GABRIEL BRUNEAU

Labour Market Adjustments to Real Exchange Rate Fluctuations

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Résumé

Ce papier évalue la sensibilité de l'emploi, des heures travaillées et des salaires aux variations du taux de change pour les industries manufacturières canadiennes et fournit une étude empirique de l'ajustement de l'emploi, des heures travaillées et des salaires dans de telles industries. L'analyse est basée sur un modèle dynamique appliqué à un panel de 21 industries de 1987 à 2006. L'effet net de l'appréciation du dollar canadien s'est avéré statistiquement significatif et négatif pour l'emploi, les heures travaillées et les salaires, bien que l'effet sur les heures travaillées soit plus prononcé. De plus, l'impact négatif de la dépendance élevée des industries canadiennes envers les exportations. conjugué à l'impact négatif créé par l'appréciation du taux de change sur les importations des intrants étrangers qui sont des substituts à l'intrant travail, augmente les effets négatifs sur ce dernier, les effets de *substitution* et de *revenu* allant dans le même sens.

Abstract

This paper evaluates the response of employment, hours worked and wages to real exchange rate shocks in the Canadian manufacturing industries and provides an empirical study of the adjustment of employment, hours worked and wages in such industries. The analysis is based on a dynamic model applied to a panel of 21 manufacturing industries from 1987 to 2006. The net effect of the Canadian dollar's appreciation was found to be statistically significant and negative for employment, hours worked and wages, although the effect on hours worked is more pronounced. Furthermore, the negative impact of the high dependency of Canadian manufacturing industries on export, in combination with the negative effect that the appreciation have on the import of foreign inputs that are substitute to labour input, enhance the negative effects on the latter, since the *substitution* and the *output* channels are going in the same direction.

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Chapter 1

Introduction

In the last couple of decades, many central banks have decided to let their domestic currency flow freely. This choice was made to allow for easier macroeconomic adjustments to both foreign and domestic shocks. In fact, economists assert a theoretical link between real exchange rates and domestic industries outputs through relative costs of production. In particular, an exchange rate change that reduces the relative costs of production for foreign firms in an industry (an appreciation of domestic relative to foreign currencies, other things being equal) will generally cause lower prices of foreign goods in the industry. Lower foreign prices will also have for effect to decrease demand for domestic output in the industry and lower domestic demand, which in return reduces output and/or prices for domestic goods and lower employment and/or wages. The magnitude of reduction in demand is determined by the pass-through of changes in exchange rate to good prices and the degree of substitutability of foreign for domestic goods. On the other hand, a depreciation of the domestic currency increases the competitiveness of domestic firms in the international markets, boosting the exports and reducing the imports. As open economies, like Canada, are more likely to be dependent to foreign inputs in production, they are usually more affected by large fluctuations in exchange rates. The net consequence of exchange rate fluctuations will be determined by which of these two opposing forces will dominate.

The empirical literature on international economics has explored the effects of exchange rates shocks on profits, investments, domestic prices, price adjustments, and the entry and exit of firms in international markets (Mann (1986), Krugman and Baldwin (1987), Feinberg (1989), Knetter (1989), Campa and Goldberg (1995, 2001), Dekle (1998)).

Of particular interest is the connection between these fluctuations in exchange rates and the labour markets, and the link between exchange rate changes and industry-specific relative costs of inputs. Leung and Yuen (2005) were the first to provide empirical evidence of labour market adjustments to exchange rate movements in Canadian manufacturing industries. They found that, from 1981 to 1997, the cumulative effect of a depreciation of 10 percent of the Canadian dollar was an increase of 10 to 12.5 percent of labour inputs. The majority of this effect was due to the increase in the demand for domestically-produced goods both at home and abroad. They also found evidence that the responsiveness of labour inputs to exchange rate movements was greater in the 1990s than in the 1980s and that industries with a high and medium net trade exposure adjust their labour inputs more than industries with a low net trade exposure.

Another study by Revenga (1992) measured the impact of import competition on employment and wages in the United States (U.S.) manufacturing industries. The estimates suggested that changes in import prices have a significant effect on both wages and employment. The appreciation of the U.S. dollar in the 80's is estimated to have reduced wages by 2 percent and employment by 4.5 to 7.5 percent on average in the industries the most exposed to international trade.

Second, Burgess and Knetter (1998) evaluated the sensitivity of manufacturing industries' employment to exchange rate fluctuations among developed countries by using fixed-effects regressions. They found that European industries (France and Germany) are much less influenced by exchange rate shocks and much slower to adjust to long-run steady states, while the U.S., Japan, Canada, the U.K. and Italy adjust quickly. They also concluded that the German and Japanese employment is quite insensitive to exchange rate movements, due to mark-up responses to exchange rates[1].

Furthermore, Campa and Goldberg (1997, 2001) empirically estimated the links between real exchange rates, employment and wages in the U.S. manufacturing industries. Especially in industries with lower price-over-cost mark-up, exchange rate had statistically significant effects on industry wages, the magnitude of these effects raising with their export orientation and declining as the use of imported input became more important. The effect of the exchange rate on jobs and hours worked was smaller and less precisely measured.

Dekle (1998) found that exchange rate fluctuations have a sizeable effect on Japanese employment in the long-run. However, he cannot detect any difference between the high and low export sectors in their responsiveness to exchange rate.

[1] This study has the great advantage to be the only one related to Canada using aggregated data at the 2-digit level.

Branson and Love (1986, 1988) examined the impact of the movements in the real exchange rate on employment and output in the U.S. manufacturing industries. They used a simple model of supply and demand to estimate the elasticity with respect to the real exchange rate and they found that the exchange rate have had important effects on the manufacturing sector, particularly on the durable goods sector.

This paper provides four contributions to the literature in the case of Canada. First, we use a more recent dataset covering the 1987 to 2006 period, which has the advantage of offering a full cycle of exchange rate fluctuations (i.e. between $US 0.62 and $US 0.90, while the previous study use an exchange rate between $US 0.70 and $US 0.88). Conversely to Leung and Yuen whose used the Standard Industrial Classification (SIC), this paper will be based on the North-American Industrial Classification System (NAICS). This paper is also among the first to use the new generation of the KLEMS data released in June 2007 by Statistics Canada. Finally, we use a more appropriate estimation method, especially built for small sample.

This paper is organized as follows. Chapter 2 will provide a brief analysis of the current economic conditions in Canada over the last few years. This will be followed in Chapter 3 by the presentation of the theoretical model, the discussion of the possible channels through which the labour market adjusts to real exchange rate, the empirical specifications and the estimation issues. Chapter 4 will introduce the data that are used for the empirical analysis. Then, the estimation results will be presented and discussed in Chapter 5. Finally, Chapter 6 will conclude the analysis.

Chapter 2

Developments in Canada

In the last decade, China's and India's rapidly expanding economies have led to strong increases in demand for commodities for which Canada is an important exporter, such as crude oil and base metals. As a result, world commodity prices have risen sharply, reaching historic highs and have contributed greatly to the appreciation of the value of the Canadian dollar (CAD)[1]. The increase in the Bank of Canada's Commodity Prices index over the last five years is the strongest since the 1970s, rising by about 90 percent since 2002. In real terms, however, the increase has only been about 74 percent over the same period. Hence, the Bank of Canada's Commodity Prices index is currently about 27 percent below its historical peak of 1980. Since Canada is a net exporter of natural resources, the CAD's value tends to increase when world commodity prices rise. However, global portfolio adjustments in recent years have also put upward pressure on the Canadian dollar in response to large and persistent U.S. current account deficits.

The increase in world commodity prices have resulted in a substantial redistribution of income from net importing countries, like the United States, to net exporting countries, like Canada, as the terms of trade of net resource importers have fallen while those of net resource exporters have risen. The positive income gain for the net exporting countries eventually led to higher production, investment and employment in the resource sector.

During this boom, the Canadian real gross domestic product (GDP) continued to grow at its historical rate, more than 1.2 million jobs were created, and the unemployment rate fell to a record-low of 6.1 percent. These facts suggest that the Canadian economy has adjusted well to the shocks.

[1] See Figure 2.1.

Over the past three years, however, the appreciation of the CAD, the strong growth in the world economy and the soaring world commodity prices have led to significant economic adjustments and to disparity in economic performance across sectors and regions. Due to the higher commodity prices, the real economic growth in resource provinces significantly outpaced the national average, especially in Saskatchewan, Alberta and British Columbia. As a result, the terms of trade for these provinces increased significantly over the period. In contrast, the appreciation of the CAD dampened growth in non-resource provinces, particularly in manufacturing provinces like Ontario and Quebec, and induced adjustment pressures in the manufacturing workforce. Surprisingly, real GDP growth in the non-resource provinces over the period was only slightly below their long-term average. The stronger U.S. demand for Canadian goods and services largely offset the negative impact of the CAD's appreciation.

As a result of stronger world demand for natural resources, the sources of economic growth in Canada has changed significantly since 2002. The average real GDP growth in the manufacturing sector has slowed down, primarily due to its higher exposure to international trade relative to other sectors. Detailed data on exports by manufacturing industries show that the CAD's appreciation has impacted primarily manufacturing industries with a high net exposure to international trade. In contrast, growth in the natural resource sector accelerated strongly, boosted by higher world demand and prices. Partly driven by the resource boom, growth remained solid in the domestic-oriented sectors (service-producing sector, construction and utilities).

Weaker real GDP growth was observed in 14 of the 15 industries the most exposed to international trade, the exception being the computer and electronic products industry. This slowdown was particularly significant in textiles, clothing, leather, furniture, and electrical equipment, appliance and component industries. These first four industries were probably also negatively impacted by import competition from low-cost producing countries. The decline in GDP growth was on average lesser in the other sectors.

The adjustment of the manufacturing sector to the appreciation of the CAD is more important in the labour market, which reflects the desire of manufacturers to restore their competitiveness. For example, 168,200 manufacturing jobs (7.4 percent of the total) were lost between 2002 and 2006. As a simple rule of thumb, 4,400 jobs were lost for each one percentage point increase in the value of the dollar, other things equal. This phenomenon was mainly observed in the manufacturing-oriented provinces. Moreover, job losses were concentrated in industries with a high net exposure to international trade. For instance, about 154,300 jobs were lost in these industries since 2002. In contrast, employment in manufacturing industries with a low net exposure to international trade fell by only 13,900 for the period 2002 to 2006. Labour mobility helped the

Canadian economy adjusting to the exchange rate fluctuations and the world resource boom of the recent years. For example, the world natural resources boom increased the demand for labour in Alberta, which in return attracted many Canadian in the province.

As for output and employment, the profit margin in the industries highly exposed to international trade are more affected by the dollar's appreciation than in industries with a low exposure. The profit margin of industries with a high net trade exposure fell to 4 percent in 2006, about 1.4 percentage point below the historical average. In contrast, the profit margin of industries with a low net trade exposure reached a record high of 9.4 percent, 2.1 percentage points above its historical average. The fact that industries with low exposure to international trade produce largely for domestic market where import competition is insignificant explain most of this difference. Not only these industries are almost unaffected by the appreciation of the CAD, but they may in fact benefit from it if a large proportion of their inputs are imported.

