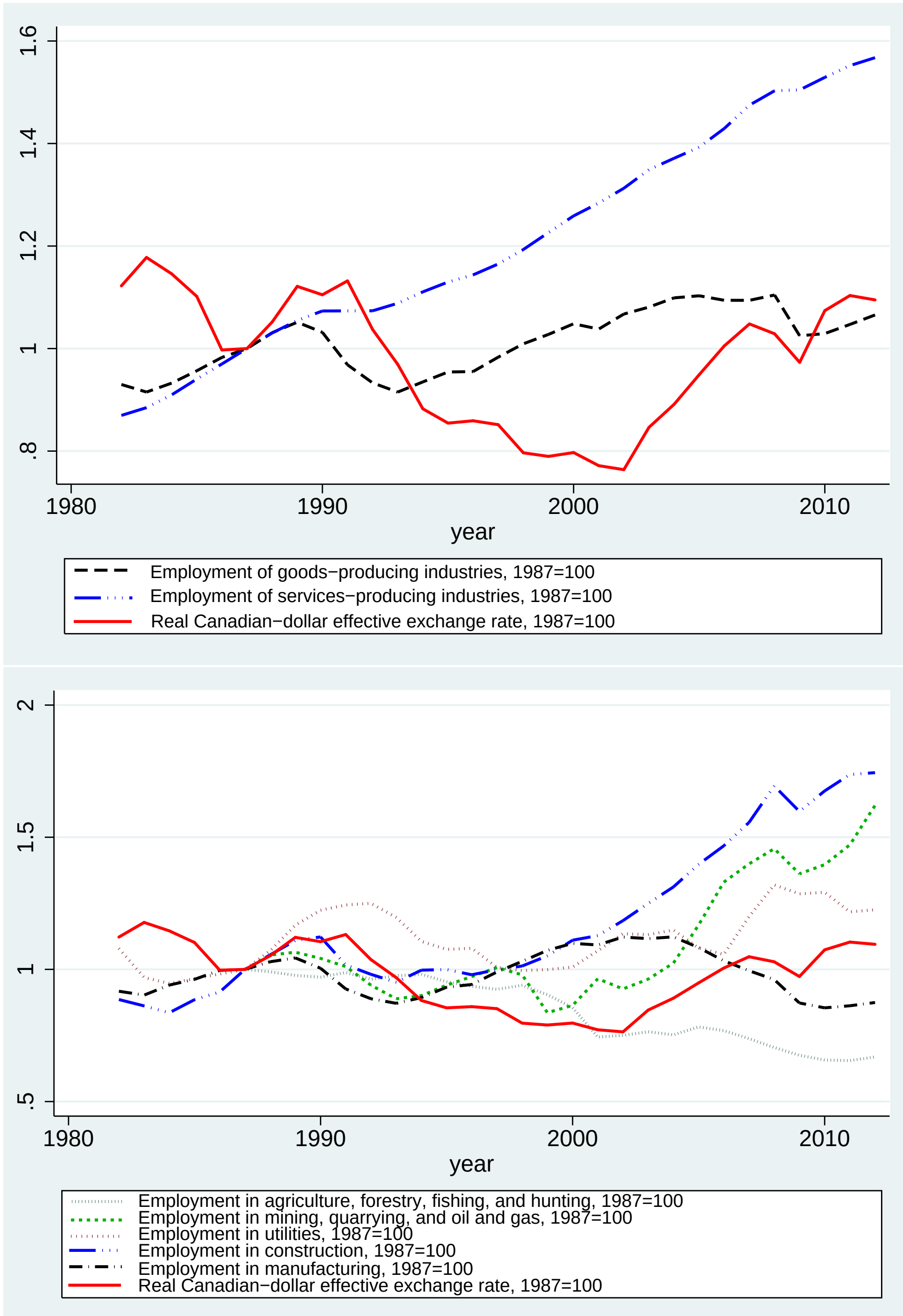

Figure 1: Real Canadian-dollor effective exchange rate and employment of major industries in Canada

Table 1: Share of Major Industries in Total Employment

Industry (NAICS code)	1982	1987	2012
Services (41-91)	69.1%	70.5%	77.9%
Goods (11-33)	30.9%	29.5%	22.1%
Agriculture (111-112)	4.0%	3.8%	1.8%
Forestry, Fishing, Mining, Quarrying, Oil and Gas (113-114, 21)	2.7%	2.3%	2.1%
Agriculture, Forestry, Fishing, and Hunting (11)		4.6%	2.2%
Mining, Quarrying, Oil and Gas (21)		1.5%	1.7%
Utilities (22)	1.1%	0.9%	0.8%
Construction (23)	5.9%	5.9%	7.2%
Manufacturing (31-33)	17.1%	16.5%	10.2%

Source: Authors' tabulations

index (CERI), a trade-weighted exchange rate index published by the Bank of Canada. The CERI is a direct rate, so an increase in the CERI represents an effective appreciation of the Canadian dollar while a decrease represents a depreciation of the Canadian dollar. We document the details regarding the construction of the real CERI in the appendix. To facilitate comparison, we normalize all variables to 100 in 1987. The real exchange rate, which is mostly driven by the movements in the nominal exchange rate, went through two complete cycles between 1982 and 2012. It depreciated moderately during the first half of the 1980s and then appreciated back by the early 1990s. Starting from 1992, the exchange rate experienced a decadelong depreciation (26.4% between 1992 and 2002) and a substantial appreciation between 2002 and 2012 (43.4%).

In the lower panel of Figure 1, we turn our attention to the five goods industry groups. Again, the manufacturing industry stands out because the employment in manufacturing appears to have an inverse relationship with the strength of the Canadian dollar. For instance, the increases in the manufacturing employment in the early 1980s and in the 1990s both correspond to episodes of appreciations of the Canadian dollar. A more noticeable example is the drop in the manufacturing employment after 2000, which largely coincides with the strong run-up of the Canadian dollar. As for the other goods industries, construction has been steadily adding jobs since 1982, except during the 1981-1982 and the 1990-1992 recessions and of course the most recent recession (2008-2009). The numbers of jobs in the agriculture, forestry, fishing, and hunting industry have been declining since the mid-1980s. The employment of the mining, quarrying, and oil and gas industry seems to track the exchange rate movements quite closely, presumably because the world demand for these commodities drives both the strength of the Canadian dollar and the employment in these Canadian industries. Interestingly, the employment of the utilities industry also seems to follow the pattern of the exchange rate. One potential explanation for this is that there exists a common factor that affects the employment of the utilities industry and the exchange rate in the same direction. For example, a recession leads to a lower demand for utilities, which hence lowers employment in the utilities industry. At the same time, a weak economy tends to weaken the currency as well. In other words, Figure 1 presents only the unconditional correlations. It does not exclude the possibility that certain observed relationship (e.g., the negative relationship between the exchange rate and the manufacturing employment) is caused by other macroeconomic factors (e.g., when the Bank of Canada raises the interest rate, the Canadian dollar is likely to become stronger while employment is likely to decrease). In the next two sections, we extend our analysis beyond the simple correlations in time series and exploit the variations in trade exposure across industries. We also control for a number of macroeconomic factors in the regression analysis.

3 Manufacturing Industries

Because the evidence in Section 2 suggests that the exchange rate is likely to affect manufacturing employment, we first estimate the effects of exchange rates on the group of four-digit NAICS manufacturing industries. The empirical strategy borrows heavily from the theoretical work and empirical specification of Campa and Goldberg (2001) which examines the effect of the exchange rate on employment from the perspective of firms. In this framework, a firm uses labour, domestically produced inputs, and imported inputs in its production and sells products in both domestic and foreign markets.

The exchange rate affects the firm's demand for labour in a number of ways, not all of which work in the same direction. First, when home currency appreciates, home products become more expensive compared with foreign products. As a result, domestic demand for a home firm's products decreases, leading the home firm to demand less labour. Second, when the home currency appreciates relative to the currencies in the export destination markets, demand for home products in those markets also decrease. This again should dent the home firm's demand for labour. Third, appreciations make imported inputs cheaper. If labour and imported inputs are complements in production, after appreciations home firms will use more imported inputs and hire more labour at the same time. However, if labour and imported inputs are substitutes in production, home firms will choose to substitute labour with cheaper imported inputs after appreciations. Demand for labour decreases in this case.

Because of the lack of data on international trade at the firm level, we follow the literature and test these theoretical implications using data at the industry level. The assumption is that the relationship between the exchange rate and employment in an industry resembles that of an average firm in the industry.

