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The Effects of Exchange Rates on Employment in Canada

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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 employment 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. The export-weighted exchange rate elasticity of employment is -0.52. However, we also find that exchange rate fluctuations have little impact on Canada's nonmanufacturing employment. Because the manufacturing sector accounts for only about 10% of the employment in Canada, the overall employment effect of exchange rates is small. In addition, we assess the potential employment impact of a boom in the global commodity market, which often leads to appreciations of the Canadian dollar. We find that a 12.21% increase in commodity prices (one standard deviation in the 1994-2007 data) reduces Canada's manufacturing employment by 0.98%, less than 0.1% of the total industrial 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, and the exchange rate is flexible, which allows the Bank to pursue 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'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 that reduces the competitiveness of the Canadian manufacturing industries in the world market.

In this paper, we use data from 1994 to 2007 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 the 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 export-weighted exchange rate will reduce employment by 0.52%. Meanwhile, changes in the import-weighted exchange rate do not have significant effects on employment, presumably because appreciations in the import-weighted exchange rate reduce the costs of imported inputs and thus mitigate the negative effects of cheaper imported final products.

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 industrial employment in Canada, the overall effects of the exchange rate on Canadian employment is relatively small.

Third, because commodity prices are often a major factor in the movements in the Canadian dollar, we also estimate the effects of a commodity boom on manufacturing employment. The estimates suggest that following a one standard deviation positive shock to commodity prices (i.e., a 12.21% increase in the overall price of commodities produced in Canada), the manufacturing employment will decrease by 0.98%, equivalent to about a 0.1% decrease in the industrial employment of Canada[1].

Overall, our empirical results suggest that the employment effects of exchange rate appreciations are small in Canada. Specifically, even with a large commodity-demand shock driving up the value of the Canadian dollar, the collateral loss in manufacturing employment represents only a small fraction of total employment of Canada. Furthermore, there is no evidence that exchange rate movements negatively affect employment in the nonmanufacturing sectors. Therefore, in terms of employment, the flexible exchange rate regime does not appear to create an undue burden to the Canadian economy. We recognize that a commodity boom can have different regional impacts due to differences in industrial composition.[2] 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.

A number of papers examine the effects of the exchange rate on various aspects of the Canadian economy, such as firm performance and survival (Baggs et al., 2009; Tom-

[1] The description for industrial employment in CANSIM Table 281-0024, from which we obtain the data, is "Industrial aggregate covers all industrial sectors except those primarily involved in agriculture, fishing and trapping, private household services, religious organizations and the military personnel of the defense services."

[2] Ontario and Quebec accounted for 43.8% and 27.7% of Canada's manufacturing employment in 2011, while Alberta accounted for 56.1% of employment in the industry of mining, quarrying, and oil and gas extraction.

lin, 2010), productivity (Tang, 2010), province-level employment (Coulombe, 2008), and industry-level employment (Leung and Yuen, 2007). In terms of employment, Coulombe (2008) and Leung and Yuen (2007) find that appreciations in the exchange rate significantly reduced employment in Canadian manufacturing industries and employment in Canadian provinces, respectively.[3]

Relative to previous studies on the employment effects of the exchange rate, our paper offers a number of improvements. 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 use the cross-sectional variation in the exchange rates and the 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 the effect of a commodity boom on the manufacturing employment via the exchange rate channel.

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 1993 and 2011. To calculate real exchange rates, we obtained nominal exchange rates and producer price indices from the Bank of Canada and the International Monetary Fund (IMF), respectively. The employment and manufacturing data are from Statistics Canada. We document the details

[3]There is 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.

of construction and treatment of key variables in the appendix. We chose 1993 as the starting point because it follows the end of the early 1990s recession in Canada.

During this period, total employment in Canada, including both full-time and part-time workers, grew from 12.8 million in 1993 to 17.5 million in 2011. Industrial employment, which is equal to total employment minus the employment in the sectors of agriculture, fishing and trapping, private household services, religious organizations, and the national defense services, increased from 10.8 million in 1993 to 14.9 million in 2011. Meanwhile, the Canadian population increased from 28.7 million to 34.5 million. Because the growth in either total employment (36.7%) or industrial employment (38.0%) is higher than the growth in population (20.2%), the overall employment picture of Canada looks healthy over the entire period, notwithstanding the 2008-9 recession during the worldwide financial and economic crisis.