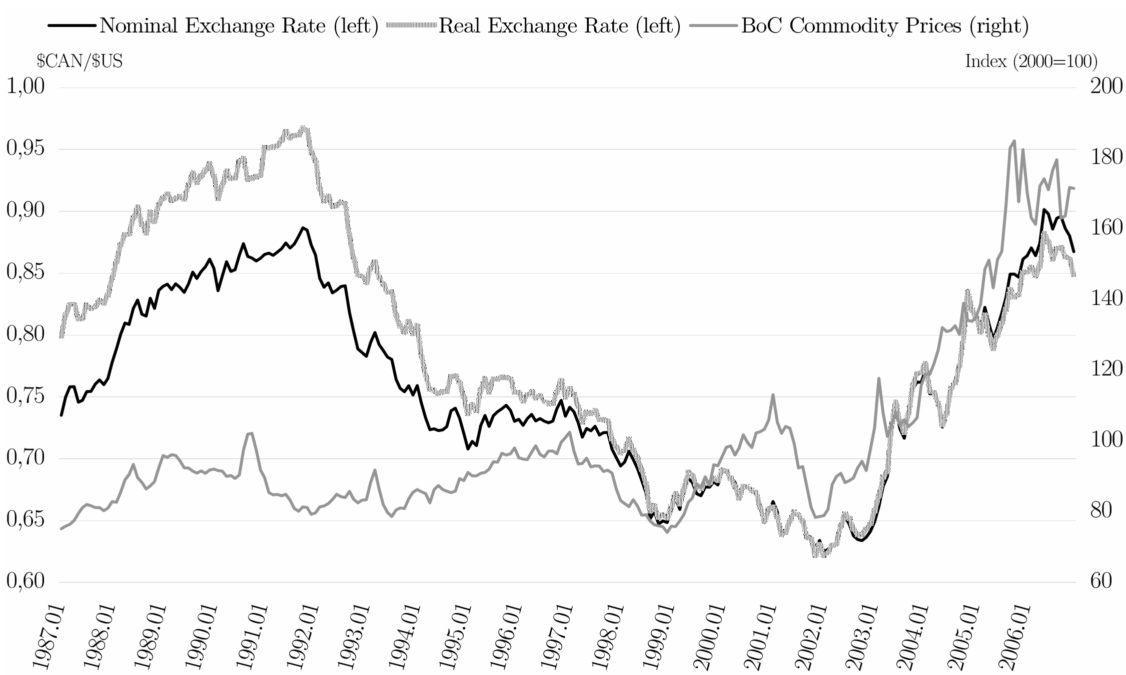
A strong demand, a historically high capacity utilization rate and a healthy corporate financial situation since 2002 have provided strong incentives to Canadian industries to increase their investments to enhance their competitiveness. This is true not only in natural-resource industries, but also in the manufacturing sector, which increased investments in machinery and equipment by 37,5 percent over the last four years. The increase occurred in industries with both a high and low exposure. These investments increased output per hour worked by 3.6 percent in 2005 and 0.2 percent in 2006.

Manufacturers responded to the challenges of higher oil prices and a stronger dollar by boosting productivity-enhancing investments. Over the last two years they have substantially boosted labour productivity and had the best performance among all industries, improving competitiveness and creating opportunities for new jobs.

Private sector economists have interpreted the rise of Canadian dollar and the decline of manufacturing employment as the onset of Dutch Disease in the Canadian economy. The evidences, however, are largely inconsistent with such an interpretation. While manufacturing employment has fallen, output has risen on account of the growth in labour productivity of the manufacturing sector. In addition, the growth in the non-tradable sector, an important trigger in the case of the Dutch Disease observed elsewhere, has been in line with its historical average. The rise in the value of Canadian dollar must be also considered in light of the decline of the U.S. dollar against major currencies, reflecting concern over the American trade and government budget deficits.

Given the recent employment and exchange rate fluctuations, demographic transition and increasing importance of international trade for the Canadian economy, it is useful to model the impact of exchange rate on resource allocation. In the next chapter, a dynamic input demand model for the manufacturing industries is developed and estimated to study and address this question.

Figure 2.1: Exchange Rate and the Bank of Canada's Commodity Prices Index



Chapter 3

Theoretical Framework, Empirical Specification and Econometrics

This section describes the theoretical framework motivating our empirical model. This framework illustrates the channels through which exchange rate movements affect the demand for labour in the manufacturing sector. In the model, firms supply their produced goods under monopolistic competition in domestic and foreign markets and are price takers in input markets. Exchange rate movements affect the labour demand of firms through the *output channel* (i.e. an appreciation, say, of the domestic currency causes a decrease in the demand faced by the firm and thus a decrease on labour demand) and the *substitution channel* (i.e. an appreciation of domestic currency causes a decrease in the costs of production through the use of imported inputs and thus potentially shifts its demand for labour downwards if, say, inputs are substitute).

3.1 Theoretical Framework

Consider the following factor demand model with employment adjustment costs. A representative firm in industry i maximizes its expected future profits subject to a production function and labour adjustment costs, that is,

$$\begin{aligned}\pi_{i,t} \quad = \quad & \max E_{i,t}[\Sigma_{\tau=1}^{T}\beta^{\tau}(P_{i,t+\tau}^{Y}\cdot Y_{i,t+\tau}-P_{i,t+\tau}^{L}\cdot L_{i,t+\tau}-P_{i,t+\tau}^{Z}\cdot Z_{i,t+\tau}- \\ & c\left(\Delta L_{i,t+\tau}\right))],\end{aligned} \tag{3.1}$$

subject to

$$Y_{i,t} = F\left(L_{i,t}, Z_{i,t}\right) \tag{3.2}$$

and

$$c\left(\Delta L_{i,t}\right) = \frac{\theta\left(L_{i,t} - L_{i,t-1}\right)^2}{2}, \tag{3.3}$$

where β is the discount factor, $\Delta L_{i,t}$ is the net variation of employment between time t and $t-1$ and $E_{i,t}$ is the conditional expectation given all the information available at time t. The firm produces one output, $Y_{i,t}$, for both the domestic and foreign markets following a CES production function $F\left(L_{i,t}, Z_{i,t}\right)$ in which $L_{i,t}$ represents labour inputs and $Z_{i,t}$ variable inputs. As the firm produces under monopolistic competition, P^Y represents the inverse demand function faced by the producers. Variables P^L and P^Z denote the input prices of L and Z, respectively. Adjustment costs affect only the adjustment process of labour inputs; other inputs adjust freely. This simplifying assumption ignore capital adjustment costs. However, we can assume that investment decisions are separable from labour-related decisions and, hence, capital stock fluctuations are incorporated into the time argument by assuming that when decisions about employment are taken, investment plans have long since been decided[1].

Solving the firm's maximization problem and taking the log-approximation of the solution yields the following partial-adjustment equation for optimal labour demand:

$$\ln L^D_{i,t} = v \ln L_{i,t-1} + (1-v)(1-\beta v) E_{i,t}\left[\sum_{t=1}^{T} (\beta v)^\tau \ln L^*_{i,t+\tau}\right], \tag{3.4}$$

where $L^*_{i,t}$ is the desired level of labour input in the absence of adjustment costs. Equation (3.4) shows that because of these costs, the firm's labour demand at any point in time is likely to be off its optimal level. Instead, $L_{i,t}$ follows a partial adjustment process where the target is a geometric sum of all expected values of $L^*_{i,t}$.

Following Campa and Goldberg (2001), we assume that changes in $L^*_{i,t}$ are largely permanent ($E_{i,t}\left(L^*_{i,t+\tau}\right) = L^*_{i,t}$). This yields:

[1]In reality, industries optimally balance the costs of adjustment of hours against those of adjusting the labour force. This is empirically relevant since in both employment and hours variations are empirically observed. A more complete model would incorporate both forms of adjustments costs.

$$\ln L_{i,t}^{D} = v \ln L_{t-1} + (1 - v) \ln L_{i,t}^{*}. \tag{3.5}$$

The parameter v is increasing with the adjustment cost parameter θ[2]. Hence, the higher is θ, the slower is the adjustment to the optimal level. In other words, the closer the estimates for v is to 1, the larger are the implied adjustment costs and the slower is the rate of adjustment of $L_{i,t}$.

Our next step is to derive an expression for the optimal labour input, $L_{i,t}^{*}$. With a monopolistically competitive market with a CES for technology, the optimal labour input without cost can be expressed as a linear function of relative input prices:

$$\ln L_{i,t}^{*} = \alpha_0 + \alpha_1 \ln \left(P^L / P^Y\right)_{i,t} + \alpha_2 \ln \left(P^Z / P^Y\right)_{i,t} + \alpha_3 \ln X_t, \tag{3.6}$$

where $\left(P^L / P^Y\right)_{i,t}$ is the relative price of labour and $\left(P^Z / P^Y\right)_{i,t}$ is the relative price of other inputs. To the extent that labour is a substitute for other inputs, demand for labour will rise with a rise in the relative price of other inputs, i.e. $\alpha_2 > 0$. On the other hand, if labour is a complement, the opposite will occur; i.e., $\alpha_2 < 0$. X_t represents an array of economic conditions to control for shifts in the demand for the domestically-produced goods. It includes GDP of all countries where the firm ships its product and the real effective exchange rate:

$$\ln X_t = \varphi_0 + \varphi_1 \ln WorldGDP_t + \varphi_2 \ln RER_t + \varepsilon_t^{X}, \tag{3.7}$$

where RER_t is defined as the real effective exchange rate (an appreciation of the domestic currency represents an increase in RER_t), $WorldGDP_t$ is the World Trade-Weighted Real Gross Domestic Product that represents shifts in total demand for domestic goods, and ε_t is a random shock on demand. Substituting (3.6) into (3.5) gives the following expression for dynamic labour demand:

$$\ln L_{i,t}^{D} = \chi_0 + \chi_1 \ln L_{i,t-1} + \chi_2 \ln \left(P^L / P^Y\right)_{i,t} + \chi_3 \ln \left(P^Z / P^Y\right)_{i,t} + \chi_4 \ln X_t. \tag{3.8}$$

In this framework, for a given wage rate, there are two channels through which the real exchange rate RER_t can affect the labour demand in (3.8),

[2]See Appendix J for further details

$$\frac{\partial \ln L_{i,t}^D}{\partial \ln RER_t} = \chi_3 \frac{\partial \ln \left(P^Z / P^Y \right)_{i,t}}{\partial \ln RER_t} + \chi_4 \frac{\partial \ln X_t}{\partial \ln RER_t}. \tag{3.9}$$

The first channel is the input *substitution channel*. Assuming that part of the variable inputs are imported, the price of the variable inputs, $\left(P^Z / P^Y\right)_{i,t}$, decrease with an appreciation of the real exchange rate ($\partial \ln \left(P^Z / P^Y\right) / \partial \ln RER < 0$) because an appreciation of the domestic currency decreases the cost of imported capital and imported intermediate inputs. Following the discussion above, the end result is an decrease in the demand for labour (if labour is a substitute) or a increase in demand for labour (if labour is a complement).

Second, there is the *output channel*. The overall demand conditions, X_t, decrease with an appreciation of the real exchange rate ($\partial \ln X / \partial \ln RER < 0$) as an appreciation of the domestic currency worsen the product demand conditions and, hence, the labour demand (i.e. $\chi_4 < 0$). The intuition is that an appreciation of the domestic currency makes foreign goods relatively cheaper for domestic consumers and domestic produced goods relatively more expensive for foreign buyers. The overall product demand for domestic firms decreases as the competition from imports risen and demand for exports lessen. As a result, less inputs, including labour, are used in production to meet the decreased demand. The empirical specification developed in Section 3.2 allows us to test the importance of these two channels.