As pointed out by Huang and Tang (2013), the exchange rate in the import trade and the exchange rate in the export trade may have different effects. First, the countries from which an industry imports inputs and against which the industry competes in the domestic market can be different from the countries to which the industry exports its products. Second, while the theory clearly predicts that appreciations in the export exchange rate decrease demand for labour, the effect of the import exchange rate on employment is ambiguous. As stated earlier, appreciations in import exchange rates have two effects: they make imported products cheaper and lower the cost of imported inputs. Depending on whether imported inputs and labour are complements or substitutes, the overall effect of the appreciation of the import exchange rate on employment can be positive or negative.[3] Therefore, for each industry we compute the export-weighted real exchange rates and the import-weighted real exchange rates. We refer to them as the export exchange rate and the import exchange rate, respectively. Because the import and export exchange rates are highly correlated with a correlation coefficient of 0.83, we use a third measure of exchange rate that is equal to the average of the import exchange rate and the export exchange rate. We will refer to it as the trade-weighted exchange rate. We construct the exchange rate variables such that an increase in the exchange rate implies an appreciation. We use data on 86 four-digit NAICS manufacturing industries in five regions in Canada from 1990 to 2010. We document the detailed information about the variable construction in the appendix. From Figure 2, we can see that, because the industries differ in how much they trade with each country, there exists considerable variation in the industry-specific export and import exchange rates.

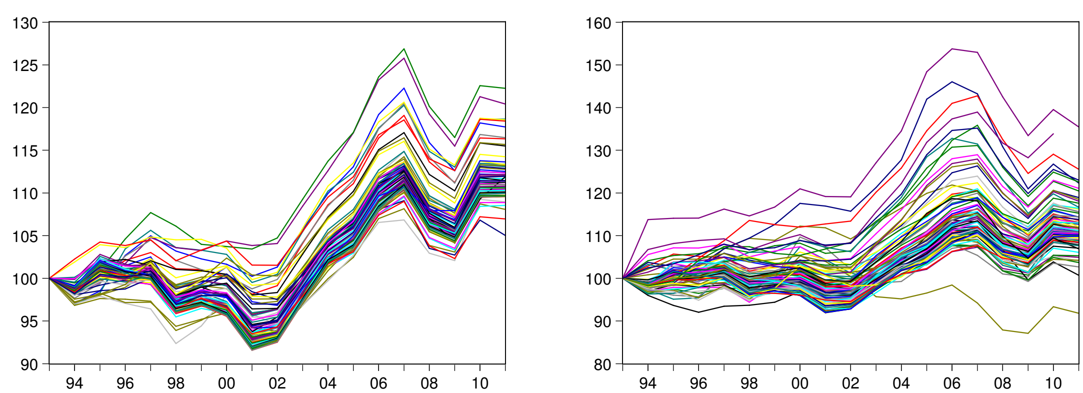

Figure 2: Industry-specific export and import exchange rates indices, all industries
Note: Each line in the left (right) panel is the export (import) exchange rate index of a four-digit NAICS manufacturing industry.

[3] Note that because it is not possible to distinguish systematically between imported intermediate inputs and final consumption goods, we are not able to compute an import exchange rate for imported inputs and an import exchange rate for final goods.

In the left panel of Figure 3, we plot the export exchange rate indices of the five largest four-digit NAICS manufacturing industries in terms of employment: plastic product manufacturing, motor vehicle parts manufacturing, printing and related support activities, meat product manufacturing, and cut and sew clothing manufacturing. Between 1990 and 2010, these five industries accounted for 4.70%, 4.65%, 4.25%, 3.40%, and 3.37% of Canada's manufacturing employment, respectively. In the right panel, we can see that for motor vehicle parts manufacturing, the export and the import exchange rates track each other quite closely, although differences remain.

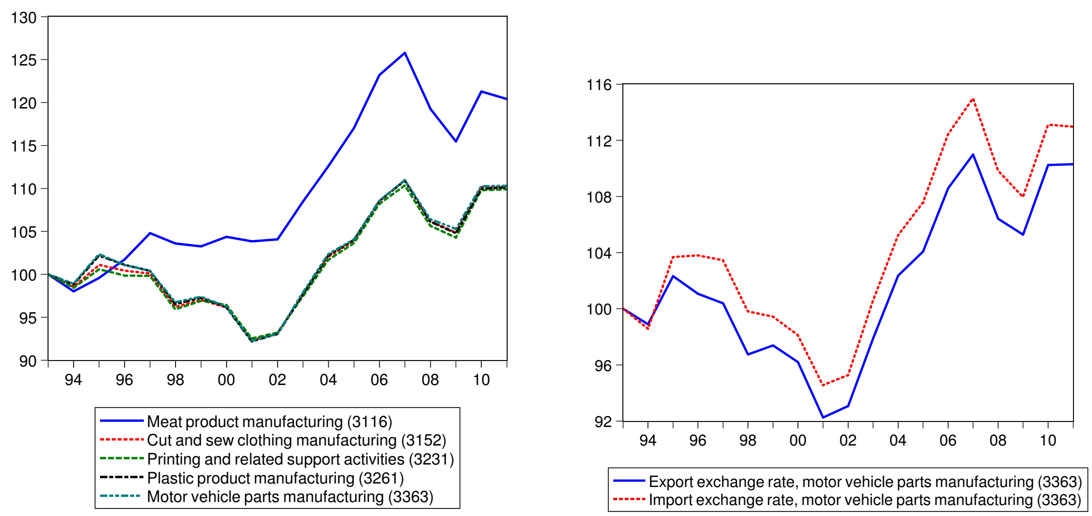

Figure 3: Industry-specific export and import exchange rates indices, selected industries
Note: Each line in the left panel is the export exchange rate index of a selected manufacturing industry.

Our baseline regression is

$$
\begin{aligned}
\Delta L_{ijt}(\%) =& \beta_0 + (\beta_1 + \beta_2 \cdot expori_{it-1} + \beta_3 \cdot impinp_{it-1} + \beta_4 \cdot imppene_{it-1}) \cdot \Delta e_{it}(\%) \\
& + \beta_5 \cdot expori_{it-1} + \beta_6 \cdot impinp_{it-1} \cdot + \beta_7 \cdot imppene_{it-1} \\
& + \beta_8 \cdot ioshare_{it} \cdot \Delta P_t^{com}(\%) + \beta_9 \cdot ioshare_{it} + \beta_{10} \cdot \Delta P_t^{com} \\
& + \beta_{11} \cdot \Delta y_t(\%) + \beta_{12} \cdot \Delta y^*_{it}(\%) + \beta_{13} \cdot \Delta r_t^s + \beta_{14} \cdot \Delta r_t^l \\
& + \beta_{15} \cdot \Delta G_t(\%) + \beta_{16} \cdot \Delta P_t^e(\%) + \beta_{17} \cdot t + \beta_{18} \cdot \Delta L_{ijt-1}(\%) \\
& + \beta_{19} \cdot \Delta L_{ijt-2}(\%) + \beta_{20} \cdot \Delta L_{ijt-3}(\%) + D_{ij} + u_{ijt} \qquad (1)
\end{aligned}
$$

where $\Delta L_{ijt}(\%)$ is the growth rate of employment of a four-digit NAICS manufacturing industry i in region j of Canada between period t and $t-1$. The five regions in our sample are Atlantic Canada, Quebec, Ontario, Prairies, and British Columbia.[4] The variable $\Delta e_{it}(\%)$ is the percentage changes in trade-weighted exchange rates specific to industry i. The variable $expori_{it}$ is the export orientation ratio, defined as the fraction of output of industry i that is exported in year t; $impinp_{it}$ is the imported input share, defined as the fraction of imported inputs in the total production cost of industry i in year t; and $imppene_{it}$ is the fraction of imports in the total domestic sales of industry i in year t.

In theory, commodity prices can affect employment through two channels. First, in a country such as Canada, which is a net exporter of commodities and where commodities account for a large portion of its total exports, commodity prices and exchange rates are often positively correlated; therefore, changes in commodity prices may affect the exchange rates which further affects employment. Second, the production of commodities requires goods from other industries. Following a commodity boom, employment tends to increase in the industries that sell a large fraction of their products to the commodity sector. Thus, we include the fraction of output of manufacturing industry i sold to the commodity industries ($ioshare_{it}$), the percentage change in the Bank of Canada commodity price

[4]At the province level, many industries report missing values for employment due to confidentiality reasons.

index ($\Delta P_t^{com}(\%)$), and the interaction between these two variables in the regressions. We define the commodity industries as agriculture, forestry, fishing and hunting (industry 11 in the NAICS) and mining, quarrying, and oil and gas extraction (industry 21 in the NAICS).

We also include variables to control for the macroeconomic conditions. The variables $\Delta y_t(\%)$ and $\Delta y^*_{it}(\%)$ are the real GDP growth of Canada and the export-weighted real GDP growth in Canadas top trading partners; they proxy for changes in the aggregate demand. The change in the real three-month prime corporate paper rate (Δr_t^s) accounts for the change in short-term real interest rate and the change in the real yield of government of Canada bonds of over 10 years (Δr_t^l) accounts for the change in long-term real interest rate. Moreover, the percentage change in the government expenditure share in GDP ($\Delta G_t(\%)$) is included to represent the fiscal policy environment. To control for the input costs, we include the percentage change in the real nonresidential electric power price ($\Delta P_t^e(\%)$). Because the manufacturing employment in Canada has experienced an across-the-board secular decline, we include a linear time trend (t) on the right-hand side. The theory of dynamic labour demand suggests that, due to hiring and firing costs, optimal labour adjustment takes more than one period to be realized (Nickell, 1986). We thus include the lag of the dependent variable to account for the dynamics in labour adjustment. Moreover, we include industry-region fixed effects (f_{ij}) to capture heterogeneity among industries and regions.