We next examine employment trends by major industry groups. From the first two columns of Table 1, we can see service industries employ far more workers than goods industries, and the share of service industries has increased over time. In the next four columns, we tabulate statistics for four main goods industries (North American Industry Classification System [NAICS] two-digit codes in parentheses): agriculture, forestry, fishing, and hunting (11); mining, quarrying, and oil and gas extraction (21); construction (23); and manufacturing (31-33). The hare of these goods industries has declined substantially, mostly due to the decline in the manufacturing industries.

The decline in manufacturing employment is concentrated in Ontario and Quebec. In 2011, Ontario and Quebec accounted for 43.8% and 27.7% of Canada's manufacturing employment, respectively. Between 1993 and 2011, the manufacturing employment of Canada decreased by 194,040. Meanwhile, the drops in manufacturing employment for Ontario and Quebec were 148,908 and 48,211, which add up to 197,119. These numbers suggest that Ontario and Quebec accounted for virtually all of the drop in manufacturing employment between 1993 and 2011 while the rest of Canada added about 3,000 manufacturing jobs.

In the left panel of Figure 1, we plot the employment of the goods industries, the employment of the services industries, and the Canadian-dollar effective exchange rate index, which is a real trade-weighted exchange rate, published by the Bank of Canada. To facilitate comparison, we normalize all variables to 100 in 1993. The exchange rate first went through a moderate depreciation between 1993 and 2002 (14.9%) before it experienced a substantial appreciation between 2002 and 2011 (49.3%).

In the right panel of Figure 1, we turn our attention to the four 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. In particular, the drop in manufacturing employment after 2000 largely coincides with the strong run-up of the Canadian dollar. As for the other goods industries, construction has been steadily adding jobs since 1993, except during the most recent recession. The numbers of jobs in the agriculture, forestry, fishing, and hunting industry have been declining since the mid-1990s. The employment of the mining, quarrying, and oil and gas industry seems to track the exchange rate quite closely, presumably because the world demand for these commodities drives both the strength of the Canadian dollar and the employment in the mining, quarrying, and oil and gas industry of Canada.

The positive relationship between the commodity price index and the Canadian-dollar effective exchange rate index can be seen in Figure 2. The commodity price index, published by the Bank of Canada, tracks the real prices of commodities produced by Canada. The two indices move in the same direction commonly. Both the academic literature and the policy works recognize this positive relationship, which is why the Canadian dollar is often referred to as one of the major commodity currencies in the world (Chen and Rogoff, 2003, 2012; Issa, Lafrance and Murray, 2008).[4]

[4]Besides Canada, Australia and New Zealand also have primary commodities constituting a major share

Table 1: Share of Major Industries in Total Industrial Employment

Industry	Services	Goods	Ariculture, forestry fishing and hunting	Mining, quarrying, oil and gas	Construction	Manufacturing
NAICS code	41-91	11-33	11	21	23	31-33
1993	77.4%	22.6%	0.8%	1.2%	4.0%	15.5%
2011	81.9%	18.1%	0.3%	1.4%	5.7%	9.9%