The *substitution* and *output channels* are influenced by various economic circumstances. First, an industry's exposure to trade can have an important impact on the magnitude of these channels; the output channel $\partial \ln X / \partial \ln RER$ could be greater if the industry is more export-oriented or if it faces more import competition. Likewise, the impact of the substitution channel, with $\left(P^Z / P^Y\right)$ as a function of the exchange rate, the derivative $\partial \ln \left(P^Z / P^Y\right) / \partial \ln RER$ would be larger if the industry imports many of its inputs.

Furthermore, exchange rate volatility may affect the size of adjustments in a dynamic framework. Because of the adjustment costs, it is important for firms to determine the nature of shocks. They will not change their labour demand if they expect the shock to be transitory. When exchange rate is very volatile, it is difficult for them to distinguish whether the movements are persistent or temporary[3]. Employment adjustments are

[3] A pure transitory shock is defined as a shock to the exchange rate that is expected to be fully reversed in the following period. In that case, firms could be inclined to adjust only marginally the labour input, by adjusting the overtime work per example, instead of hiring or firing employees.

likely to be delayed until the signal is clear enough. Therefore, uncertainty tends to lower the employment sensitivity to exchange rate.

To complete our description of the labour market, we must also introduce labour supply conditions. Following Campa and Goldberg (2001), we assume that the labour supply is an increasing function of wages (*substitution effect*) and a decreasing function of the aggregate demand conditions (*revenue effect*), assuming that the size of the supply sensitivities depend on worker preferences and characteristics:

$$\ln L^S_{i,t} = \lambda_0 + \lambda_1 \ln \left(P^L / P^Y \right)_{i,t} + \lambda_2 \ln M_t, \tag{3.10}$$

where the economic conditions, M_t, can be different from those expressed in (3.8). Finally, market clearing condition requires that demand equal supply so we have:

$$\ln L^D_{i,t} = \ln L^S_{i,t}. \tag{3.11}$$

3.2 Empirical Specification

In this section, we develop the specifications that we will test empirically in the Chapter 5. The first specification we use follows Dekle (1998) and only uses labour demand (3.8) to obtain the following econometric specification:

$$\begin{aligned} \ln L_{i,t} = {} & \gamma_0 + \gamma_1 \ln L_{i,t-1} + \gamma_2 \ln \left(P^L / P^Y \right)_{i,t} + \gamma_3 \ln \left(P^K / P^Y \right)_{i,t} + \\ & \gamma_4 \ln \left(P^E / P^Y \right)_{i,t} + \gamma_5 \ln \left(P^M / P^Y \right)_{i,t} + \gamma_6 \ln \left(P^S / P^Y \right)_{i,t} + \\ & \gamma_7 \ln RER_{i,t} + \gamma_8 \ln WorldGDP_t + \gamma_9 FE_i + \varepsilon^L_{i,t}, \end{aligned} \tag{3.12}$$

where the industry-specific variables are the relative price of labour $\left(P^L / P^Y \right)_{i,t}$, the relative price of capital $\left(P^K / P^Y \right)_{i,t}$, the relative price of energy $\left(P^E / P^Y \right)_{i,t}$, the relative price of materials $\left(P^M / P^Y \right)_{i,t}$, and the relative price of services $\left(P^S / P^Y \right)_{i,t}$[4]. The relative price of inputs (capital, energy, materials and services) represents the expression

[4]Appendix B describes in details how the data used in this paper have been constructed and calculated.

$\left(P^Z/P^Y\right)_{i,t}$ in equation (3.8). To exploit the panel nature of the data, equation (3.12) includes industry fixed-effects FE_i. Because the relative price of labour is potentially endogenous with the dependent variable and the error terms, we will have to instrument these variables (see below). The variables defining the economic conditions, (i.e. the demand shifters X_t) are the real exchange rate RER_t and the World Trade-Weighted Real Gross Domestic Product $WorldGDP_t$[5]. Dekle argues for this specification because specification errors in labour supply can potentially spill over in the more complex general equilibrium specification (see 3.13 and 3.14 below) and, thus, the coefficients for labour demand are easier to interpret.

We also use a alternative empirical specification, which follows Revenga (1992) and Campa and Goldberg (1997, 2001). In this paper, the authors estimate a reduced-form equation for labour input and wages that is derived from the intersection of the demand (3.8) and supply (3.10) of labour. Following this approach, we obtain:

$$\begin{aligned}\ln L_{i,t} = {} & \alpha_0 + \alpha_1 \ln L_{i,t-1} + \alpha_2 \ln \left(P^K/P^Y\right)_{i,t} + \\ & \alpha_3 \ln \left(P^E/P^Y\right)_{i,t} + \alpha_4 \ln \left(P^M/P^Y\right)_{i,t} + \\ & \alpha_5 \ln \left(P^S/P^Y\right)_{i,t} + \alpha_6 \ln RER_t + \\ & \alpha_7 \ln WorldGDP_t + \alpha_8 FE_i + \varepsilon^L_{i,t},\end{aligned} \tag{3.13}$$

and

$$\begin{aligned}\ln \left(P^L/P^Y\right)_{i,t} = {} & \beta_0 + \beta_1 \ln L_{i,t-1} + \beta_2 \ln \left(P^K/P^Y\right)_{i,t} + \\ & \beta_3 \ln \left(P^E/P^Y\right)_{i,t} + \beta_4 \ln \left(P^M/P^Y\right)_{i,t} + \\ & \beta_5 \ln \left(P^S/P^Y\right)_{i,t} + \beta_6 \ln RER_t + \\ & \beta_7 \ln WorldGDP_t + \beta_8 FE_i + \varepsilon^W_{i,t}.\end{aligned} \tag{3.14}$$

[5] Many economic conditions have been tested, like the U.S. GDP, U.S. Final Demand, U.S. Industrial Production, Canadian Final Demand, Canadian Personal Consumption and Import Penetration into both Canadian and U.S. markets, and the World Trade-Weighted Real Gross Domestic Product appears to be the one with the most explanation power for the demand shifts.

3.3 Econometric Issues

Economic relationships usually involve dynamic adjustment processes. Situations in which past decisions have impacts on current behavior are quite common in economics. As explained above, the short-run labour demand of the firm depends on past employment levels in the presence of employment adjustment costs. The two challenges of this kind of estimation is to take into account the dynamic process and the heterogeneity of the cross-section units. Using a panel (cross-section time-series) dataset - where the behavior of N cross-sectional units is observed over T time periods - allows us to model the joint occurrence of dynamics and unobserved individual heterogeneity in the phenomena of interest. Because of their relatively stable cross-sectional distribution, balanced panel models are known to be better at measuring the dynamics of adjustments than pure time-series or pure cross-section models. Therefore, we will solely used panel data to estimate our model.

3.3.1 Panel Data Analysis

It is well known that the data-generating processes for many economic variables are characterized by stochastic trends that might result in spurious inference if the time-series properties are not carefully investigated. However, Kao (1999) and Phillips and Moon (1999) have shown that panel data spurious regression estimates are consistent estimators of the true value of the parameters. They argued that panel estimators average across units and the information contained in the independent cross-section data of the panel leads to a stronger overall signal than in pure time-series cases. Furthermore, the heterogeneity in Canada's manufacturing industries increases the information contained in the cross-sectional dimension of the data.

Our point of departure for the estimation of employment behavior in the Canadian's manufacturing industry is the general panel error correction model. In our framework, after an exogenous shock such as an appreciation of the real exchange rate, employment responds by partially adjusting to its new equilibrium level. In a dynamic panel model, the evolution through time of industrial employment following an appreciation of the real exchange rate is determined by the long-run elasticity ($(\gamma_7/(1-\gamma_1))$ for specification (3.12) and $(\alpha_6/(1-\alpha_1))$ for specification (3.13)) of real exchange rate movements on industrial employment and by the speed of adjustment ($(1-\gamma_1)$ for specification (3.12) and $(1-\alpha_1)$ for specification (3.13)) to the new equilibrium. The challenge of our empirical analysis will be to get unbiased estimates of the long-run elasticity and the speed of adjustment.

Notice that in specifying (3.12), (3.13) and (3.14), we have used fixed-effects at the industry-level. This is because, for labour demand regressions, it is usually better to use fixed-effects instead of random-effects. In dynamic model, the individual effects are likely to be correlated with the regressors. Therefore, the standards errors for the random effects model are inconsistent. An approach to fixed-effect is the Least Square Dummy Variable estimator (LSDV), through which the unobserved effects are brought explicitly into the model by the fixed-effects.

However, Nickell (1981) has shown that the LSDV is biased for a finite T in autoregressive panel data models, but this bias becomes less significant as T increases. A number of consistent Instrumental Variables (IV) and Generalized Method of Moments (GMM) estimators have also been proposed in the econometric literature as an alternative to LSDV. Anderson and Hsiao (1982) (AH) suggest two simple IV estimators that, upon transforming the model in first difference to eliminate the unobserved individual heterogeneity, use the second lags of the dependent variable, either differenced or in level, as an instrument for the differenced one-time lagged dependent variable. Arellano and Bond (1991) (AB) propose a GMM estimator for the first difference model, that relies on both the correlation structure of the disturbance and a greater number of internal instruments and has been shown to be more efficient than the AH estimator. Blundell and Bond (1998) (BB) observed that with highly persistent data, first-differenced IV or GMM estimators might suffer from a severe small-sample bias due to weak instruments. As a solution, they suggest a system GMM estimator with first-differenced instruments for the equation in level and instruments in level for the first-differenced equation.

A weakness of IV and GMM estimators is that their properties hold for large N, so they can be severely biased and imprecise in panel data with a small number of cross-sectional units, as it is often the case in macroeconomic datasets. On the other hand, earlier Monte Carlo studies (Arellano and Bond (1991), Kiviet (1995) and Judson and Owen (1999)) demonstrate that LSDV, although inconsistent, has a relatively small variance compared to IV and GMM estimators. Another weakness of the GMM estimators is the underlying assumptions of stationarity of the dependent variables in the Blundell-Bond case. In fact, the validity of this procedure rests on the assumptions of the stationarity of the dependent variable, which is often not the case in macroeconomic data. Although the non-stationarity of the dependent variable may also lead to problems with the Arellano-Bond estimator. However, Bun and Kiviet (2001) have shown that, in a small sample case, the additional bias due to non-stationarity is small.

An alternative approach based upon the bias-correction of LSDV has recently become popular in the econometric literature. Nickell (1981) derives an expression for the inconsistency of LSDV as N goes to infinity, while Kiviet (1995) uses higher order asymptotic expansion techniques to approximate the small sample bias of the LSDV estimator, which he finds can be predicted with a good precision. Because they are evaluated, the approximation terms are of no direct use for estimation. To make them operational, Kiviet suggests replacing the true parameters by estimates from some consistent estimators. Monte Carlo evidence showed that the resulting Bias-corrected least squares dummy variables estimator (LSDVC) often outperforms the IV and GMM estimators in terms of bias and root mean squared error (RMSE). Another evidence from the Monte Carlo experiments by Judson and Owen (1999) in a case of stationary dependent variables and Kiviet (2001) in a case of non-stationary dependent variables strongly supports LSDVC when N is small, which is the case in most macroeconomic panels. However, the Kiviet's approach does not address the potential endogeneity of other regressors, like GMM does.