Under the assumption that u_{ijt} is an independent and identically distributed (i.i.d.) error term, the model can be estimated with the Arellano-Bond General Method of Moments (GMM) estimator (Arellano and Bond, 1991) which can accommodate lag-dependent variables in panel regressions. Specification tests indicate that, when we include at least three lags of the dependent variable, we cannot reject the null hypothesis that u_{ijt} is i.i.d. Therefore, we include three lags of the dependent variables in the regressions for the four-digit NAICS manufacturing industries. Because of the presence of interaction terms, the effects of the exchange rates depend on the values of the variables with which they are interacted. To facilitate interpretation, we remove the sample mean from all the explanatory variables that are interacted.

Table 2 reports the regression results. In column 1 of the table, we estimate the baseline model (equation 1). The coefficient on the trade-weighted exchange rate is -0.66 (significant at the 1% level), meaning that a 1% appreciation in the average exchange rate is associated with a 0.66% reduction in manufacturing employment.[5] In column (2), we include both export exchange rate and import exchange rate. We also interact the export exchange rate with the one-period lag of the export orientation ratio, and the import exchange rate with the one-period lags of the imported input share and the import penetration ratio, respectively. Conditional on the import exchange rate, the estimated export exchange rate elasticity of employment is -0.77 and is significant at the 5% level. The import exchange rate, however, does not have significant partial effects on employment; the coefficient is 0.13 and is not statistically different from zero.[6]

In Columns (1) and (2), we use information from the Input-Output (IO) tables to compute several variables (the fraction of output sold to the commodity industries, the imported input share, and the export orientation ratio). Because the IO tables are available only from 1997 to 2009 and we use one-year lags of the variables derived from the IO tables in the regression, our sample period is effectively from 1998 to 2010. In Column (3), we exclude variables that are constructed from the IO tables so that we can include the extra information from 1990 to 1997 in the regressions.[7] While this regression does not account for industry-level heterogeneities, such as differences in export

[5]This estimate is much larger than the coefficient of -0.38 from a comparable regression for the US manufacturing industries in Huang and Tang (2013).

[6]Huang and Tang (2013), using US data, reported similar findings on the difference between the export and import exchange rates' effects on employment.

[7]The results are similar if we exclude the period affected by the most recent recession, using only data before 2009.

orientation, the magnitude of the coefficient on the trade-weighted exchange rate (-0.5) is only slightly smaller than that in the baseline model (-0.66). Overall, the results confirm the descriptive analysis in Section 2 that manufacturing employment responds to the exchange rate movements.

According to equation (1), the effects of exchange rate on jobs differ across industries due to the interaction between exchange rate and other variables. In Table 3, we tabulate the effects of exchange rate for 21 three-digit NAICS manufacturing industries.[8] More precisely, the effect of exchange rate on employment in industry i is computed as

$$\hat{\beta}_1 + \hat{\beta}_2 \cdot \overline{expori}_i + \hat{\beta}_3 \cdot \overline{impinp}_i + \hat{\beta}_4 \cdot \overline{imppene}_i$$

where $\overline{expori}_i$, $\overline{impinp}_i$, and $\overline{imppene}_i$ are the average export orientation ratio, the average imported input share, and the average import penetration ratio of industry i between 1997 and 2009.

Table 3 ranks all three-digit NAICS manufacturing industries according to the total effect of exchange rate on employment. It also reports the individual components of the total exchange rate effect that are attributable to the exchange rate itself or the interactions between exchange rate and industry specific characteristics such as the imported input share, the import penetration ratio, and the export orientation ratio. It is clear that there exits substantial variation in the effects of exchange rate, ranging from -0.42 in wood product manufacturing (industry 321 in the NAICS) to -1.65 in beverage and tobacco product manufacturing (industry 312 in the NAICS).

The estimates show that industries such as beverage and tobacco product manufacturing (312), petroleum and coal products manufacturing (324), computer and electronic product manufacturing (334), transportation equipment manufacturing (336), textile mills (313), textile product mills (314), and plastics and rubber products manufacturing (326) are the ones most affected by exchange rate movements; while industries such as fab-

[8]The effects for the 86 four-digit manufacturing industries are available upon request.

ricated metal product manufacturing (332), paper manufacturing (322), furniture and related product manufacturing (337), printing and related support activities (323), food manufacturing (311), nonmetallic mineral product manufacturing (327), and wood product manufacturing (321) are the ones least affected.

Most of the cross-industry differences are driven by the differences in imported input share. The estimated coefficient on the interaction term between exchange rate and the share of imported input is negative, which is consistent to the theoretical scenario in which imported inputs and labour are substitutes. In other words, when the Canadian dollar appreciates, imported inputs become relatively cheaper, and firms/industries will choose to use more imported inputs but less labour. The size of this substitution effect depends on how much imported inputs are used in each industry. In particular, industries that use more imported inputs (relative to the mean across all four-digit NAICS manufacturing industries) tend to experience a larger negative effect on employment if the Canadian dollar appreciates. On the contrary, industries that use less imported inputs (relative to the mean) tend to experience a much smaller negative effect on employment if the Canadian dollar appreciates. Our results are also compatible to the findings of Shakeri, Gray and Leonard (2012) and Beine, Bos and Coulombe (2012), even though the exact rankings vary due to different approaches and data used. The industries that both the literature and we find most affected by Dutch disease tend to be labour intensive such as computer and electronics, transportation equipment, and textile mills. Domestic labour used in these industries can be easily replaced by intermediate goods from abroad when the Canadian dollar appreciates. In contrast, for industries that use mostly domestic inputs such as wood, nonmetallic mineral, food, printing, and paper, this substitution effect is much smaller, hence, they are much less affected by Dutch disease.

We also find that export orientation plays little role in determining the exchange rate effect on employment. The estimated coefficient on the interaction term between exchange rate and the import penetration ratio has a wrong sign, but this coefficient is not significant by itself and has a small absolute value. Overall, most of the cross-industry differences are driven by the differences in imported input share. Of course, we recognize that the interaction between imported input share and exchange rate is not statistically significant by itself (although the joint effect of exchange rate on employment is significant); therefore, the evidence of heterogeneity in this dimension is weak.

Table 2: Regression Analysis for the Four-digit NAICS Manufacturing Industries

	98-10	98-10	90-10
Variables	(1)	(2)	(3)
Δ avg ER (%)	-.66 (0.25)***		-.50 (0.14)***
Δ avg ER (%) · lag export orientation	-.0002 (0.004)		
Δ avg ER (%) · lag share of imported input	-.02 (0.02)		
Δ avg ER (%) · lag import penetration	0.003 (0.007)		
Δ exp ER (%)		-.77 (0.37)**	
Δ exp ER (%) · lag export orientation		-.0003 (0.004)	
Δ imp ER (%)		0.13 (0.39)	
Δ imp ER (%) · lag share of imported input		-.01 (0.01)	
Δ imp ER (%) · lag import penetration		0.005 (0.007)	
lag export orientation	0.05 (0.03)	0.06 (0.03)*	
lag share of imported inputs	0.11 (0.33)	0.11 (0.33)	
lag import penetration	0.6 (0.23)**	0.57 (0.23)**	
Δ real commodity price (%) × lag IO share	0.006 (0.006)	0.006 (0.006)	
lag IO share	-.27 (1.05)	-.27 (1.03)	
Δ real commodity price (%)	-.08 (0.07)	-.10 (0.07)	
Δ real GDP of Canada (%)	3.94 (1.65)**	3.84 (1.67)**	0.03 (0.47)
Δ real foreign GDP (%)	-2.23 (1.68)	-2.10 (1.67)	1.94 (0.49)***
Δ real interest rate, 3m prime corporate paper	2.03 (0.58)***	2.03 (0.57)***	0.11 (0.31)
Δ real interest rate, 10y+ government bond	-3.24 (1.65)**	-3.32 (1.66)**	-.81 (0.27)***
Δ government expenditure share (%)	0.34 (1.57)	0.25 (1.58)	0.43 (0.38)
Δ real nonresidential electric power price (%)	0.08 (0.26)	0.09 (0.25)	0.17 (0.09)*
time	1.06 (0.71)	1.23 (0.7)*	-.33 (0.17)**
Obs.	1187	1187	2726
Wald χ^2	104.40	104.16	143.13
p-value for AR(2) test	0.39	0.40	0.65

Note: [1] All equations are estimated with the Arellano-Bond GMM estimator for dynamic panel regressions (Arellano and Bond, 1991). [2] The symbols "*", "**", and "***" indicate statistical significance at the 10%, 5%, and 1% levels, respectively. [3] The "model χ^2" is the Wald statistic (with degree of freedom equal to 20, 21, and 11, respectively) that measures overall significance of the model. [4] The "p-value for AR (2) test" is the p-value for testing the H0 that the errors are not autocorrelated, a condition under which the Arellano-Bond GMM estimator is consistent.