Source: Authors' tabulations

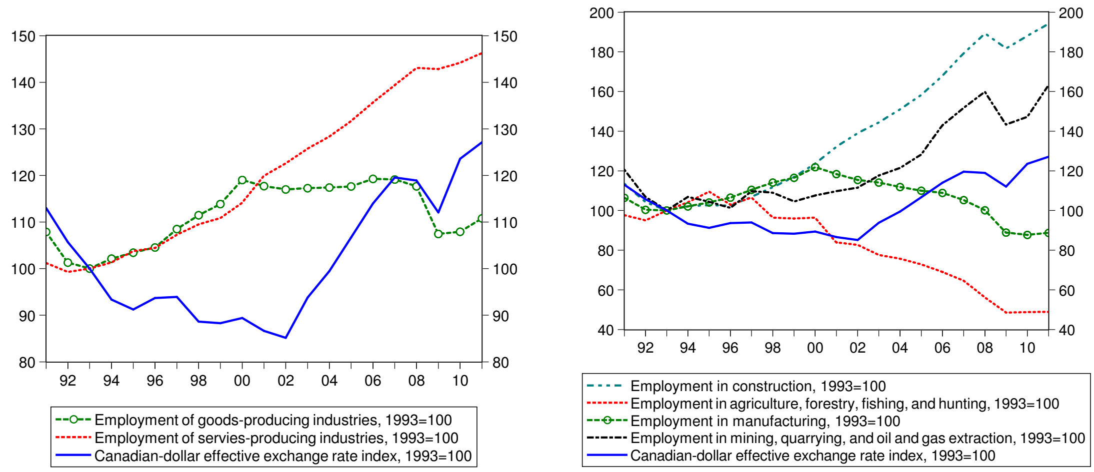

Figure 1: Real exchange rate and employment of major industries in Canada.

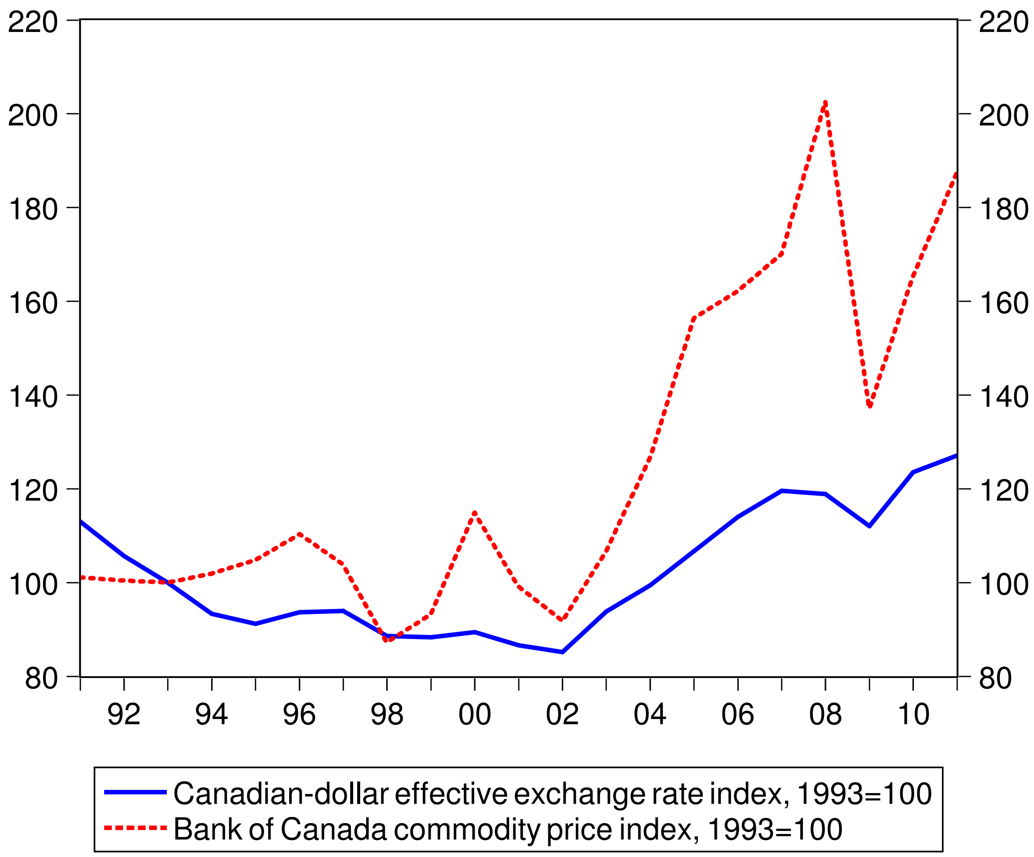

Figure 2: Commodity price index and real exchange rate.

From the graphical evidence, it appears plausible that appreciations in the Canadian dollar have reduced employment in the Canadian manufacturing industry while employment in other industries has not been affected by the exchange rate. However, Figure 1 presents only the information from the time series variation. It does not exclude the possibility that the negative relationship between the exchange rate and the manufacturing employment is caused by other macroeconomic factors. For instance, 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 section, extending our analysis beyond the correlations in time series, we exploit the cross-sectional variations in trade exposure across manufacturing industries. In particular, we construct industry-specific movements in exchange rates and relate them to the dynamics of employment by industries. We also control for a number of macroeconomic factors in the regression analysis.