3.3.2 The Chosen Approach

Given the finite sample on which our empirical analysis is based, it is critical to choose estimators that strike a good balance between consistency and efficiency. First, all regressions are estimated in logarithmic values, to be able to estimate directly the elasticities between the main variables and to deal with the cointegration (see below). The lagged labour input of the equations (3.12), (3.13) and (3.14), while giving a dynamic nature, also create an endogeneity problem. It is indeed well known that the lagged dependent variables, $L_{i,t-1}$, is correlated with the error terms (Nickell, 1981). The industry-specific prices may also be endogenous. To control for endogeneity and inconsistency, the hours worked/employment equations can be estimated using AB (both one-step and two-step), BB and LSDVC. As describe above, these techniques deals with the endogeneity problems by using lagged levels of the explanatory variables (in the case of the AB estimator) and the differenced lagged levels (in the case of the BB estimator). In the case of the LSDVC, only the lagged dependent variables can be instrumented by using the lagged levels and the other explanatory variables are assumed to be exogenous.

In selecting an estimator for our model, we need to take into account the potential non-stationarity of many series - employment, hours worked, wages, the relative input prices, the real effective exchange rate and the world real gross domestic product. We applied the augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests to each of the industry series used in our empirical analysis and none of the test values rejected the null hypothesis of unit roots at a 5 percent confidence level. The unit roots test for heterogeneous panel proposed by Im, Pesaran and Shin (2003) provided the same results. Moreover, the Hadri test provided the same results by rejecting the null hypothesis of stationarity of the dependent and independent variables. Due to the presence of non-stationarity, we cannot estimate the model using the BB estimator. The Kao Residual Cointegration Test revealed that the series are integrated of order one, $I(1)$. To avoid the potential problem of spurious panel regression caused by cointegration and the presence of indexed series like prices of inputs, we have to use the logarithmic value of all the variables to estimate our model.

Each of the specifications (3.12), (3.13) and (3.14) is submitted to three specification tests. First, the Sargan test of over-identifying restrictions is performed for up to three lags of the dependent variables and industry-specific prices and, in each case, the null hypothesis that the regression is over-identified is rejected[6].

Second, based on the Arellano-Bond test of serial correlation, the hypothesis that there is first-order but not second-order serial correlation for both equations could not be rejected. The presence of first-order autocorrelation in the differenced residuals does not imply that the estimates are inconsistent, but the presence of second-order autocorrelation would imply that the estimates are inconsistent[7].

Finally, a test of exogeneity is performed to determine which variables need to be instrumented. This test was based on two hypotheses. First, all industry-specific variables $(RUC_{i,t}, RPE_{i,t}, RPM_{i,t}, RPS_{i,t})$[8] in the equations were assumed to be endogenous and, hence, the model was estimated using instrumental variables regressions. The second hypothesis assumes that only the lagged dependent variable $\ln L_{i,t-1}$ is endogenous and that all the industry-specific prices are exogenous. Whether industry-specific prices are exogenous or not can be tested by comparing the estimates from these two models under the Hausman specification test (1978)[9]. Staiger and Stock (1997) have shown that using the estimate of the error variance from an efficient estimator (in our case by assuming exogenous industry input prices) and comparing it to the estimates of the error variance from a consistent estimator (in our case by assuming endogenous industry input prices) provides robust test statistics in the presence of weak instruments. For both dependent variables, labour input and wages, the results of the Hausman test statistic are smaller than the critical value at a 10 percent confidence level. The null hypothesis that the differences in coefficients are not systematic (i.e. no difference between our efficient and consistent estimators) could not be rejected. Thus, at first sight, only the lagged

[6] Appendix I contains details of this test.

[7] Appendix G contains details of this test.

[8] This notation represents the relative user cost of capital, the relative price of energy, the relative price of materials and the relative price of services, respectively, which are the industry-specific prices already showed before. The notation have been changed for convenience only.

[9] Appendix H contains details of this test.

dependent variable needs to be instrumented[10].

The AB estimators can also produce unsatisfactory results in certain cases. Although lagged levels of the regressors, which they used as instruments, are arguably uncorrelated to the error term in the current time period, their validity as instruments also depends on how correlated they are to the variables they are instrumenting. The appropriateness of the Arellano-Bond estimators depends therefore on whether the instruments are weak. As pointed out by Bound, Jaeger, and Baker (1993, 1995), the *cure can be worse than the disease* when the excluded instruments are only weakly correlated with the endogenous variables. As Staiger and Stock (1997) suggest, GMM estimates can be subject to substantial problems if the instruments are weak: they have bias in same direction as OLS, have no consistency (Chao and Swanson (2005), have tests of significance of incorrect size, and have wrong confidence intervals. Staiger and Stock have also formalized the definition of *weak instruments*, but most researchers seem to have concluded (incorrectly) from that paper that if the F-statistic on the excluded instruments is greater than 10, one need worry no further about weak instruments. Stock and Yogo (2005) go into more detail and provide a useful rule of thumb regarding the weakness of instruments based on a statistic developed by Cragg and Donald (1993) for a context of two-stage least squares. Based on 6 different estimations (1, 2 and 3 lags of all endogenous variables (both dependent and industry-specific prices) and 1, 2 and 3 lags of dependent variable only (industry-specific prices treated as exogenous)) using IV estimators, the results of this test are always greater than the critical value needed to deem the instruments adequate. Thus, to select the appropriate specification for the optimal model, we used the Donald and Newey criterion (2001), which determines the optimal number of valid instruments for a model. Their test is based on the minimization of the root mean square error (RMSE). Choosing instruments to minimize RMSE should help reduce misleading IV inferences that can occur with many instruments. By testing all the 6 specifications mentioned above, we found that it is optimal to use 3 lags (including the first lag already included in the model) of each of the dependent variables (wages, hours worked and employment), treating the industry-specific prices as exogenous. Therefore, in all the estimates provided in this paper, two lags of the dependent variables are included as instruments.

[10]However, the assumption that one of the estimators is efficient (i.e., has minimal asymptotic variance) is a demanding one. It is violated, for instance, if the observations are clustered or if the model is miss-specified. Moreover, even if the assumption is satisfied, there may be a *small sample* problem with the Hausman test. Hausman's test estimates the variance of the difference of the estimators, $var(b - B)$, by the difference of the variances $var(b) - var(B)$. Under these assumptions, $var(b) - var(B)$ is a consistent estimator of $var(b - B)$, but it is not necessarily positive definite "in finite sample", which is the case here. Hence, Hausman's test is undefined. In their study, Leung and Yuen erroneously based their specification on this test even in small sample. In fact, we cannot determine whether the industry-specific variables need to be instrumented. Further tests are needed.

As discussed above, the presence of a common stochastic trend between cross-section units indicates that the regression is not spurious. In order to determine whether such a trend exist in the dependent variables of the panel, we applied the Nyblom-Harvey test. We found that a common stochastic trend exists between the cross-section units. Therefore, the cross-section units are considered to be cointegrated, and we do not care about spurious regression.

The presence of a common stochastic trend in our model can be an indication that there is a cross-sectional dependence in the panel. We tested this hypothesis by using three tests of cross-section dependence based on the cross-sectional correlation (Pesaran (2004), Frees (1995) and Friedman (1937)). We found that the cross-sectional units of the dependent variables series are clearly dependent. Frees' test showed that all the variables are cross-sectionally dependent, while the Friedman and Pesaran tests showed that the hours worked are not dependent. However, these two last tests are based on the sum of cross-correlations and they can suffer from severe drawbacks if the cross-correlation alternates in sign. Thus, the result from Frees test, which is corrected for this drawback, prevails. Therefore, assuming that cross-sectional dependence is caused by the common stochastic trend, which is unobserved, uncorrelated with the included regressors, and, hence, felt through the disturbance term, the standard fixed-effects estimators is consistent, although not efficient, ant the estimated standard errors are biased. However, up to now, no estimation method exists to deal with cross-sectional dependence in the case of non-stationary time-series. Therefore, we cannot correct the non-efficiency and the biased standard errors caused by the cross-sectional dependence between cross-section units. However, our estimates are still consistent.

Considering all the tests performed on our sample and the specification chosen in this section, we will estimate the model using by the Bias-corrected LSDVC initialized by AB.

Chapter 4

Data

We constructed a balanced panel of annual data to evaluate our dynamic model of employment's adjustment in Canada's manufacturing sector. The database includes both industry-specific and aggregate data. The main sources of data are the KLEMS database from Statistics Canada's Canadian Productivity Accounts and the Labour Force Survey (LFS).

4.1 Industry-specific data

This paper uses the KLEMS database released in June 2007 by Statistics Canada from its Canadian Productivity Accounts. KLEMS provides data on both prices and quantities for output, capital, labour, energy, materials and services inputs for all the Canadian industries under NAICS. This paper focuses on the 21 manufacturing industries. The data are annual and at the industry 3-digit level. The labour input (in hours worked) and the relative prices and user costs (labour, capital, energy, materials and services) variables that we use in the empirical section come from this database. Specifically, these variables are: total hours worked $H_{i,t}$, relative price of labour $RPL_{i,t}$, relative user cost of capital $RUC_{i,t}$, relative price of energy $RPE_{i,t}$, relative price of materials $RPM_{i,t}$ and relative price of services $RPS_{i,t}$ for $i = 1, ..., 21$ and $t = 1, ..., 20$. These relative prices are computed as the industry-specific price of input deflated by the industry-specific volume of input (i.e. chained Fisher index of prices calculated as the ratio of cost of the input index to the Fisher volume index of this input). These data differ from those used by Leung and Yuen (2005), which covered the 1961 to 1997 period and were organized under SIC.

In the KLEMS database, the only labour input available is hours worked. Since we want to evaluate the effect of exchange rate movements on both hours worked and employment, we also use employment data from the LFS (Labour Force Survey), which is denoted $E_{i,t}$ $(i = 1, ..., 21)$ from 1987 to 2006.

This paper will also use Dion's (1999) methodology to classify the industries based on their trade exposure. We define the *net trade exposure* of an industry as exports as a share of production less imported output as a share of production plus competing imports as a share of the domestic market. The ratios of net trade exposure for all the manufacturing industries were computed internally with an input-output table for the year 2000. Industries with a net trade exposure ratio above the manufacturing sector average are classified as having a high net trade exposure. Industries with a ratio below the manufacturing sector average of 0.6 are classified in the low-net-trade-exposure group. This classification is used to isolate the effect by type of net exposure[1].

4.2 Aggregate data

In this paper, we also use two aggregate variables, namely real World Trade-Weighted Real Gross Domestic Product $WorldGDP_t$ and the real effective exchange rate RER_t. The real effective exchange rate is the Canadian-dollar effective exchange rate index (CERI) deflated by the Consumer Price Index (CPI)[2]. Recall that an increase in the real effective exchange rate corresponds to a appreciation of the Canadian dollar vis-à-vis other currencies. As a lead-into the regression analysis, Figure 2.1 plots the movements of the nominal and real exchange rate Canada - U.S. and the Bank of Canada's Commodity Prices Index between 1987 and 2006. First, the exchange rate movements can be broken into three distinct periods from 1987 to 2006. The Canadian dollar appreciated from 1987 to 1991, then started to depreciate significantly, reaching a low in 2002. Since then, it has significantly appreciated, gaining over 44 percent between 2002 and 2006. Compared to previous studies (Leung and Yuen, 2005), our sample includes a full depreciation and appreciation cycle, as well as more amplitude in the movements of the exchange rate (between $US 0.70 and $US 0.88 for Leung and Yuen but between $US 0.62 and $US 0.90 for this paper). Furthermore, our data show that the exchange rate movements are highly correlated with the commodity prices since 1995.