Table 3: Industry-Specific Exchange Rate Effect on Employment at the Three-digit NAICS Level

Industry	Total marginal effect of ER on employment	ER × import input sh	ER × import penetration	ER × export orientation
Beverage and Tobacco Product (312)	-1.65(.89)*	-0.92	-0.08	0.01
Petroleum and Coal Products (324)	-1.01(.46)**	-0.24	-0.12	0.01
Computer and Electronic Product (334)	-.92(.36)**	-0.33	0.06	0.00
Transportation Equipment (336)	-.88(.32)***	-0.22	0.00	-0.00
Textile Mills (313)	-.79(.3)***	-0.17	0.03	0.00
Textile Product Mills (314)	-.77(.3)***	-0.16	0.05	0.00
Plastics and Rubber Products (326)	-.71(.31)**	-0.10	0.06	-0.01
Miscellaneous (339)	-.69(.3)**	-0.09	0.05	0.00
Electrical Equipment, Appliance, and Component (335)	-.69(.29)**	-0.08	0.05	0.00
Primary Metal (331)	-.69(.26)***	0.00	-0.03	0.00
Chemical (325)	-.66(.28)**	-0.04	0.03	0.00
Leather and Allied Product (316)	-.65(.35)*	-0.08	0.10	-0.01
Machinery (333)	-.63(.3)**	-0.03	0.06	-0.01
Apparel (315)	-.62(.27)**	0.02	0.01	0.00
Fabricated Metal Product (332)	-.56(.26)**	0.14	-0.04	-0.00
Paper (322)	-.55(.29)*	0.18	-0.08	-0.00
Furniture and Related Product (337)	-.55(.27)**	0.18	-0.08	0.00
Printing and Related Support Activities (323)	-.51(.28)*	0.20	-0.06	0.01
Food (311)	-.48(.29)*	0.25	-0.08	0.01
Nonmetallic Mineral Product (327)	-.47(.28)*	0.25	-0.07	0.00
Wood Product (321)	-.42(.34)	0.35	-0.11	-0.00

Note: The symbols "*", "**", and "***" indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

4 All Industries

In this section, we extend our analysis to all industries. Because employment data are not available for nonmanufacturing industries at the four-digit NAICS level, we use data for two-digit NAICS industries for a systematic analysis of the effect of exchange rate on jobs. Employment data are available from 1976 to 2012 in CANSIM (Table 282-0008). Our panel data set covers 10 provinces (Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, Nova Scotia, Ontario, Prince Edward Island, Quebec, and Saskatchewan) and 17 industries. The 17 industries, with their two-digit NAICS codes in parentheses, are

- Agriculture, forestry, fishing, and hunting (11)
- Mining, quarrying, and oil and gas extraction (21)
- Utilities (22)
- Construction (23)
- Manufacturing (31-33)
- Wholesale trade (41)
- Retail trade (44-45)
- Transportation and warehousing (48-49)
- Information, culture, arts, entertainment, and recreation (51, 71)
- Finance, insurance, real estate, and rental and leasing (52, 53)
- Professional, scienific and technical services (54)
- Business, buiding, and other support services (55-56)

- Educational services (61)
- Health care and social assistance (62)
- Accommodation and food services (72)
- Other services (81)
- Public administration (91)

Note that we combine industries 52 and 53 following the industry structure in the Canadian input-output tables. For industries 41, 44-45, and 52-53, employment data starts in 1987 in all provinces. In Prince Edward Island, employment data for industry 21 are only available for 1989-1990, 1993, 1997-1998, and 2007-2012. For industry 11, employment data in Prince Edward Island and Quebec starts in 1988, and there is no employment data at all for Alberta, Manitoba, Ontario, and Saskatchewan. Because these four provinces account for the majority of the employment in the agriculture sector in Canada, we use only agriculture (i.e., industries that produce crops and animals, coded as 111-112 in the NAICS) in the analysis. Employment data for industries 111-112 are available for the entire sample (i.e., 1976-2012 and all 10 provinces).[9]

Due to the lack of trade data of the nonmanufacturing industries, we are unable to construct the trade-weighted export and import exchange rates for each industry. Instead, we use the CERI in the empirical analysis. Data for CERI are available from 1982 to 2012 in CANSIM (Table 176-0064). The CERI is a weighted average of bilateral exchange rates for the Canadian dollar against the currencies of Canada's six major trading partners. Table 4 lists the six foreign currencies and gives the weight for each currency in the CERI. Note that the Chinese yuan has replaced the South Korean won in the index since 1996. We use the CPI deflated real CERI in the regressions in the empirical analysis below.

[9]Our results do not change qualitatively when using data from industry 11.

Table 4: Currency Weights in the CERI

Currency	Weights since 1996	Weights before 1996
US dollar	0.7618	0.5886
Euro	0.0931	0.1943
Japanese yen	0.0527	0.1279
Chinese yuan	0.0329	–
Mexican peso	0.0324	0.0217
UK pound	0.0271	0.0368
South Korean won	–	0.0307

Source: Bank of Canada

Using the same weights in the CERI, we construct the weighted foreign real GDP growth as a proxy for foreign demand in our empirical model. Data for real GDP growth are also from the IMF World Economic Outlook Database (October 2013). The real GDP growth for the Euro zone is the weighted real GDP growth of the Euro 12 countries.[10] We use GDP based on PPP valuation as the weights.

Our baseline regression for the two-digit NAICS industries is

$$\begin{aligned}\Delta L_{ijt}(\%) =& \beta_0 + (\beta_1 + \beta_2 \cdot expori_{it-1} + \beta_3 \cdot impinp_{it-1} + \sum \beta_4^i \cdot D_i) \cdot \Delta e_t(\%) \\ & + \beta_5 \cdot expori_{it-1} + \beta_6 \cdot impinp_{it-1} \\ & + \beta_7 \cdot ioshare_{it} \cdot \Delta P_t^{com}(\%) + \beta_8 \cdot ioshare_{it} + \beta_9 \cdot \Delta P_t^{com} \\ & + \beta_{10} \cdot \Delta y_t(\%) + \beta_{11} \cdot \Delta y_{it}^*(\%) + \beta_{12} \cdot \Delta r_t^s + \beta_{13} \cdot \Delta r_t^l \\ & + \beta_{14} \cdot \Delta G_t(\%) + \beta_{15} \cdot \Delta P_t^e(\%) + \sum \beta_{16}^i \cdot t \cdot D_i + \beta_{17} \cdot \Delta L_{ijt-1}(\%) \\ & + \beta_{18} \cdot \Delta L_{ijt-2}(\%) + \beta_{19} \cdot \Delta L_{ijt-3}(\%) + \beta_{20} \cdot \Delta L_{ijt-4}(\%) + D_{ij} + u_{ijt} \quad (2)\end{aligned}$$

where $\Delta L_{ijt}(\%)$ is the growth rate of employment of a two-digit NAICS industry i in province j between period t and $t-1$. Similar to before, we include the lags of the dependent variable in the regression to account for the dynamics in labour adjustment.

[10]The Euro 12 countries are Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, Netherland, Portugal, and Spain.

We use four lags because with four lags in the regressions, we cannot reject the null that u_{ijt} is i.i.d, a condition under which the model is identified.

Most specifications in this section are similar to the previous section, i.e., we include the percentage change in the exchanger rate, the share of imported inputs ($impinp_{it-1}$), the export orientation ($expori_{it-1}$), and the interactions between them in regressions in this section. However, two-digit NAICS industries we study in this section are arguably more heterogeneous compared to the four-digit NAICS manufacturing industries in the previous section. Therefore, in regressions in this section, we also interact the exchange rate with a full set of industry dummies (D_i).[11] As a result, the exchange rate effect on employment in industry i in the sample period can be computed as

$$\hat{\beta}_1 + \hat{\beta}_2 \cdot \overline{expori}_i + \hat{\beta}_3 \cdot \overline{impinp}_i + \hat{\beta}_4^i$$

where $\overline{impinp}_i$ ($\overline{expori}_i$) is the average imported input share (export orientation) of industry i over the sample period.

A full set of industry-specific time trends ($t \cdot D_i$) is included to capture any industry-level trends over time (e.g. industry-level technological changes). We also include industry and province fixed effects (D_{ij}) to control for other unobserved heterogeneities among industries and across provinces. Finally, the variable u_{ijt} is an independent and identically distributed (i.i.d.) error term.

To construct the imported input share, the export orientation, and the IO share for each industry, we need data from the input-output tables. Provincial input-output tables are only available for the period of 2004-2009. To expand the sample period, we use data from national input-output tables that are available from 1997 to 2009. As a result, the most reliable sample period for our analysis is 1998-2010.[12] By assuming that

[11] The dummy for the manufacturing industry is dropped as the omitted group.

[12] Note that variables constructed from the input-output tables are available for 1997-2009. However, we use one-year lags of these variables in the regression, which is why our sample for the period for which we actually have input-output data starts in 1998 and ends in 2010.

the input-output structure pre-1997 (post-2009) is the same as that in 1997 (2009), we can expand our sample to 1983-2012. To address the concern that the recent financial crisis might play a role here, we also check the results by truncating the sample at year 2008 (i.e., 1983-2008 and 1998-2008).