3 Regression Analysis

3.1 Manufacturing Industries

Because the evidence in Section 2 suggest that the exchange rate is likely to affect manufacturing employment, we first estimate the effects of exchange rates on the group of NAICS four-digit manufacturing industries. For the regressions of manufacturing industries, our empirical strategy borrows heavily from the theoretical work and empirical specification of Campa and Goldberg (2001) who examine 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

of their exports, and movements in commodity prices have been a significant driver for their currencies as well.

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 is crucial in production in the sense that it cannot be substituted with imported inputs,[5] then the firm is likely to increase labour demand in response to the decrease in the cost of imported inputs.

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), it is important to distinguish the exchange rate in the import trade and the exchange rate in the export trade. 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. 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. We document the details about constructing the exchange rates in the appendix. From Figure 3, 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.

In the left panel of Figure 4, we plot the export exchange rate indices of the five

[5] The increase in globalization and specialization in production likely reduces the substitutability between inputs in the short run. The recent literature on output comovement and trade emphasize the complementarity between imported and domestic inputs in production (Burstein, Kurz and Tesar, 2008; di Giovanni and Levchenko, 2010; Johnson, 2012). Existing empirical evidences, albeit limited, suggest that either imported inputs and labour are not substitutes (Falk and Koebel, 2002) or they are complements (Jara-Diaz, Ramos-Real and Martinez-Budria, 2004).

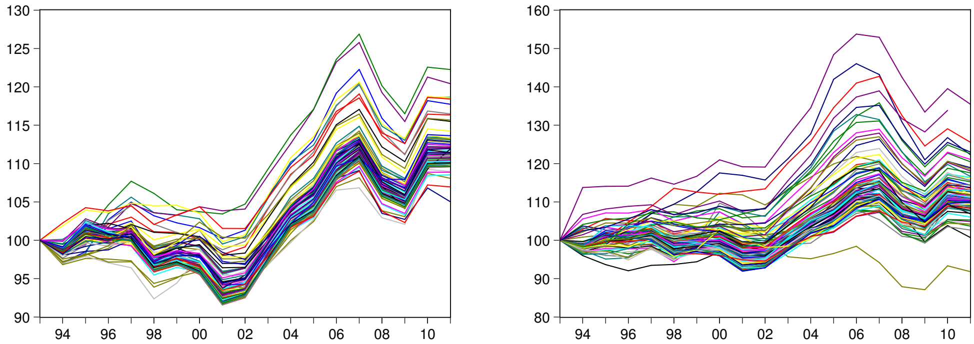

Figure 3: Industry-specific export and import exchange rates indices, all industries
Note: Each line in the left (right) panel is the export (import) exchange rate index of a NAICS four-digit manufacturing industry.

largest NAICS four-digit 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, they 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 plastic-product manufacturing, export and import exchange rates track each other quite closely although there remain differences.

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 discussed at the beginning of this section, appreciations in import exchange rates have two effects: they make imported products cheaper and lower the cost of imported inputs. Therefore, the overall effect of the appreciation of the import exchange rate on employment can be positive or negative.[6]

[6]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.

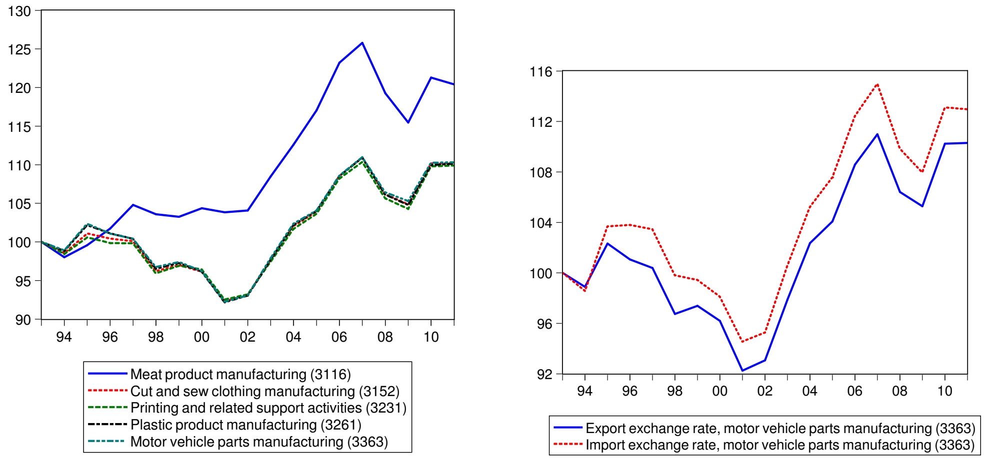

Figure 4: Industry-specific export and import exchange rates indices, selected industries
Note: Each line in the left (right) panel is the export (import) exchange rate index of a selected manufacturing industry.