[1]Appendix A presents the classification of the 21 industries as either high- or low-net-trade exposure.

[2]Lafrance, Osakwe and St-Amant, 1998, found that the CPI is the best choice to deflate the exchange rate. See Appendix B for sources and further explanations for these data.

Figure 4.1 shows the evolution of the manufacturing employment and the real exchange rate. The figure suggests that the labour input follows the same trend as the real exchange rate with a lag of about one year. Theory predicts that export-oriented firms tend to be more sensitive to changes in the exchange rate. Figure 4.2 and 4.3 show that there is a clear distinction across the trade groups. They suggest, as expected, that a appreciation of the Canadian dollar tend to decrease manufacturing employment with a lag about one year, and this relationship is stronger in the manufacturing industries with a high net trade exposure. Whether this is a causal relationship or the result of the influence of a third unidentified factor has yet to be determined. Detailed empirical analysis will be performed in the next section.

Figure 4.1: Total Manufacturing Employment and Real Exchange Rate

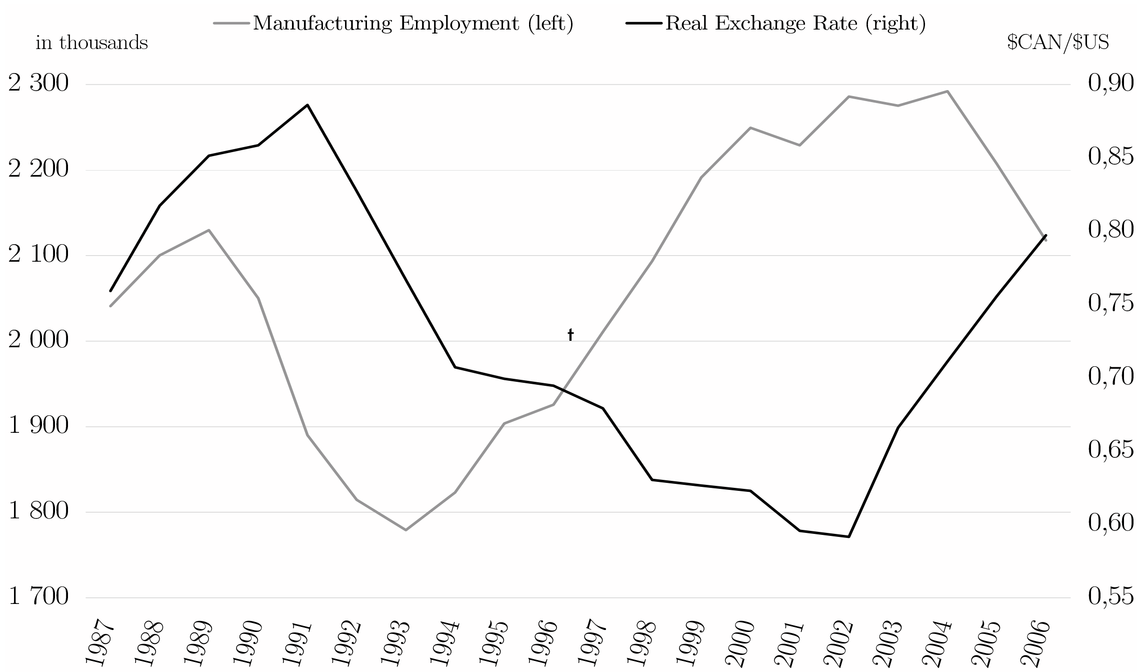


Figure 4.2: Manufacturing Employment and Real Exchange Rate in the Industries with a High Net Trade Exposure

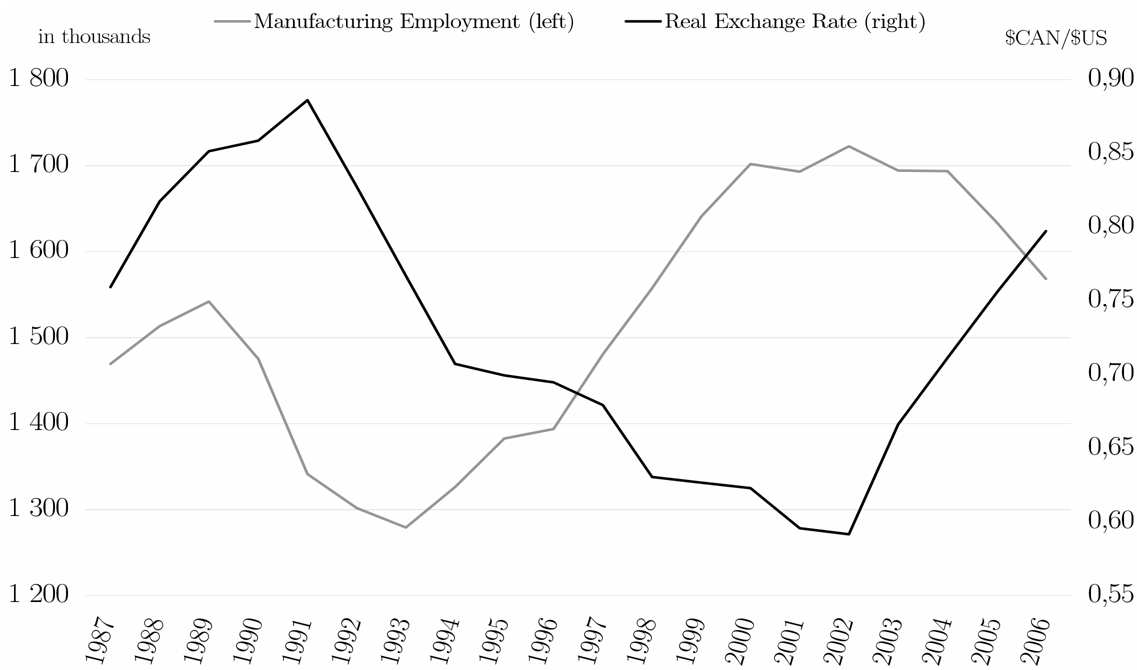


Figure 4.3: Manufacturing Employment and Real Exchange Rate in the Industries with a Low Net Trade Exposure

Chapter 5

Results

This chapter presents the empirical estimation of our model and answers our research question, by discussing and analyzing the empirical results.

5.1 Hours worked

In this section, we examine the adjustment of hours worked to real exchange rate fluctuations. Recall that econometric method we selected is Bias-corrected least squares dummy variables estimator (LSDVC)[1]. Tables 5.1 and 5.2 report LSDVC estimates of equation (3.12) and some variations of equation (3.12) with hours worked as the dependent variable. As a benchmark for comparison, we report the results from ordinary least squares (OLS) estimations in the last column of Tables 5.1. Column (1) of 5.1 gives estimates of equation (3.13) with all the industry-specific input prices, while the relative price of energy is omitted in column (2), the relative price of materials in column (3) and the relative price of services in column (4). The omission of industry-specific prices allow us to test the interaction and the correlation between the regressors in the model.

In Table 5.1, the negative impact of the relative price of labour on the level of hours worked is significant. The elasticity between these two variables is between -0.146 and -0.177. As expected, an increase in wages decrease the level of hours worked in the manufacturing sector.

[1] See Section 3.3.

On the output channel side, the short-run elasticity of the hours worked to fluctuation in real exchange rate is located between -0.147 and -0.171 and the long-run elasticity $(((\gamma_7/(1-\gamma_1)))$ is in a range of -1.73 to -4.24. In others words, if we take the estimates of column (1), a 10-percent appreciation in the real exchange rate leads to a 22.2-percent decrease in hours worked in the manufacturing industries in the long-run, all other things equal (i.e. relative price of inputs constant). These results are consistent with the predictions of our theoretical framework. The estimates for World Trade-Weighted Real GDP is also significant across the estimations. The elasticity of the hours worked to an increase in the world demand is 0.123 and 0.148, if we exclude the column (4) where the coefficient is not significant. In other words, when the world demand increases by 10 percent, the hours worked in the Canadian manufacturing industries rise by 1.23 percent, if taking into account the regressors of the column (1). The influence of the world demand over the hours worked is positive, as expected

On the substitution channel side, all but one of the coefficients for the relative prices of inputs are significant. The coefficients of the relative user cost of capital, whose estimates lie between 0.021 and 0.03, indicate that capital and labour are substitutes, since an increase in capital cost increase the level of hours worked. Because of the high real exchange rate and the high proportion of capital bought abroad (mainly in the U.S.), this substitution effect can be translated into a decrease of the labour inputs for a stronger utilization of capital in the production. The relative price of energy is never significant. Because of the high correlation between the energy prices and the real exchange rate[2], the coefficient of the latter may capture all the effect of the high energy prices and may reflect the fact that movements in the real exchange rate are largely driven by energy prices[3]. The sign, however, suggests that the energy and labour are substitute, as expected. The relative price of materials, however, is strongly significant. The elasticity between labour and materials is in the range of 0.058 to 0.063. The recent increase in the commodity prices may have enhanced this expected substitutability between these two variables. Furthermore, the coefficient of relative price of services is strongly significant and negative. The range of the elasticity is between -0.24 and -0.245. Finally, we can interpret the significativeness of the coefficient of the relative price of energy in column (3) by the correlation between the energy and materials prices.

In Table 5.2, we estimated the model of equation (3.12) with some variants of the real exchange rate. Column (1) of Table 5.2 gives the same LSDVC estimates as in column (1) of Table 5.1. A lag of the real exchange rate as well as the current period is included in column (2), while we replace these variables by a two-year moving average

[2] See Figure 2.1.

[3] An estimation has been done to test the significance of the relative price of energy's coefficient in the absence of the real exchange rate in the specification, and the coefficient of the energy price was strongly significant and positive.

of the real exchange rate in column (3) and a three-year moving average in column (4). In column (2), the inclusion of a lag of the real exchange rate make the current period of this variable insignificant, while the lag is strongly significant and negative, suggesting that firms reacts with a lag to real exchange rate movements. In column (3) and (4), the coefficients of the real exchange rate's moving average estimated, at -0.219 and -0.211 respectively, are both stronger than the current period and the lag and are both significant. This suggests that firms wait for a clear signal of the real exchange rate fluctuations and react if the volatility is low.

The second specification set is presented in Tables 5.3 and 5.4. Tables 5.3 and 5.4 report LSDVC estimates of equation (3.13) and some variations of equation (3.13) with hours worked as the dependent variable. Column (1) of Table 5.3 provided LSDVC estimates of equation (3.13). As a benchmark for comparison, we report the results from OLS estimations in the last column of Tables 5.3. The relative price of energy is omitted in column (2), the relative price of materials in column (3) and the relative price of services in column (4). Through the output channel, the short-run elasticity of the real exchange rate is located between -0.138 and -0.164 and the long-run elasticity $((\alpha_6/(1-\alpha_1)))$ is between -1.716 and -2.22 (i.e. we do not take into account the extreme value in column (4)). In other words, if we take column (1) as a benchmark, a 10-percent appreciation leads to a 22.2-percent decrease in hours worked in the manufacturing industries in the long-run, all other things equal. In Table 5.3, we find that the effect of an exchange rate appreciation is significant and negative. This shows that the Canadian manufacturing industries are quite sensitive to exchange rate movements. Therefore, the estimated elasticities reveal that exchange rates influence industry employment in the expected way.