Table 5 reports the results. Again, to obtain consistent estimates for the parameters, we use the Arellano-Bond GMM estimator. The first three columns examine the periods that starting in 1983 (i.e., 1983-2008, 1983-2010, and 1983-2012). We find that most coefficients are statistically insignificant at conventional levels except the real GDP growth of Canada. The estimated coefficient of the IO share is negative and significant (at the 5% level) for the period of 1983-2010 and 1983-2012. This unexpected (unintuitive) sign is likely due to the lack of accurate input-output data before 1997 and after 2009. For the periods starting in 1998 (i.e., 1998-2008, 1998-2010, and 1998-2012), we find that most coefficients are again statistically insignificant, including the real GDP growth of Canada. There are only a few exceptions. Between 1998 and 2008, the estimated coefficients of the export orientation and its interaction with the exchange rate are negative (consistent to the theory) and significant at the 10% level. Between 1998 and 2012, employment is positively correlated with the foreign real GDP growth and the percentage change in real nonresidential electric power price. These two coefficients have signs as expected and are significant at the 10% and the 5% level, respectively.

Table 6 reports the industry-specific exchange rate effect on employment. Consistent with what we find in Table 5, employment in most industries is not affected by exchange rate movements at any conventional level of statistical significance. Results from the most reliable sample period (i.e., 1998-2010) show that none of the industries responds significantly to the value of the Canadian dollar. The pre-crisis data (i.e., 1998-2008) largely confirm the finding here. During this period, the exchange rate effect on employment in the utilities industry (22) is negative and significant at the 1% level. Meanwhile, employment in the transportation and warehousing industry (48-49) responds positively to an appreciation of the Canadian dollar, although it is only significant at the 10% level. For the period of 1983-2008, we find that the employment of the transportation and warehousing industry (48-49) and the employment of the professional, scientific, and technical services industry (54) are positively correlated with the exchange rate changes. The former is significant at the 10% level, while the latter is significant at the 5% level. Extending the sample to the post-crisis period (i.e., 1983-2010 and 1983-2012) has little effect on our results. Employment of the professional, scientific, and technical services industry (54) is again positively correlated with the value of the Canadian dollar. Employment of the transportation and warehousing industry (48-49) does not show any significant response to exchange rate changes any more, but employment of the educational services industry (61) is negatively correlated with the exchange rate between 1983 and 2012. The results of 1998-2012 are somewhat different from the others. Besides uilities (22) and educational services (61), employment of the information, culture, arts, entertainment, recreation (51, 71) and the other services (81) also respond negatively to an appreciation of the Canadian dollar. Because we do not have reliable input-output data for the years pre-1997 and post-2009, we conclude that, based on the results from 1998-2008 and 1998-2010, overall we do not find a significant impact of exchange rate on employment at the two-digit NAICS level.

Table 5: Regression Analysis for the Two-digit NAICS Industries

	83-08	83-10	83-12	98-08	98-10	98-12
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Δ real ER (%)	0.58 (2.01)	-.61 (1.28)	-.83 (1.14)	3.68 (2.52)	2.02 (1.74)	0.69 (1.42)
Δ real ER (%) · lag export orientation	-.02 (0.03)	0.0005 (0.01)	-.001 (0.01)	-.07 (0.04)*	-.02 (0.02)	-.01 (0.02)
Δ real ER (%) · lag share of imported input	0.006 (0.08)	0.03 (0.05)	0.05 (0.05)	-.06 (0.1)	-.06 (0.07)	-.02 (0.06)
lag export orientation	-.10 (0.26)	0.24 (0.21)	0.15 (0.2)	-.61 (0.33)*	-.14 (0.24)	-.09 (0.21)
lag share of imported input	0.46 (0.36)	-.17 (0.32)	-.21 (0.3)	0.53 (0.38)	-.33 (0.34)	-.06 (0.34)
Δ real commodity price (%) · lag IO share	0.004 (0.004)	0.0002 (0.003)	-.0002 (0.002)	0.005 (0.006)	-.0006 (0.004)	-.002 (0.004)
lag IO share	-.02 (2.37)	-2.61 (1.26)**	-2.82 (1.16)**	0.98 (3.12)	-.63 (1.68)	-1.84 (1.38)
Δ real commodity price (%)	-.02 (0.02)	-.02 (0.02)	-.03 (0.02)*	-.01 (0.04)	0.03 (0.03)	0.03 (0.03)
Δ real GDP of Canada (%)	0.68 (0.25)***	0.7 (0.19)***	0.69 (0.18)***	1.30 (0.82)	0.6 (0.65)	-.31 (0.47)
Δ real foreign GDP (%)	-.33 (0.35)	-.02 (0.25)	0.18 (0.22)	-.98 (1.37)	-.43 (0.93)	1.01 (0.61)*
Δ real interest rate, 3m prime corporate paper	0.009 (0.18)	-.04 (0.15)	-.06 (0.15)	-.05 (0.55)	-.005 (0.32)	-.13 (0.31)
Δ real interest rate, 10y+ government bond	-.21 (0.17)	-.22 (0.16)	-.21 (0.15)	-.23 (0.43)	0.21 (0.37)	0.25 (0.38)
Δ government expenditure share (%)	0.02 (0.19)	0.14 (0.13)	0.18 (0.13)	0.25 (0.54)	0.31 (0.27)	0.27 (0.21)
Δ real nonresidential electric power price (%)	0.08 (0.08)	0.03 (0.07)	0.05 (0.07)	0.09 (0.11)	0.08 (0.09)	0.2 (0.08)**
Obs.	3343	3681	4019	1849	2187	2525
Wald χ^2	305.25	240.68	346.82	305.81	227.36	275.75
p-value for AR(2) test	0.64	0.22	0.69	0.24	0.37	0.16

Note: [1] All equations are estimated with the Arellano-Bond GMM estimator for dynamic panel regressions (Arellano and Bond, 1991). [2] The symbols "*", "**", and "***" indicate statistical significance at the 10%, 5%, and 1% levels, respectively. [3] The "Wald χ^2" is the Wald statistic (with degree of freedom equal to 51) that measures overall significance of the model. [4] The "p-value for AR (2) test" is the p-value for testing the H0 that the errors are not autocorrelated, a condition under which the Arellano-Bond GMM estimator is consistent. [5] All equations include a full set of industry-specific time trends and interactions between exchange rate and industry dummies.

Table 6: Industry-Specific Exchange Rate Effect on Employment at the Two-digit NAICS Level

Industry (Two-digit NAICS code)	**83-08**	**83-10**	**83-12**	**98-08**	**98-10**	**98-12**
Agriculture, forestry, fishing and hunting (11)	.35(.33)	.32(.47)	.31(.49)	.47(.48)	.39(.58)	.3(.64)
Mining, quarrying, and oil and gas extraction (21)	0(.35)	.17(.32)	.11(.37)	.15(.43)	.08(.38)	-.07(.45)
Utilities (22)	-.19(.2)	-.09(.17)	-.1(.17)	-.86(.33)***	-.29(.22)	-.45(.26)*
Construction (23)	-.12(.12)	-.03(.11)	0(.11)	-.03(.18)	.04(.16)	-.09(.14)
Manufacturing (31-33)	.14(.12)	.1(.1)	.06(.09)	.12(.2)	.06(.17)	-.17(.14)
Wholesale trade (41)	.17(.28)	.08(.23)	.09(.2)	.05(.34)	.05(.26)	-.15(.2)
Retail trade (44-45)	-.01(.14)	.07(.12)	.14(.11)	.09(.18)	.11(.14)	.05(.13)
Transportation and warehousing (48-49)	.27(.15)*	.13(.14)	.11(.14)	.39(.21)*	.05(.2)	-.08(.17)
Information, culture, arts, entertainment, and recreation (51,71)	.07(.12)	-.13(.1)	-.11(.09)	.27(.22)	-.05(.18)	-.23(.14)*
Finance, insurance, real estate, and rental and leasing (52,53)	.04(.14)	-.01(.12)	.01(.11)	.11(.15)	-.01(.14)	-.12(.13)
Professional, scientific, and technical services (54)	.32(.13)**	.35(.11)***	.31(.11)***	-.11(.2)	.04(.16)	-.17(.14)
Business, building and other support services (55-56)	-.13(.17)	-.16(.15)	-.2(.16)	.12(.29)	.02(.23)	-.26(.21)
Educational services (61)	.02(.13)	-.17(.1)	-.16(.1)*	.21(.21)	-.06(.16)	-.27(.14)**
Health care and social assistance (62)	.01(.1)	-.01(.08)	.02(.08)	.19(.18)	.1(.15)	-.03(.12)
Accommodation and food services (72)	-.03(.15)	-.12(.14)	-.1(.15)	.1(.24)	-.02(.21)	-.25(.18)
Other services (81)	.04(.13)	-.1(.12)	-.15(.12)	.26(.21)	-.03(.19)	-.32(.14)**
Public administration (91)	.13(.11)	-.04(.11)	-.04(.11)	.26(.2)	.01(.19)	-.13(.17)

Note: The symbols "*", "**", and "***" indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

5 Boom in Commodity Prices and Job Loss in Manufacturing Industries

As shown in Figure 4, the real Canadian-dollar effective exchange rate index tend to move in the same direction as the commodity price index published by the Bank of Canada, an index that tracks the prices of commodities produced in Canada. This positive relationship explains why the Canadian dollar is often referred to as one of the major commodity currencies in the world.[13] From Section 3 and Section 4, we can see that the employment effects of the Canadian dollar exchange rate are concentrated in the manufacturing industries. While neither the observed or the estimated positive correlation proves that there is a causal effect from the commodity prices to the value of the Canadian dollar, it remains useful to quantify the expected loss of manufacturing jobs when the commodity sector booms. In this section, we first estimate the exchange rate responses to an increase in commodity prices. Then, we calculate the loss of manufacturing jobs associated with a commodity boom by combining the estimates in this section with the exchange rate elasticity of employment estimated in Section 3.