Our baseline regression is

$$\begin{aligned}\Delta L_{it}(\%) =& \beta_0 + \beta_1 \cdot \Delta e^x_{it}(\%) + \beta_2 \cdot \Delta e^i_{it}(\%) + \beta_3 \cdot \Delta y_t(\%) + \beta_4 \cdot \Delta y^*_{it}(\%) \\ &+ \beta_5 \cdot \Delta r_t + \beta_6 \cdot \Delta P^e_t(\%) + \beta_7 \cdot t + \beta_8 \cdot \Delta L_{t-1}(\%) + f_i + u_{it} \qquad (1)\end{aligned}$$

where $\Delta L_{it}(\%)$ is the growth rate of employment of a NAICS four-digit manufacturing industry. The variables $\Delta e^x_{it}(\%)$ and $\Delta e^i_{it}(\%)$ are the percentage changes in export and import exchange rates specific to industry i. The variables $\Delta y_t(\%)$ and $\Delta y^*_{it}(\%)$ are the real GDP growth of Canada, and the export-weighted real GDP growth in trade partners; they proxy for changes in the aggregate demand. We also control for the input costs by including the change in the real interest rate of 10-year government bond (Δr_t), and the percentage change in real nonresidential power price ($\Delta P^e_t(\%)$). Given that the share of manufacturing employment in Canada has experienced a 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 fixed effects (f_i) to capture heterogeneity among industries. Lastly, u_{it} is an independent and identically distributed (i.i.d.) error term.

Because we construct the exchange rate variables such that an increase in the exchange rate implies an appreciation, we expect that $\beta_1 < 0$ under the hypothesis that appreciations in the export exchange rate decrease employment. Meanwhile, the expected sign of β_2 is ambiguous.

Our sample includes 82 NAICS four-digit manufacturing industries from 1994 to 2007. We do not use the years after 2007 to leave out the recent recession, which had severe effects on employment.[7] We document the detailed information about the variable construction in the appendix. Because our specification includes the lag-dependent variable, we use the Arellano-Bond General Method of Moments (GMM) estimator (Arellano and Bond, 1991) to obtain consistent estimates of the parameters. Because we include one lag in regression and the Arellano-Bond estimator uses a further lag as an instrument, our regression analysis effectively uses data from 1996 to 2007.

Table 2 reports the regression results. In column 1 of the table, we combine the import exchange rate and the export exchange rate into a simple average serving as a summary measure of exchange rate movements. The coefficient on this average exchange rate variable is -0.41, meaning that a 1% appreciation in the average exchange rate of a particular industry will lead to a 0.41% reduction in employment in that industry. Interestingly, this estimate is very close to the coefficient of -0.38 from a comparable regression for the US manufacturing industries in Huang and Tang (2013).

In column 2 of Table 2, we estimate the baseline model (equation 1), which includes both the import exchange rate and the export exchange rate on the right-hand side. Conditional on the import exchange rate, the estimated export exchange rate elasticity of employment is -0.52 with strong statistical significance. The import exchange rate, on

[7] When we include the data from 2008 to 2011, the results are similar.

the other hand, does not have significant partial effects on employment; the coefficient is 0.13 and is not statistically different from zero. Huang and Tang (2013), using US data, report similar findings on the difference between the export and import exchange rates' employment effects. Overall, the results confirm the graphical analysis in Section 2 that manufacturing employment responds to the exchange rate movements. In addition, we find that the effects of the export and the import exchange rates are different.[8]

[8]In unreported regressions, we also include other variables that may affect the response of employment to exchange rate: the export orientation, which is defined as the fraction of the output of an industry that is exported, the import penetration, which is defined as the fraction of import in the total domestic sales of an industry, and import input share, which is defined as the share of imported inputs in the total production cost of an industry. These additional variables generally do not have significant effects on employment.