The coefficients of the relative price of capital and material are positive, which suggest that capital and materials inputs are substitutes to labour input, while the coefficients of the relative price of services is negative, suggesting that the services and labour are complements. The coefficients of the relative price of energy is not significant. All the estimated coefficients are about in the same order as in the first specification explained above. The World Trade-Weighted Real GDP, in contrast of the first specification (3.12), is not significant and sometimes even negative. We would have expected a positive coefficient, since the world demand should have a positive impact on the output, and the output on the hours worked.

In all the estimations presented in Tables 5.1 to 5.4, the speed of adjustment is very slow compared to the estimations of Leung an Yuen (2005). In fact, the speed of adjustment for the estimates presented in column (1) of Tables 5.1 and 5.3 is around 0.075, nearly a third of the estimated speed of adjustment in Leung and Yuen. This may reflect the estimation method and the full cycle of the exchange rate that we use in this paper. First, the estimation method that Leung and Yuen used in their paper (AB) is well-known to be biased downward in small sample, which, in our case, represent a faster speed of adjustment than the LSDVC. Furthermore, the exchange rate in the last four years increased so quickly that the firm may have be surprised by this increase and tend to react at a slower pace than in the period used in Leung and Yuen (1981 to 1997).

Overall, we find that a change in the exchange rate affects substantially hours worked in the manufacturing sector. In the long-run, a 10-percent appreciation of the currency leads to a 22-percent decrease in the hours worked. Because the speed of adjustment is less than the elasticity and that the inputs are mainly substitutes, we can assume that the negative impact of the high dependency of Canadian manufacturing industries on exports, in combination with the negative effect of the appreciation have on the imports of foreign inputs that are substitutes to labour input, enhance the negative effect on the latter, since the *substitution* and the *output* channels are going in the same direction.

5.2 Employment

In this section, we examine the adjustment of employment to real exchange rate fluctuations. Tables 5.5 and 5.6 report LSDVC estimates of equation (3.12) and some variants of (3.12) for employment, while Tables 5.7 and 5.8 report LSDVC estimates of equation (3.13) and some variants of (3.13) for employment. As a benchmark for comparison, we report the results from OLS estimations in the last columns of Tables 5.5 and 5.7.

The first specification is presented in Tables 5.5 and 5.6. Column (1) of 5.5 gives LSDVC estimates of equation (3.13) with all the industry-specific input prices. The relative price of energy is omitted in column (2), the relative price of materials in column (3) and the relative price of services in column (4). The omission of industry-specific prices allow us to test the interaction and the correlation between the regressors in the model.

In Table 5.5, the negative impact of the relative price of labour on the level of employment is significant. The elasticity between these two variables indeed is between -0.181 and -0.21. As expected, an increase in wages decrease the level of employment in the manufacturing sector.

On the output channel side, the short-run elasticity of the employment to fluctuations in real exchange rate is ranging from -0.258 to -0.273 and the long-run elasticity $(((\gamma_7/(1-\gamma_1)))$ from -3.21 to -5.64. In other words, if we take the estimation in column (1), a 10-percent increase of the real exchange rate leads to a 36.4-percent decrease in employment in the manufacturing industries in the long-run, all other things being equal (i.e. relative price of inputs constant). As expected, the effect of exchange rate is significant and negative. However, in contrast to hours worked, the World Trade-Weighted Real GDP is not significant across the estimations.

On the substitution channel side, all the coefficients of the relative prices of inputs are insignificant, except for services, whose estimates lie between -0.267 and -0.271. The negative sign suggests that services are a complement of labour in the production. The relative prices of other inputs, which are not significant, suggest that, in contrast with the hours worked that are very sensitive to their influence, employment is only impacted by them through the real exchange rate. This may be because firms tend to adjust the more flexible labour input (i.e. hours worked) based on the prices of other inputs by the substitution channel, and adjust employment only on the output signal from real exchange rate.

In Table 5.6, we estimate equation (3.12) with some variants of the real exchange rate. Column (1) of Table 5.6 gives the same LSDVC estimates as in column (1) of Table 5.5. A lag of the real exchange rate as well as the current period is included in column (2), while we replace these variables by a two-year moving average of the real exchange rate in column (3) and a three-year moving average in column (4). In columns (3) and (4), the coefficients of the real exchange rate's moving average, estimated at -0.333 and -0.373 respectively, are both stronger than that of the current period and the lag and are both significant. This suggests that firms wait for a clear signal from the real exchange fluctuations when the real exchange rate is volatile, but react quickly if the volatility is low.

The second specification for employment is presented in Tables 5.7 and 5.8. Column (1) of Table 5.7 provides LSDVC estimates of equation (3.13) with all the industry-specific input prices. The relative price of energy is omitted in column (2), the relative price of materials in column (3) and the relative price of services in column (4). Again, the omission of industry-specific prices allows us to test the interaction and the correlation between the regressors in the model. These results present the same pattern in these two tables as the Tables 5.5 and 5.6 presented above, even with the exclusion of the relative price of labour, supporting the evidence that only the real exchange rate has influence on employment.

Overall, the results presented in these tables suggest that the real effective exchange rate has the same effect on employment as on the hours worked, but at a lower speed of adjustment. These results also suggest that the effect of the job losses (which is considered to be more permanent than the adjustment of hours worked) is highly driven by the real exchange rate and less by the internal incentives like the relative price of inputs. Tables 5.6 and 5.8 also suggest that the effect of real exchange rate is more significant and stronger in the long-run than in the short-run. In fact, the coefficient of the 3-year moving average is higher than the coefficient of the current or the lag period. The volatility of exchange rate movements has changed over time and the employment adjustment to a change in the exchange rate is stronger when the exchange rate is less volatile.

5.3 Wages

We now examine the real wages adjustment to real exchange rate fluctuations. Table 5.9 and Table 5.10 report LSDVC estimates of equation (3.14) and some variants of (3.14) for the relative price of labour. As a benchmark for comparison, we report the results of OLS estimations in the last columns of Table 5.9.

The first set of results is presented in Table 5.9. Column (1) of Table 5.9 provides LSDVC estimates of equation (3.14) with all the industry-specific input prices. Again, the relative price of energy is omitted in results in column (2), the relative price of materials in column (3) and the relative price of services in column (4). These omitted variables permit to check the different interactions between the variables. The real exchange rate coefficients are statistically insignificant in all estimations. Moreover, there is no evidence that the exchange rate may have an impact through the price of imported inputs on wages, because the coefficients on the relative price of capital, energy and materials are statistically insignificant in all estimations, except for the relative price of energy in OLS. The signs of the coefficients, however, are consistent with the results presented in the Table 5.1 for the effects of real exchange rate on hours worked. Tables 5.1 to 5.4 suggest that a rise in the relative price of capital lead to an increase in labour input (i.e. the labour and capital input are substitute), and the Table 5.9 suggests that wages also rise following an increase in relative capital cost. Similarly, Table 5.1 suggest that a rise in relative price of energy leads to an increase in hours worked, and Table 5.9 suggests that wages should also rise in that case. However, the coefficient of relative price of materials and relative price of services in Table 5.1 suggest that a rise in price of materials and services lead to an increase and a decrease in labour input, respectively, but Table 5.9 suggest that wages suggest the inverse effect on the wages. However, none of these coefficients (except for the relative price of services) are significant. We also found a strong positive effect of the World Trade-Weighted Real GDP on the wages in all specifications in Table 5.9 and 5.10. The final column provides OLS estimates of (3.14). The estimates are of the same signs and same significance of the LSDVC estimates.

In Table 5.10, we estimated the model of equation (3.14) with some variants of the real exchange rate. Column (1) of Table 5.10 provides the same LSDVC estimates of column (1) of Table 5.9. A lag of the real exchange rate as well as the current period is included in column (2), while we replace these variables by a two-year moving average of the real exchange rate in column (3) and a three-year moving average in column (4). In the column (2), the inclusion of a lag of the real exchange rate make the current period of this variable significant and negative, while the lag is strongly significant and positive, suggesting that the firms reacts with a lag to real exchange movements. In column (4), with a coefficient of -0.158, the coefficients of the real exchange rate's moving average is lower than the coefficient of the lagged value. This suggests that the firms does not wait for a clear signal of the real exchange fluctuations and react more instantly to real exchange rate movements.

Overall, therefore we find that the exchange rate does not have a strong impact on wages. Even if an exchange rate were inferred through the coefficients of the relative of capital, energy and materials, this impact would be negligible.

5.4 Differences across industries

Empirical results have been concentrated so far on the average effect of the real exchange rate on the manufacturing employment as a whole. In other words, the coefficients of the exchange rate in Tables 5.1 to 5.10 are constrained to be the same across all the 21 manufacturing industries. These results, however, could be ignoring the fact that labour adjustments occur differently across industries. As Campa and Goldberg (2001) showed, the effects of real exchange rate fluctuations may be increasing with the industry export orientation and when the share of imported input increased.

Tables 5.11 to 5.15 report results for labour inputs and wages depending on the net trade exposure and specification. Industries are grouped into low and high net exposure to international trade.

Table 5.11 reports the estimations in comparison with Table 5.1, except that the regressions are run on group based on their net trade exposure. Evidence of hours adjustment is consistently found among all groups[4]. As expected, the coefficients of the real exchange rate are negative in the three cases and lower in the group highly exposed to international trade. While the short-run elasticity of the hours worked to real exchange rate is -0.165 for all the industries, it reaches -0.23 for the high exposure group and it is lowered to -0.09 in the low exposure group. Furthermore, the estimates for the long-run elasticities for the high net trade exposure group (-3.574) are consistently larger than those that have low exposure to international trade (-0.214). Table 5.12 replicates the estimates of Table 5.3 and we can observe the same results.

On the substitution channel side, we find that the relative price of labour is negative for both groups, but is significant only for the high exposure group (-0.387). In comparison with the all industries results in column (1), this suggests that the industries with a high net trade exposure have a stronger reaction to an increase in wages than the low exposure group. We also find that all the relative price of inputs are significant, suggesting that the substitution channel is stronger in the industries with a high net trade exposure and the firms have more imperative to adapt their behavior to the foreign market than the group with a low net exposure to international trade. These patterns can be observed in Table 5.12 as well.

The above analysis is repeated with the employment as dependent variables in Tables 5.13 and 5.14. These Tables replicate the estimations made in the Tables 5.5 and 5.7, respectively. The results found are not as expected by the theory.

In Table 5.13, which replicates the specification (3.13), suggests that the short-run elasticity of the low-exposure group is negative and lower than the high exposure, which contradicts the theory that the high exposure group is more responsive to real exchange rate fluctuations. On the substitution side, the employment level is not responsive to any of the relative price of inputs.

In Table 5.14, which estimates the specification (3.13), we found that the exchange rate coefficient is negative and significant in all the cases and lower in the high exposure group, but only slightly. Furthermore, all the long-run elasticities estimated are non-significant. Moreover, the only significant relative price is the services, with a coefficient of -0.365. This suggests that the relative price of inputs have only impact on the level of hours worked, which is the most flexible form of the labour input, but the decision to fire employees, which is more permanent, take only into account the real exchange rate.

The Table 5.15 replicates the specifications estimated for wages in Table 5.9. In

[4]The Appendix A shows the division among the groups.

contrast with the estimations for all industries, the estimates for the high- and low-exposed groups are not significant for any of the regressors.