The relationship between commodity prices and the Canadian dollar is well researched. The pioneer of this literature is Amano and van Norden (1995). They estimated a single error correction model equation for Canada's bilateral real exchange rate with the United States that linked the real exchange rate to real energy and non-energy commodity prices, and the real interest rate differential between Canada and the United States. They found that all the estimated coefficients were significant and display intuitive signs, except that the estimated coefficient of the energy prices was negative. The negative relationship between energy prices and the Canadian dollar found in this paper was left as a puzzle and led to a number of researchers trying to solve the puzzle.[14]

[13]Besides Canada, Australia and New Zealand also have primary commodities constituting a major part of their exports, and movements in commodity prices have been consideredas a significant driver for their currencies.

[14]For a brief survey, see Bailliu and King (2005).

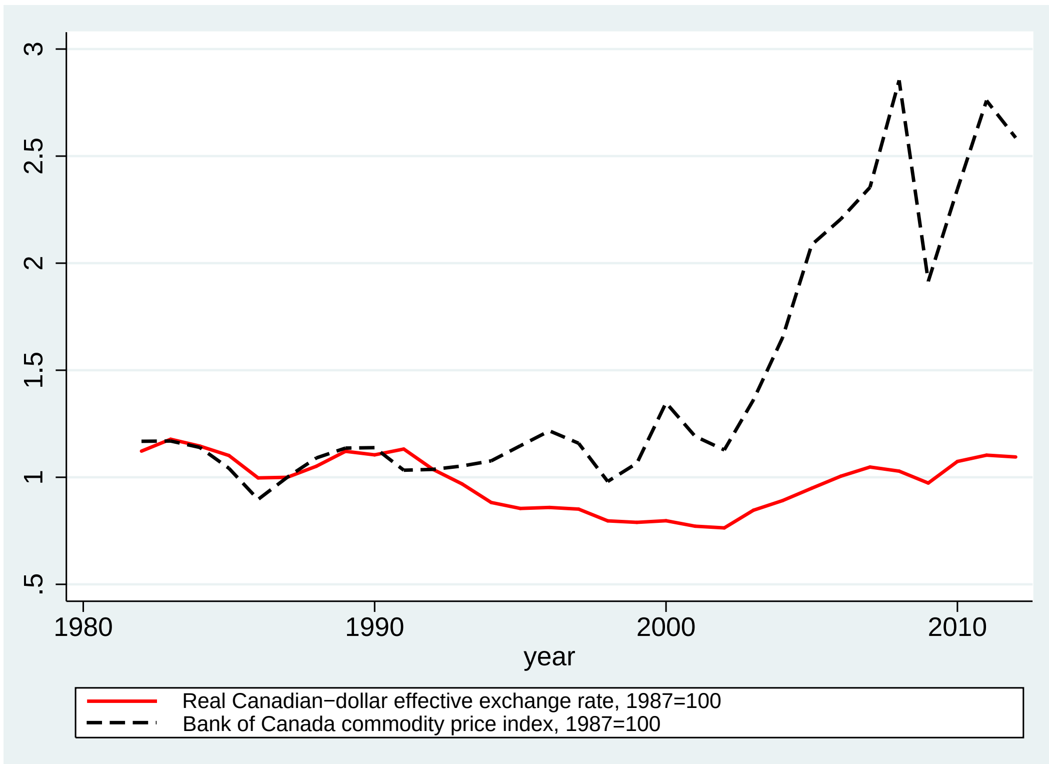

Figure 4: Commodity price index and real Canadian-dollar effective exchange rate

Issa, Lafrance and Murray (2008) first noted that the effect of energy prices on the Canadian dollar had changed over time. They found a structural break in the long-run relationship between energy prices and the Canadian dollar, which turned from negative to positive in the early 1990s and was consistent with the changes in energy prices and Canada's energy and trade policies that happened at the time.

Bailliu, Dib, Kano and Schembri (2014) further expanded the Issa, Lafrance and Murray exchange rate equation, developed a regime-switching model with a time-varying transition matrix, and examined the role of multilateral adjustment to US external imbalances in driving the US-Canada bilateral real exchange rate movements. They found that during periods of large US imbalances, allowing for multilateral adjustment effects was crucial for a successful exchange rate model. The main message of this paper was similar to that of Beine, Bos and Coulombe (2012). Essentially, a real depreciation of the US dollar due to its unsustainable level of external balances may account for a significant fraction of the exchange rate movements in Canada and other countries. Because these so-called US factors are completely exogenous to the domestic economy, standard bilateral exchange rate equations that only emphasize country-specific macroeconomic fundamentals would be insufficient in terms of its explanatory and forecasting power.

Bayoumi and Mühleisen (2006) extended the original Amano and van Norden exchange rate equation and argued that commodity exports affect the exchange rate through not only changes in terms of trade but also in volumes of commodity trade. In other words, the impact of commodity prices depends on the size of the commodity sector. They found that, conditional on the magnitude of commodity production and exports, both energy and non-energy commodity prices had significant positive effects on the Canadian dollar.

Helliwell, Issa, Lafrance and Zhang (2004) estimated a nominal bilateral exchange rate equation and found that their model can successfully account for the movements of the Canadian dollar since 1975. The key difference between their model and the previous ones is that they included the labour productivity differentials between Canada and the United States. Moreover, they considered a set of financial market variables, such as stock market prices, international risk premiums, US current account deficit, and the fiscal deficit differential between Canada and the United States. However, they concluded that these financial variables add little to the fit of their exchange rate equation.

Based on the existing literature, we estimate the following equation that links industry-specific trade-weighted exchange rate to commodity price,

$$\begin{aligned}\Delta(e_{it}) =& \alpha_0 + \alpha_1 \cdot (i_t^{Canada} - i_t^{US}) + \alpha_2 \cdot (labourprod_t^{US} - labourprod_t^{Canada}) + \alpha_3 \cdot CA_t^{US} \\ &+ \sum_i \gamma_i \cdot \Delta(P_t^{com}) \cdot D_i + v_{it}. \end{aligned} \tag{3}$$

where P_t^{com} is the real commodity price index. The variables i_t^{Canada} and i_t^{US} are the interest rates on the 10-year government bonds in Canada and the United States, respectively. The variables $labourprod_t^{Canada}$ and $labourprod_t^{US}$ measure the labour productivities in the two countries. CA_t^{US} is the ratio of current account balance to GDP in the United States. Let the parameters γ_i denote the commodity price elasticity of the trade-weighted exchange rate for industry i. We present the regression results with respect to the first three variables in Table 7, and summarize the estimates of γ_i for the 86 four-digit NAICS manufacturing industries in the first row of Table 8. On average, a 1% increase in commodity prices leads to a 0.08% appreciation in industry-specific trade-weighted exchange rates. All estimates of γ_i are statistically significant at the 0.1% level.

Holding other factors constant, we can compute the effect of commodity prices on employment by multiplying the exchange rate elasticity of employment to the commodity price elasticity of the exchange rate. Specifically, for each industry i, the effect of a one standard deviation positive shock to commodity prices (which is 15.77% between 1994 and

Table 7: Exchange Rate Regression

	L1
Variables	(1)
Canada-US long-run interet rate differential	0.22
	(0.08)***
Canada-US labour productivity differential	-.10
	(0.02)***
US current account deficit	-.31
	(0.03)***
Δ commodity prices $\times$ industry dummies	included
Obs.	1538
R^2	0.24

Table 8: Effects of Commodity Price on Employment in the Four-digit NAICS Manufacturing Industries

	mean	min	max	std	total
γ_i: commodity price elasticity of trade-weighted exchange rate of industry i	0.08	0.05	0.11	0.01	NA
$\Delta L_i(\%)$: predicted employment growth after a 15.77% increase in commodity price	-0.8	-1.73	-0.30	0.27	NA
ΔL_i: predicted change in employment after a 15.77% increase in commodity price	-136	-740	-1	137	-11,656

2010) on employment is

$$\Delta L_i(\%) = 15.77\% \cdot \hat{\gamma}_i \cdot (\hat{\beta}_1 + \hat{\beta}_2 \cdot \overline{expori}_i + \hat{\beta}_3 \cdot \overline{impinp}_i + \hat{\beta}_4 \cdot \overline{imppene}_i]$$

where the expression in the bracket is the marginal effect of exchange rate on employment in industry i.