Table 2: Regression Analysis for 82 Manufacturing Industries

Variables	Δ L (%) (1)	Δ L (%) (2)
Δ real average exchange rate (%)	-.41 (0.14)***	
Δ real export-weighted exchange rate (%)		-.52 (0.22)**
Δ real import-weighted exchange rate (%)		0.13 (0.24)
Δ real GDP of Canada (%)	0.16 (0.4)	0.13 (0.4)
Δ real foreign GDP (%)	-.08 (0.67)	-.20 (0.68)
Δ real power price (%)	-.11 (0.1)	-.13 (0.1)
Δ real 10-year i rate	-.34 (0.22)	-.33 (0.22)
time	-.39 (0.1)***	-.39 (0.11)***
lag Δ L (%)	-.01 (0.05)	-.01 (0.05)
Constant	4.95 (2.35)**	5.42 (2.42)**
Obs.	1117	1117
model χ^2	40.95	45.35
p-value for AR(2) test	0.92	0.99

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 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.

3.2 Nonmanufacturing Industries

In Section 2, we see that the exchange rate appears to have no effect on employment in industries other than manufacturing. We now run a panel regression for 12 NAICS two-digit nonmanufacturing industries from 2000 to 2007 for a systematic analysis of the effect of the exchange rate on jobs.[9] The 12 industries, with their NAICS two-digit codes in parentheses, are

- Agriculture, forestry, fishing, and hunting (11),
- Mining, quarrying, and oil and gas extraction (21),
- Construction (23),
- Trade (41-45),
- Transportation and warehousing (48-49),
- Information and cultural industries (51),
- Professional, scientific and technical services (54),
- Educational services (61),
- Health care and social assistance (62),
- Arts, entertainment and recreation (71),
- Accommodation and food services (72),
- Public administration (91).

[9]The starting year of the regression is restricted by data availability and the specific requirement of the Arellano-Bond estimator that it includes a one-year lag of the dependent variable and a further lag as an instrumental variable in the estimation.

We do not have employment information for the following industries: utility (21); finance and insurance (52); real estate and rental and leasing (53); management of companies and enterprises (55); and administrative and support, waste management, and remediation services (56). The lack of data on the industry of finance and insurance and the industry of management of companies and enterprises is particularly unfortunate because these industries engage in substantial international trade of services.

The specification is identical to equation 1, except that we use the Canadian-dollar effective exchange rate in the regression because of the lack of information on the international trade partners of all 12 industries. In addition, at the national level, the correlation between the import and export exchange rate are 0.98, indicating that they are almost identical.

Table 3 presents the regression result for the nonmanufacturing industry. The coefficient on the exchange rate variable is statistically insignificant with t-statistics that are well below conventional critical values. Therefore, there is no evidence that the exchange rate systematically affects employment in these main industry groups. The finding confirms the impression from the graphical analysis in Section 2.

4 Effects of Commodity Prices on Manufacturing Jobs

From Section 3.1 and Section 3.2, we can see that the employment effects of the Canadian dollar's exchange rate are concentrated in manufacturing industries. In addition, global commodity prices are widely seen as an important factor in fluctuations in the value of Canadian dollars. It follows that a global commodity boom can potentially create imbalances between the resource industries and the manufacturing industries in Canada. In this section, we quantify the effect of an increase in commodity prices on manufacturing employment. To do so, we first estimate the exchange rate responses to an increase in commodity prices. When combined with the exchange rate elasticity of employment

Table 3: Regression Analysis for Nonmanufacturing Industries

	Δ L (%)
Δ real exchange rate (%)	0.32
	(0.23)
Δ real GDP of Canada (%)	2.41
	(1.27)*
Δ real foreign GDP (%)	-3.68
	(1.25)***
Δ real power price (%)	-.27
	(0.08)***
Δ real 10-year i rate	-.46
	(0.51)
time	-.08
	(0.17)
lag Δ L (%)	-.20
	(0.12)
Constant	5.45
	(3.26)*
Observations	96
model χ^2	74.97
p-value for AR(2) test	0.41

Note: [1] The regression is estimated with the Arellano-Bond GMM estimator for dynamic panel regressions (Arellano and Bond, 1991). [3] The symbols "*", "**", and "***" indicate statistical significance at the 10%, 5%, and 1% levels, respectively. [4] The "model χ^2" is the Wald statistic that measures overall significance of the model. [5] 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.

estimated in Section 3.1, the estimates in this section allow us to calculate the effect of commodity prices on manufacturing jobs.