Comparison across industries shows that there is evidence of differences in the extent of the industries' employment elasticity to exchange rate changes. Such cross-industry variations are related to industry-specific characteristics.

Table 5.1: Effects of Exchange Rate Fluctuations on Hours Worked - A

Dependent variable is the log of hours worked[a]

Number of observations = 378 (sample period: 1987-2006)

	(1)	**(2)**	**(3)**	**(4)**	**OLS**[b]
$\ln H_{i,t-1}$	0.9254*	0.9238*	0.9155*	0.9598*	0.8587*
	(0.0272)	(0.0269)	(0.0266)	(0.0268)	(0.0178)
$\ln RPL_{i,t}$	-0.1484*	-0.1463*	-0.1529*	-0.1767*	-0.1502**
	(0.0299)	(0.0294)	(0.0301)	(0.0314)	(0.0663)
$\ln RUC_{i,t}$	0.0210*	0.0206*	0.0302*	0.0208*	0.0274*
	(0.0069)	(0.0069)	(0.0067)	(0.0072)	(0.0087)
$\ln RPE_{i,t}$	0.0145	-	0.0353***	0.0101	0.0149
	(0.0222)		(0.0197)	(0.0224)	(0.0250)
$\ln RPM_{i,t}$	0.0575*	0.0614*	-	0.0634*	0.0471***
	(0.0222)	(0.0198)		(0.0231)	(0.0248)
$\ln RPS_{i,t}$	-0.2399*	-0.2407*	-0.2454*	-	-0.2939*
	(0.0651)	(0.0644)	(0.0647)		(0.0645)
$\ln RER_t$	-0.1644*	-0.1469*	-0.1466*	-0.1706*	-0.1398*
	(0.0333)	(0.0260)	(0.0340)	(0.0345)	(0.0409)
$\ln WorldGDP_t$	0.1228**	0.1476*	0.1400**	0.0083	0.1622**
	(0.0561)	(0.0516)	(0.0558)	(0.0499)	(0.0693)
Long-run Elasticity[c]	-2.2038**	-1.9554**	-1.7349**	-4.2438	-0.9915*
Speed of Adjustment[d]	0.0746*	0.0762*	0.0845*	0.0402	0.1413*

[a]The specification is the equation (3.12) from the Section 3.2. All the regressions were estimated in log forms. *,** and *** indicate significance at 1, 5 and 10 percent level, respectively. Bootstrapped standard errors (LSDVC) and robust standard errors (OLS) are presented in parentheses.

[b]The OLS regression includes industry-specific dummies.

[c]The Long-run Elasticity is the coefficient of the real effective exchange rate divided by one minus the coefficient of the lagged labour input.

[d]The Speed of Adjustment is one minus the coefficient of the lagged labour input.

Table 5.2: Effects of Exchange Rate Fluctuations on Hours Worked - B

Dependent variable is the log of hours worked[a]

Number of observations = 378 (sample period: 1987-2006)

	(1)	(2)	(3)	(4)
$\ln H_{i,t-1}$	0.9254*	0.9247*	0.9249*	0.9137*
	(0.0272)	(0.0270)	(0.0271)	(0.0266)
$\ln RPL_{i,t}$	-0.1484*	-0.1235*	-0.1313*	-0.1189*
	(0.0299)	(0.0310)	(0.0294)	(0.0299)
$\ln RUC_{i,t}$	0.0210*	0.0159**	0.0168**	0.0187*
	(0.0069)	(0.0071)	(0.0070)	(0.0070)
$\ln RPE_{i,t}$	0.0145	0.0142	0.0192	0.0011
	(0.0222)	(0.0221)	(0.0223)	(0.0218)
$\ln RPM_{i,t}$	0.0575*	0.0697*	0.0673*	0.0654*
	(0.0222)	(0.0223)	(0.0222)	(0.0223)
$\ln RPS_{i,t}$	-0.2399*	-0.2001*	-0.2113*	-0.2000*
	(0.0651)	(0.0661)	(0.0645)	(0.0646)
$\ln RER_t$	-0.1644*	-0.0700	-	-
	(0.0333)	(0.0467)		
$\ln RER_{t-1}$	-	-0.1568*	-	-
		(0.0608)		
$\ln RER_{2year-ma}$	-	-	-0.2188*	-
			(0.0412)	
$\ln RER_{3year-ma}$	-	-	-	-0.2113*
				(0.0499)
$\ln WorldGDP_t$	0.1228**	0.0347	0.0487	0.0539
	(0.0561)	(0.0682)	(0.0638)	(0.0724)
Long-run Elasticity[b]	-2.2038**	-2.0823***	-2.9134**	-2.4484**
Speed of Adjustment[c]	0.0746*	0.0753*	0.0751*	0.0863*

[a]The specification is the equation (3.12) from the Section 3.2. All the regressions were estimated in log forms. *,** and *** indicate significance at 1, 5 and 10 percent level, respectively. Bootstrapped standard errors (LSDVC) and robust standard errors (OLS) are presented in parentheses.

[b]The Long-run Elasticity is the coefficient of the real effective exchange rate divided by one minus the coefficient of the lagged labour input.

[c]The Speed of Adjustment is one minus the coefficient of the lagged labour input.

Table 5.3: Effects of Exchange Rate Fluctuations on Hours Worked - C

Dependent variable is the log of hours worked[a]

Number of observations = 378 (sample period: 1987-2006)

	(1)	**(2)**	**(3)**	**(4)**	**OLS**[b]
$\ln H_{i,t-1}$	0.9295*	0.9284*	0.9197*	0.9828*	0.8609*
	(0.0284)	(0.0283)	(0.0282)	(0.0298)	(0.0187)
$\ln RUC_{i,t}$	0.0199*	0.0198*	0.0296*	0.0183**	0.0262*
	(0.0072)	(0.0072)	(0.0070)	(0.0075)	(0.0086)
$\ln RPE_{i,t}$	0.0038	-	0.0253	-0.0038	0.0037
	(0.0225)		(0.0200)	(0.0226)	(0.0242)
$\ln RPM_{i,t}$	0.0605*	0.0613*	-	0.0680*	0.05178**
	(0.0226)	(0.0201)		(0.0240)	(0.0253)
$\ln RPS_{i,t}$	-0.2928*	-0.2940*	-0.2998*	-	-0.3540*
	(0.0667)	(0.0657)	(0.0665)		(0.0639)
$\ln RER_t$	-0.1567*	-0.1515*	-0.1378*	-0.1635*	-0.1337*
	(0.0340)	(0.0268)	(0.0349)	(0.0352)	(0.0418)
$\ln WorldGDP_t$	0.0480	0.0558	0.0634	-0.1167**	0.0890
	(0.0545)	(0.0478)	(0.0546)	(0.0465)	(0.0646)
Long-run Elasticity[c]	-2.2227**	-2.1159**	-1.7161**	-9.5058	-0.9612**
Speed of Adjustment[d]	0.0705**	0.0716**	0.0803*	0.0172	0.1391*

[a]The specification is the equation (3.13) from the Section 3.2. All the regressions were estimated in log forms. *,** and *** indicate significance at 1, 5 and 10 percent level, respectively. Bootstrapped standard errors (LSDVC) and robust standard errors (OLS) are presented in parentheses.

[b]The OLS regression includes industry-specific dummies.

[c]The Long-run Elasticity is the coefficient of the real effective exchange rate divided by one minus the coefficient of the lagged labour input.

[d]The Speed of Adjustment is one minus the coefficient of the lagged labour input.

Table 5.4: Effects of Exchange Rate Fluctuations on Hours Worked - D

Dependent variable is the log of hours worked[a]

Number of observations = 378 (sample period: 1987-2006)

	(1)	**(2)**	**(3)**	**(4)**
$\ln H_{i,t-1}$	0.9295*	0.9276*	0.9307*	0.9194*
	(0.0284)	(0.0279)	(0.0282)	(0.0276)
$\ln RUC_{i,t}$	0.0199*	0.0134**	0.0148**	0.0157**
	(0.0072)	(0.0073)	(0.0073)	(0.0073)
$\ln RPE_{i,t}$	0.0038	0.0056	0.0159	0.0022
	(0.0225)	(0.0222)	(0.0227)	(0.0223)
$\ln RPM_{i,t}$	0.0605*	0.0766*	0.0722*	0.0722*
	(0.0226)	(0.0224)	(0.0225)	(0.0225)
$\ln RPS_{i,t}$	-0.2928*	-0.2276*	-0.2557*	-0.2342*
	(0.0667)	(0.0673)	(0.0658)	(0.0658)
$\ln RER_t$	-0.1567*	-0.0313	-	-
	(0.0340)	(0.0458)		
$\ln RER_{t-1}$	-	-0.2111*	-	-
		(0.0594)		
$\ln RER_{2year-ma}$	-	-	-0.2295*	-
			(0.0420)	
$\ln RER_{3year-ma}$	-	-	-	-0.2396*
				(0.0501)
$\ln WorldGDP_t$	0.0480	-0.0537	-0.0365	-0.0430
	(0.0545)	(0.0632)	(0.0613)	(0.0672)
Long-run Elasticity[b]	-2.2227**	-2.9157**	0.0693**	-2.9727**
Speed of Adjustment[c]	0.0705**	0.0724*	-3.3117**	0.0806*

[a] The specification is the equation (3.13) from the Section 3.2. All the regressions were estimated in log forms. *,** and *** indicate significance at 1, 5 and 10 percent level, respectively. Bootstrapped standard errors (LSDVC) and robust standard errors (OLS) are presented in parentheses.

[b] The Long-run Elasticity is the coefficient of the real effective exchange rate divided by one minus the coefficient of the lagged labour input.

[c] The Speed of Adjustment is one minus the coefficient of the lagged labour input.

Table 5.5: Effects of Exchange Rate Fluctuations on Employment - A

Dependent variable is the log of employment[a]

Number of observations = 378 (sample period: 1987-2006)

	(1)	**(2)**	**(3)**	**(4)**	**OLS**[b]
$\ln E_{i,t-1}$	0.9252*	0.9254*	0.9197*	0.9534*	0.8149*
	(0.0398)	(0.0393)	(0.0374)	(0.0372)	(0.0500)
$\ln RPL_{i,t}$	-0.1816*	-0.1810*	-0.1858*	-0.2099*	-0.1981*
	(0.0688)	(0.0677)	(0.0684)	(0.0696)	(0.0770)
$\ln RUC_{i,t}$	0.0182	0.0178	0.0230	0.0200	0.0308**
	(0.0156)	(0.0157)	(0.0151)	(0.0158)	(0.0149)
$\ln RPE_{i,t}$	0.0094	-	0.0258	-0.0002	0.0187
	(0.0508)		(0.0434)	(0.0495)	(0.0523)
$\ln RPM_{i,t}$	0.0446	0.0470	-	0.0485	0.0065
	(0.0536)	(0.0469)		(0.0539)	(0.0569)
$\ln RPS_{i,t}$	-0.2672***	-0.2669***	-0.2708***	-	-0.3616*
	(0.1445)	(0.1428)	(0.1423)		(0.0953)
$\ln RER_t$	-0.2725*	-0.2604*	-0.2581*	-0.2626*	-0.2352*
	(0.0758)	(0.0587)	(0.0769)	(0.0745)	(0.0892)
$\ln WorldGDP_t$	0.1189	0.1355	0.1361	-0.0020	0.2072
	(0.1251)	(0.1177)	(0.1233)	(0.1091)	(0.1511)
Long-run Elasticity[c]	-3.6430***	-3.4906	-3.2142***	-5.6352	-1.2707***
Speed of Adjustment[d]	0.0748***	0.0746***	0.0803**	0.0466	0.1851*

[a]The specification is the equation (3.12) from the Section 3.2. All the regressions were estimated in log forms. *,** and *** indicate significance at 1, 5 and 10 percent level, respectively. Bootstrapped standard errors (LSDVC) and robust standard errors (OLS) are presented in parentheses.