The second and third rows in Table 8 summarize the predicted growth rate of employment and the change in the number of jobs based on the level of employment in 2010. The change in the number of jobs for industry i is calculated as $\Delta L_i = \Delta L_i(\%) \cdot L_{i,2010}$. After a 15.77% increase in commodity prices, on average the employment in a manufacturing industry is predicted to decrease by 0.8%. The predicted total loss of manufacturing jobs is 11,656, equivalent to about 0.08% in Canada's total employment in 2010.

Lastly, we aggregate the numbers of predicted job losses to three-digit NAICS manufacturing industries and tabulate the predicted effects of a 15.77% increase in commodity prices on employment in Table 9. Among all industries, the berverage and tobacco prodcut industry, the petroleum and coal product industry, and the transportation equipment manufacturing industry stand out because they account for 1.78%, 0.89%, and 10.76% of the total manufacturing employment, but are predicted to account for 4.78%, 1.47%, and 14.95% of the total manufacturing job losses, respectively. The wood product industry and the food industry also stand out because they account for 6.04% and 15.72% of the toal manufacturing employment, but are predicted to account for only 3.52% and 9.88% of the toal manufacturing job losses. For the other industries, their shares in the predicted job losses are mostly in line with their shares in the total manufacturing employment.

Table 9: Job Loss at the Three-digit NAICS Level

Industry	Employment in 2010	% in total manu employment	Predicted change of employment (%)	Predicted change of employment	% in total predicted change of employment
Food (311)	232,710	15.72	-0.49	-1,151	9.88
Beverage and Tobacco Product (312)	26,362	1.78	-2.11	-557	4.78
Textile Mills (313)	8,026	0.54	-0.86	-69	0.59
Textile Product Mills (314)	9,762	0.66	-0.99	-97	0.83
Apparel (315)	25,670	1.73	-0.92	-236	2.03
Leather and Allied Product (316)	3,957	0.27	-0.95	-38	0.32
Wood Product (321)	89,381	6.04	-0.46	-410	3.52
Paper (322)	57,501	3.89	-0.67	-383	3.29
Printing and Related Support Activities (323)	56,325	3.81	-0.71	-397	3.41
Petroleum and Coal Products (324)	13,152	0.89	-1.31	-172	1.47
Chemical (325)	81,314	5.49	-0.84	-681	5.85
Plastics and Rubber Products (326)	95,069	6.42	-0.86	-819	7.03
Nonmetallic Mineral Product (327)	47,375	3.20	-0.63	-301	2.58
Primary Metal (331)	59,038	3.99	-0.74	-436	3.74
Fabricated Metal Product (332)	151,788	10.26	-0.69	-1,047	8.99
Machinery (333)	124,056	8.38	-0.75	-929	7.97
Computer and Electronic Product (334)	71,927	4.86	-1.05	-752	6.45
Electrical Equipment, Appliance, and Component (335)	36,740	2.48	-0.90	-332	2.84
Transportation Equipment (336)	159,301	10.76	-1.09	-1,742	14.95
Furniture and Related Product (337)	73,783	4.99	-0.76	-561	4.81
Miscellaneous (339)	56,773	3.84	-0.96	-545	4.67
Total	1,480,010	100%	NA	11,656	100%

6 Discussion and Conclusion

In this paper, we examine the effects of exchange rate movements on jobs in Canada. We find that a real appreciation of the Canadian dollar has negative effects on employment in the manufacturing industries but not in the other industries. Because the manufacturing sector accounts for only about 10% of employment in Canada, our estimates suggest that the exchange rate movements have little impact on Canadian jobs as a whole.

In the regression analysis for the manufacturing industries, we find that a 1% appreciation in the trade-weighted exchange rate is associated with a 0.66% decrease in employment on average. When we distinguish between import- and export-weighted exchange rates, we find that the export-weighted exchange rate has a significant effect on employment, while the partial effect of a change in the import-weighted exchange rate is statistically insignificant.

Following a boom in the global commodity market, the value of the Canadian dollar tends to rise and employment in the manufacturing industries typically drops. In our analysis, we quantify the loss of manufacturing jobs associated with a one standard deviation increase in commodity prices on manufacturing jobs. We find that the predicted loss of manufacturing jobs is about 0.8% of the total manufacturing employment, or about 0.08% of the total employment in Canada. We note that even though the predicted job loss is moderate in terms of the aggregate Canadian economy, the effects are concentrated in Ontario and Quebec because they account for 44.8% and 28.7% of Canada's manufacturing employment in 2010, respectively. However, monetary and exchange rate policies are not suitable for addressing such regional imbalances.

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Appendix to "The effects of exchange rates on employment in Canada"

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This appendix contains supplemental materials to Huang, Pang and Tang (2014). Section A.1 documents the construction of industry-specific exchange rates and the sources of relevant data used in the analysis of the four-digit NAICS manufacturing industries. We discuss the other variables in Section A.2 and the deflation of the Candian-dollar effective exchange rate (CERI) in Section A.3. Table 1 lists the key variables used in our analysis, the corresponding data sources, and the time periods during which data are available.

A.1 Industry-specific Exchange Rates

We first construct the bilateral real exchange rate between Canada and its top 30 export destination and import source countries in terms of merchandise trade from 1990 to 2012. The top 30 export destinations, in descending order of export volume, are the United States, Japan, the United Kingdom, China, Germany, South Korea, Mexico, France, Belgium & Luxembourg, the Netherlands, Italy, Hong Kong, Taiwan, Australia, Brazil, Norway, Spain, India, Indonesia, Switzerland, Algeria, Venezuela, Malaysia, Iran, the Russian Federation, Denmark, Thailand, Singapore, Colombia, and the Philippines. From 1997 to

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2012, these countries accounted for 97.7% of Canada's total export, with the United States alone accounting for 85.1% of Canada's total export. By subtracting Columbia, Iran, and the Russian Federation from the previous list, and adding Ireland, Saudi Arabia, and Sweden, we have the list of the top 30 import sources. These economies accounted for 95.2% of Canada's total import from 1997 to 2012. The United States' share of Canada's total import is 64.1%. The bilateral real exchange rate between Canada and country j, $e_{j,t}$, is calculated as

$$e_{j,t} = \frac{s_{j,t} P_{Canada,t}}{P_{j,t}}, \tag{A.1}$$

where $s_{j,t}$ is the bilateral nominal exchange rate in year t, defined as the price of the Canadian dollar in terms of the currency of country j. The variables $P_{Canada,t}$ and $P_{j,t}$ are the Producer Price Index (PPI) in Canada and in country j, respectively. We favour PPI over the Consumer Price Index (CPI) in the construction of the real exchange rate because, as suggested by Betts and Kehoe (2006), the PPI is more suitable than the CPI for computing relative price in international trade. When the PPI is not available, we use the Wholesale Price Index (WPI) instead in the calculation of the real exchange rate. If the WPI is also not available, we use the CPI. We obtain the bilateral nominal exchange rate, the PPI, the WPI, and the CPI from the International Financial Statistics (IFS) dataset published by the International Monetary Fund (IMF). Because the level of the bilateral real exchange rate depends on the two countries' base years for PPIs, the levels of the bilateral real exchange rate are not directly comparable across different pairs of countries. Therefore, we rely on the rate of change in the bilateral real exchange rate to measure the strength of the Canadian dollar against foreign currencies. For industry i, the rate of change in the export-weighted real exchange rate is given by

$$\frac{e^x_{i,t} - e^x_{i,t-1}}{e^x_{i,t-1}} = \sum_j \underbrace{\frac{1}{5} \cdot \sum_{k=1}^{5} \frac{export_{i,j,t-k}}{export_{i,t-k}}}_{trade\ weight} \cdot \frac{e_{j,t} - e_{j,t-1}}{e_{j,t-1}}, \tag{A.2}$$

where $e^x_{i,t}$ is the export-weighted real exchange rate for industry i, $export_{i,j,t-k}$ denotes the export of products from industry i to country j in year $t-k$, and $export_{i,t-k}$ is the total export of products from industry i in year $t-k$. We use the average of the previous five years' export shares to weight the rate of change in the corresponding real exchange rates. The lags of export shares are used in calculating the weights to avoid contemporaneous correlation between these trade-based weights and exchange rates. The construction of the import-weighted exchange rate is similar.