For each NAICS four-digit manufacturing industry i, we regress the industry specific import and export exchange rates on the commodity price. We estimate the following simple equations which are identical to the specification in Chen and Rogoff (2012)

$$ln(e_{it}^{x}) = \delta + \gamma_i \cdot ln(P_t^{comm}) + \phi \cdot t + v_{it}^{x}$$
$$ln(e_{it}^{i}) = \psi + \theta_i \cdot ln(P_t^{comm}) + \eta \cdot t + v_{it}^{i} \quad (2)$$

where P_t^{comm} is the real commodity price index, obtained by adjusting the nominal commodity price index published by the Bank of Canada for CPI inflation. The error terms v_{it}^{x} and v_{it}^{i} are assumed to be iid. The parameters γ_i and θ_i are the commodity price elasticity of the export exchange rate for industry i and the commodity price elasticity of the import exchange rate for industry i, respectively. We summarize the estimates of γ_i and θ_i in the first two rows of Table 4. On average, a 1% increase in commodity prices leads to a 0.21% appreciation in industry-specific export exchange rates and a 0.24% appreciation in industry-specific import exchange rates.

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 12.21% between 1994 and 2007) on employment is

$$\Delta L_i(\%) = 12.21\% \cdot (\beta_1 \cdot \gamma_i + \beta_2 \cdot \theta_i)$$
$$= 12.21\% \cdot (-0.52 \cdot \gamma_i + 0.13 \cdot \theta_i)$$

The third and fourth rows in Table 4 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 12.21% increase in commodity prices, on average the employment in a manufacturing industry decreases by -0.98%. The total loss of manufacturing jobs is 15,285, equivalent to 0.1% in Canada's industrial employment in 2010.[10]

One potential concern in the analysis is the assumption that both the real exchange rates and the real commodity prices are a stationary time series. Loosely speaking, the assumption is that the time series cannot grow in unbounded ways. However, as discussed in Chen and Rogoff (2003, 2012), there are questions about whether the real exchange rate is truly stationary or not. It is our view that real exchange rates (as opposed to nominal exchange rates) are likely to be stationary. Nonstationarity would mean that the general price level in Canada can be arbitrarily higher or lower compared to those in other countries expressed in the same currency. Given the relatively low trade cost (especially between Canada and the United States) and the high level of international trade, this divergence in real prices is unlikely to occur or last for a long period of time. There are also arguments in favor of the view that the prices of commodities relative to other goods and services are stationary. If they rise sharply for a long time, profit incentives will lead to discoveries of new technologies that either increase the supply of the commodities or the supply of substitutes. This line of argument, however, may not hold if future technologies fail to deliver; but our results are robust even if we assume that both the real exchange rates and the real commodity prices follow a random walk. Under this alternative assumption, we should regress $\Delta ln(e^x_{it})$ and $\Delta ln(e^i_{it})$ on $\Delta ln(P^{comm}_t)$, respectively, to estimate exchange rate responses to commodity prices. This would give us an estimated loss of 19,861 manufacturing jobs, as opposed to 15,285. The difference is rather small.

Lastly, we aggregate the numbers of predicted job losses to NAICS three-digit manufacturing industries and tabulate the predicted effects of a 12.21% increase in commodity

[10] If we redo the calculation based on the regression reported in column (1) of Table 2, the estimated loss of manufacturing jobs is 16,511.

Table 4: The Effects of Commodity Price on Employment in 82 NAICS Four-digit Manufacturing Industries

	mean	min	max	std	total
γ_i: commodity price elasticity of export exchange rate	0.21	0.16	0.32	0.03	NA
θ_i: commodity price elasticity of import exchange rate	0.24	-0.04	0.52	0.09	NA
$\Delta L_i(\%)$: predicted employment growth after a 12.21% increase in commodity price	-0.98	-1.82	-0.46	0.22	NA
ΔL_i: predicted change in employment after a 12.21% increase in commodity price	-178	-1,272	-7	194	-15,285

prices on employment in Table 5. Among all industries, the food manufacturing industry stands out because it accounts for 15.7% of the total manufacturing employment, but is predicted to account for 20.1% of the total manufacturing job losses. The reason is that the exchange rates specific to the food manufacturing industry are more responsive to commodity prices. For the other industries, their shares in the predicted job losses are mostly in line with their shares in the manufacturing employment.