We obtain the export and import data on merchandise trade from Statistics Canada. The original export and import data are coded at the Harmonized System (HS) eight-digit and ten-digit levels, respectively. Because our purpose is to study employment of the manufacturing industries at the four-digit North American Industry Classification System (NAICS) level, we map the trade data into the four-digit NAICS industries by applying the concordance constructed by Stoyanov (2009). In the actual computation of the export-weighted exchange rate and the import-weighted exchange rate, we apply the 2003 export and import weights to all subsequent years because, starting in 2004, the data on merchandise exports are mapped into only 24 four-digit NAICS industries, while the data up to 2003 are mapped into about 110 industries, which include most manufacturing industries and some nonmanufacturing industries. Because the concordance between the HS codes and the NAICS codes are stable around 2003, and it is unlikely that more than 80 industries suddenly stopped exporting after 2003, the reduction in the number of industries matched is likely caused by the change in the classification of merchandise exports in the HS coding. Because we do not have the information to address such potential problems in the original data, we use the import and export weights for manufacturing industries in 2003 to measure their trade composition after 2003. Otherwise, we will have no trade weights to calculate the trade-weighted exchange rates for most of the four-digit NAICS manufacturing industries after 2003.

A.2 Other Variables

The export-weighted real GDP growth in trade partners is obtained by replacing the rate of change in the real bilateral exchange rate with the real GDP growth rate of country j in equation (A.2). We retrieve the real GDP growth rates for Canada and other countries from the IFS. We summarize the sources of other variables in Table **??**, where the abbreviation CANSIM stands for Canadian Socio-economic Information Management System from Statistics Canada. We use the CPI to deflate the nominal variables in the regressions.

Due to a change in data collection methodology, the manufacturing employment data from the Annual Survey of Manufacturing (ASM) dataset (covering 1990 to 2003) and the Principal Statistics for Manufacturing Industries (PSMI) dataset (covering 2004 to 2007) are not directly comparable. These dataset state that the total employment of all manufacturing industries was 1,947,301 in 2003 and 1,823,349 in 2004. These numbers imply a growth rate of -6.365% between 2003 and 2004. Based on CANSIM Table 281-0024, which consistently tracks employment at the two-digit NAICS level, the actual growth rate of manufacturing employment was -1.970% from 2003 to 2004. Therefore, the growth rate obtained by comparing the 2004 employment data from the PSMI to the 2003 employment data from the ASM appears to overstate the drop in employment between 2003 and 2004. To use the data from these two sources, we add a correction factor of 4.395% (which is equal to -1.970%-(-6.365%)) to the growth rate of employment in each four-digit NAICS industry between 2003 and 2004 computed from the original data.

Our rationale for the correction is as follows. Let $L_{i,04}^{PSMI}$ be the measure of employment in manufacturing industry i in 2004 observed from the PSMI dataset. Let $L_{i,04}^{ASM}$ denote the would-be measure of employment in manufacturing industry i in 2004 from the ASM dataset, had it been continued to 2004. Let ϵ_i be the industry-specific measurement discrepancy arising from the switch from the ASM to the PSMI, defined by

$L_{i,04}^{PSMI} = L_{i,04}^{ASM}(1 + \epsilon_i)$. We can write

$$\begin{aligned} ln(L_{i,04}^{PSMI}) &= ln[L_{i,04}^{ASM}(1 + \epsilon_i)] \\ &= ln(L_{i,04}^{ASM}) + ln(1 + \epsilon_i) \\ &\approx ln(L_{i,04}^{ASM}) + \epsilon_i \end{aligned} \tag{A.3}$$

where the approximation follows from $ln(1 + x) \approx x$ for a small x. It is plausible that the change from the ASM to the PSMI represents a systematic change in measurement for each industry i, but there may be idiosyncratic errors as well when applying the new method to each industry. Hence, we can assume that

$$\epsilon_i = \overline{\epsilon} + u_i$$

where $\overline{\epsilon}$ is the systematic change in measurement, and u_i is a zero-mean idiosyncratic error term. Substituting the last line into equation (A.3), we have

$$\begin{aligned} ln(L_{i,04}^{PSMI}) &\approx ln(L_{i,04}^{ASM}) + \overline{\epsilon} + u_i \\ ln(L_{i,04}^{PSMI}) - \overline{\epsilon} &\approx ln(L_{i,04}^{ASM}) + u_i \\ ln(L_{i,04}^{PSMI}) - ln(L_{i,03}^{ASM}) - \overline{\epsilon} &\approx ln(L_{i,04}^{ASM}) - ln(L_{i,03}^{ASM}) + u_i \end{aligned} \tag{A.4}$$

where $ln(L_{i,03}^{ASM})$ is the measure of employment in industry i in 2003 observed in the ASM. Note that on the left-hand side of equation (A.4), the first two terms ($ln(L_{i,04}^{PSMI}) - ln(L_{i,03}^{ASM})$) are the approximate growth rate of employment constructed by comparing the 2004 employment number from the PSMI to the 2003 employment number from the ASM. Our best guess for the systematic error is the factor of 4.395% calculated above. Therefore, the left-hand side is the corrected growth rate proposed above. On the right-hand side, the first two terms ($ln(L_{i,04}^{ASM}) - ln(L_{i,03}^{ASM})$) are the growth rate we could have computed if the ASM had been continued to 2004. Taken together, equation (A.4) states that our corrected employment growth rate for 2004 is approximately equal to a consistently defined employment growth rate plus a measurement error. As long as the measurement error u_i

associated with the program change from the ASM to the PSMI in Statistics Canada is not correlated with the independent variables in our regression, such as exchange rates and GDP growth rates, the use of our corrected growth rate for the year 2004 will not cause bias in regressions.

A.3 Real CERI

According to the information posted on the Bank of Canada's website, the formula for the CERI is

$$I_t = I_{t-1} \cdot \prod_{j=1}^{N(t)} \left(\frac{e_{j,t}}{e_{j,t-1}} \right)^{w_{j,t}}, \quad j = 1, 2, \cdots, N(t) \tag{A.5}$$

where I_t is the index in period t and $e_{j,t}$ is the price of foreign currency j per Canadian dollar at time t. $N(t)$ is the number of foreign currencies in the index at time t. $w_{j,t}$ is the weight of currency j in the index at time t, and $\Sigma_j w_{j,t} = 1$. Following Ong (2006), we can construct a real CERI by changing the nominal exchange rate to a real exchange rate in the above formula. That is,

$$R_t = R_{t-1} \cdot \prod_{j=1}^{N(t)} \left(\frac{e_{j,t} \cdot P_t / P_{j,t}}{e_{j,t-1} \cdot P_{t-1} / P_{j,t-1}} \right)^{w_{j,t}}, \quad j = 1, 2, \cdots, N(t) \tag{A.6}$$

where P_t is the price deflator for Canada and $P_{j,t}$ is the price deflator for country j at time t. Although producer price index is a more suitable deflator to use when it comes to explain movements in output and employment, such data are often not available. Instead, we use CPI as the price deflator. Data on CPI are from the IMF World Economic Outlook Database (October 2013). Let π_t denote the CPI inflation between period t and $t-1$ (i.e., $\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}}$), and combine equations (A.5) and (A.6). The real CERI is given by

$$\frac{R_t}{R_{t-1}} = \frac{I_t}{I_{t-1}} \cdot (1 + \pi_t) \cdot \prod_{j=1}^{N(t)} \left(\frac{1}{1 + \pi_{j,t}} \right)^{w_{j,t}}, \quad j = 1, 2, \cdots, N(t) \tag{A.7}$$

Note that the CPI inflation for the Euro zone is the weighted CPI inflation of the Euro 12 countries.[1] We use GDP based on PPP valuation as the weights.

[1] The Euro 12 countries are Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, Netherland, Portugal, and Spain.

Table 1: Sources of Data

Variable	Time Period	Data Source
Employment in four-digit NAICS manufacturing industries	1990-2003	CANSIM Table 301-0003, Annual Survey of Manufacturing
Employment in four-digit NAICS manufacturing industries	2003-2007	CANSIM Table 301-0006, Principal statistics for manufacturing industries
Employment in two-digit NAICS industries	1976-2013	CANSIM Table 282-0008
Canadian Dollar Effective Exchange Rate Index	1982-2013	CANSIM Table 176-0064
Real GDP Growth	1980-2012	IMF World Economic Outlook Database (October 2013)
Nominal 3 month prime corporate paper rate	1956-2013	CANSIM Table 176-0043
Nominal average yield on government of Canada bond of over 10 years	1956-2013	CANSIM Table 176-0043
Consumer price index, 2011 basket (2002=100)	1914-2013	CANSIM Table 326-0021
Government expenditure share	1981-2013	CANSIM Table 380-0064
Nonresidential electric power price	1981-2013	CANSIM Table 329-0073
Commodity Price	1972-2013	Bank of Canada
Share of imported inputs	1997-2009	Statistics Canada National Symmetric Input-Output Tables
Export orientation	1997-2009	Statistics Canada National Symmetric Input-Output Tables
IO demand	1997-2009	Statistics Canada National Symmetric Input-Output Tables 15-207/8-XCB
Canada labour productivity	1981-2012	CANSIM Table v1409153
US 10-year government bond yield	1980-2013	IMF International Financial Statistics
US labour productivity	1970-2011	Bureau of Labor Statistics
US current account deficit	1980-2012	IMF World Economic Outlook Database (October 2013)

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