Table 5: The Effects of Commodity Price on Employment in NAICS Three-digit Manufacturing Industries

Industry	Employment in 2010	% in total manu employment	Predicted growth of employment	Predicted loss of employment	% in total predicted loss of manu employment
Food	232,710	15.7	-1.3	-3,069	20.1
Beverage and Tobacco Product	26,362	1.8	-1.2	-308	2.0
Textile Mills	8,026	0.5	-0.9	-76	0.5
Textile Product Mills	9,762	0.7	-1.2	-114	0.8
Apparel	25,670	1.7	-0.7	-171	1.1
Leather and Allied Product	3,957	0.3	-0.7	-26	0.2
Wood Product	89,381	6.0	-1.2	-1,078	7.1
Paper	57,501	3.9	-1.1	-620	4.1
Printing and Related Support Activities	56,325	3.8	-0.9	-520	3.4
Petroleum and Coal Products	13,152	0.9	-1.0	-131	0.9
Chemical	81,314	5.5	-1.1	-895	5.9
Plastics and Rubber Products	95,069	6.4	-0.9	-885	5.8
Nonmetallic Mineral Product	47,375	3.2	-1.0	-449	2.9
Primary Metal	59,038	4.0	-0.9	-552	3.6
Fabricated Metal Product	151,788	10.3	-1.0	-1,538	10.1
Machinery	124,056	8.4	-1.0	-1,190	7.8
Computer and Electronic Product	71,927	4.9	-0.9	-676	4.4
Electrical Equipment, Appliance, and Component	36,740	2.5	-0.9	-342	2.2
Transportation Equipment	159,301	10.8	-1.0	-1,516	9.9
Furniture and Related Product	73,783	5.0	-0.9	-639	4.2
Miscellaneous Manufacturing	56,773	3.8	-0.9	-489	3.2
Total	1,480,010	100%		-15,285	100%

Note: The predicted changes are for a 12.21% increase in real commodity price.

5 Discussion and Conclusion

In this paper, we examine the effects of exchange rates movements on jobs in Canada. We find that the Canadian dollar's real appreciation has negative employment effects on manufacturing industries but not on other industries. Because the manufacturing sector accounts for 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 distinguish between the export-weighted exchange rate and the import-weighted exchange rate. We find that a 1% appreciation in the export-weighted exchange rate decreases employment by 0.52%. Meanwhile, the effect of a change in the import-weighted exchange rate on employment is not statistically different from zero. The insignificance can be due to two competing effects that are at work simultaneously: appreciations in the import-weighted exchange rate make home products less competitive and decrease the cost of imported inputs.

A boom in the global commodity market tends to increase the value of the Canadian dollar and thus reduces employment in the manufacturing industries. In our analysis, we quantify the effect of a one standard deviation increase in commodity prices (12.21%) on manufacturing jobs. From a number of alternative ways of calculation, we find that the predicted loss of manufacturing jobs is about 1% of the total manufacturing employment, or 0.1% of the total industrial 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 43.8% and 27.7% of Canada's manufacturing employment in 2011, 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 (2013). Section A.1 documents the construction of industry-specific exchange rates and the sources of relevant data, and we discuss the other variables in Section A.2.

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 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 Swe-

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den, 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 1, where the abbreviation CANSIM stands for Canadian Socio-economic Information Management System from Statistics Canada. We use the CPI to deflate the nominal power price index, the nominal commodity price index, and the nominal interest rate on ten-year Canadian government bonds.

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

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

where $\bar{\epsilon}$ 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

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

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.

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Table 1: Sources of data for other variables

Variable	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, 1991-2007	CANSIM Table 281-0024, Employment (SEPH)
Canadian consumer price index, 2009 basket	CANSIM Table, 326-0021
Nominal power price index	CANSIM Table 329-0050, Electric power selling price indexes (nonresidential)
Nominal commodity price index	Bank of Canada
Nominal interest rate on ten-year Canadian government bonds	Bank of Canada
Canadian-dollar effective exchange rate index	Bank of Canada