[b]The OLS regression includes industry-specific dummies.

[c]The Long-run Elasticity is the coefficient of the real effective exchange rate divided by one minus the coefficient of the lagged labour input.

[d]The Speed of Adjustment is one minus the coefficient of the lagged labour input.

Table 5.6: Effects of Exchange Rate Fluctuations on Employment - B

Dependent variable is the log of employment[a]

Number of observations = 378 (sample period: 1987-2006)

	(1)	**(2)**	**(3)**	**(4)**
$\ln E_{i,t-1}$	0.9252⋆	0.9231⋆	0.9211⋆	0.9094⋆
	(0.0398)	(0.0403)	(0.0401)	(0.0397)
$\ln RPL_{i,t}$	-0.1816⋆	-0.1571⋆⋆	-0.1549⋆⋆	-0.1295⋆⋆⋆
	(0.0688)	(0.0718)	(0.0681)	(0.0691)
$\ln RUC_{i,t}$	0.0182	0.0135	0.0134	0.0128
	(0.0156)	(0.0160)	(0.0159)	(0.0157)
$\ln RPE_{i,t}$	0.0094	0.0099	0.0079	-0.0061
	(0.0508)	(0.0510)	(0.0516)	(0.0513)
$\ln RPM_{i,t}$	0.0446	0.0558	0.0563	0.0588
	(0.0536)	(0.0534)	(0.0533)	(0.0531)
$\ln RPS_{i,t}$	-0.2672⋆⋆⋆	-0.2321	-0.2268	-0.1927
	(0.1445)	(0.1483)	(0.1431)	(0.1426)
$\ln RER_t$	-0.2725⋆	-0.1831⋆⋆⋆	-	-
	(0.0758)	(0.1072)		
$\ln RER_{t-1}$	-	-0.1497	-	-
		(0.1389)		
$\ln RER_{2year-ma}$	-	-	-0.3327⋆	-
			(0.0930)	
$\ln RER_{3year-ma}$	-	-	-	-0.3733⋆
				(0.1131)
$\ln WorldGDP_t$	0.1189	0.0341	0.0304	-0.0233
	(0.1251)	(0.1535)	(0.1423)	(0.1628)
Long-run Elasticity[b]	-3.6430⋆⋆⋆	-1.9467	-4.2167⋆⋆⋆	-4.1203⋆⋆⋆
Speed of Adjustment[c]	0.0748⋆⋆⋆	0.0769⋆⋆⋆	0.0789⋆⋆⋆	0.0906⋆⋆⋆

[a]The specification is the equation (3.12) from the Section 3.2. All the regressions were estimated in log forms. ⋆,⋆⋆ and ⋆⋆⋆ indicate significance at 1, 5 and 10 percent level, respectively. Bootstrapped standard errors (LSDVC) and robust standard errors (OLS) are presented in parentheses.

[b]The Long-run Elasticity is the coefficient of the real effective exchange rate divided by one minus the coefficient of the lagged labour input.

[c]The Speed of Adjustment is one minus the coefficient of the lagged labour input.

Table 5.7: Effects of Exchange Rate Fluctuations on Employment - C

Dependent variable is the log of employment[a]

Number of observations = 378 (sample period: 1987-2006)

	(1)	**(2)**	**(3)**	**(4)**	**OLS**[b]
$\ln E_{i,t-1}$	0.9276*	0.9271*	0.9214*	0.9726*	0.8178*
	(0.0412)	(0.0409)	(0.0390)	(0.0382)	(0.0507)
$\ln RUC_{i,t}$	0.0170	0.0170	0.0225	0.0177	0.0293***
	(0.0160)	(0.0160)	(0.0154)	(0.0161)	(0.0157)
$\ln RPE_{i,t}$	-0.0042	-	0.0133	-0.0189	0.0036
	(0.0502)		(0.0430)	(0.0480)	(0.0525)
$\ln RPM_{i,t}$	0.0478	0.0460	-	0.0506	0.0131
	(0.0535)	(0.0469)		(0.0536)	(0.0574)
$\ln RPS_{i,t}$	-0.3323**	-0.3344**	-0.3391**	-	-0.4411*
	(0.1451)	(0.1426)	(0.1427)		(0.0989)
$\ln RER_t$	-0.2618*	-0.2652*	-0.2467*	-0.2440*	-0.2269**
	(0.0763)	(0.0594)	(0.0773)	(0.0741)	(0.0893)
$\ln WorldGDP_t$	0.0288	0.0234	0.0446	-0.1434	0.1109
	(0.1192)	(0.1071)	(0.1177)	(0.0974)	(0.1356)
Long-run Elasticity[c]	-3.6160	-3.6379	-3.1387***	-8.9051	-1.2399***
Speed of Adjustment[d]	0.0724***	0.0786**	0.0274	0.0466	0.183*

[a]The specification is the equation (3.13) from the Section 3.2. All the regressions were estimated in log forms. *,** and *** indicate significance at 1, 5 and 10 percent level, respectively. Bootstrapped standard errors (LSDVC) and robust standard errors (OLS) are presented in parentheses.

[b]The OLS regression includes industry-specific dummies.

[c]The Long-run Elasticity is the coefficient of the real effective exchange rate divided by one minus the coefficient of the lagged labour input.

[d]The Speed of Adjustment is one minus the coefficient of the lagged labour input.

Table 5.8: Effects of Exchange Rate Fluctuations on Employment - D

Dependent variable is the log of employment[a]

Number of observations = 378 (sample period: 1987-2006)

	(1)	**(2)**	**(3)**	**(4)**
$\ln E_{i,t-1}$	0.9276⋆	0.9238⋆	0.9242⋆	0.9119⋆
	(0.0412)	(0.0417)	(0.0414)	(0.0410)
$\ln RUC_{i,t}$	0.0170	0.0103	0.0111	0.0098
	(0.0160)	(0.0164)	(0.0163)	(0.0161)
$\ln RPE_{i,t}$	-0.0042	-0.0011	0.0039	-0.0044
	(0.0502)	(0.0505)	(0.0516)	(0.0515)
$\ln RPM_{i,t}$	0.0478	0.0636	0.0611	0.0652
	(0.0535)	(0.0528)	(0.0531)	(0.0528)
$\ln RPS_{i,t}$	-0.3323⋆⋆	-0.2664⋆⋆⋆	-0.2804⋆⋆	-0.2310
	(0.1451)	(0.1491)	(0.1431)	(0.1426)
$\ln RER_t$	-0.2618⋆	-0.1309	-	-
	(0.0763)	(0.1042)		
$\ln RER_{t-1}$	-	-0.2209⋆⋆⋆	-	-
		(0.1341)		
$\ln RER_{2year-ma}$	-	-	-0.3433⋆	-
			(0.0939)	
$\ln RER_{3year-ma}$	-	-	-	-0.4028⋆
				(0.1124)
$\ln WorldGDP_t$	0.0288	-0.0781	-0.0681	-0.1283
	(0.1192)	(0.1401)	(0.1343)	(0.1489)
Long-run Elasticity[b]	-3.6160	-2.8990	-4.5290⋆⋆⋆	-4.5721⋆⋆⋆
Speed of Adjustment[c]	0.0724⋆⋆⋆	0.0762⋆⋆⋆	0.0758⋆⋆⋆	0.0881⋆⋆

[a]The specification is the equation (3.13) from the Section 3.2. All the regressions were estimated in log forms. ⋆,⋆⋆ and ⋆⋆⋆ indicate significance at 1, 5 and 10 percent level, respectively. Bootstrapped standard errors (LSDVC) and robust standard errors (OLS) are presented in parentheses.

[b]The Long-run Elasticity is the coefficient of the real effective exchange rate divided by one minus the coefficient of the lagged labour input.

[c]The Speed of Adjustment is one minus the coefficient of the lagged labour input.

Table 5.9: Effects of Exchange Rate Fluctuations on Wages - A

Dependent variable is the log of relative price of labour[a]

Number of observations = 357 (sample period: 1988-2006)

	(1)	**(2)**	**(3)**	**(4)**	**OLS**[b]
$\ln H_{i,t-1}$	0.0076	0.0079	0.0094	-0.0118	-0.0146
	(0.0325)	(0.0329)	(0.0323)	(0.0303)	(0.0251)
$\ln RUC_{i,t}$	0.0052	0.0043	0.0039	0.0055	0.0080
	(0.0104)	(0.0106)	(0.0092)	(0.0100)	(0.0165)
$\ln RPE_{i,t}$	0.0415	-	0.0370	0.0362	0.0741**
	(0.0353)		(0.0336)	(0.0328)	(0.0325)
$\ln RPM_{i,t}$	-0.0115	0.0027	-	-0.0108	-0.0314
	(0.0327)	(0.0316)		(0.0315)	(0.0338)
$\ln RPS_{i,t}$	0.1795***	0.1779***	0.1830***	-	0.4004*
	(0.1020)	(0.0985)	(0.1021)		(0.0758)
$\ln RER_t$	-0.0096	0.0367	-0.0115	0.0036	-0.0401
	(0.0530)	(0.0378)	(0.0520)	(0.0509)	(0.0463)
$\ln WorldGDP_t$	0.2896*	0.3572*	0.2852*	0.3580*	0.4868*
	(0.0861)	(0.0720)	(0.0851)	(0.0870)	(0.0651)
Long-run Elasticity[c]	-0.0096	0.0370	-0.0116	0.0036	-0.0395

[a] The specification is the equation (3.14) from the Section 3.2. All the regressions were estimated in log forms. *,** and *** indicate significance at 1, 5 and 10 percent level, respectively. Bootstrapped standard errors (LSDVC) and robust standard errors (OLS) are presented in parentheses.

[b] The OLS regression includes industry-specific dummies.

[c] The Long-run Elasticity is the coefficient of the real effective exchange rate divided by one minus the coefficient of the lagged labour input.

Table 5.10: Effects of Exchange Rate Fluctuations on Wages - B

Dependent variable is the log of relative price of labour[a]

Number of observations = 357 (sample period: 1988-2006)

	(1)	**(2)**	**(3)**	**(4)**
$\ln H_{i,t-1}$	0.0076	0.0057	0.0004	-0.0024
	(0.0325)	(0.0318)	(0.0318)	(0.0312)
$\ln RUC_{i,t}$	0.0052	0.0152	0.0106	0.0152
	(0.0104)	(0.0105)	(0.0107)	(0.0106)
$\ln RPE_{i,t}$	0.0415	0.0421	0.0111	-0.0043
	(0.0353)	(0.0339)	(0.0346)	(0.0342)
$\ln RPM_{i,t}$	-0.0115	-0.0383	-0.0216	-0.0319
	(0.0327)	(0.0336)	(0.0335)	(0.0342)
$\ln RPS_{i,t}$	0.1795***	0.0974	0.1616	0.1341
	(0.1020)	(0.0999)	(0.1017)	(0.1013)
$\ln RER_t$	-0.0096	-0.1987**	-	-
	(0.0530)	(0.0825)		
$\ln RER_{t-1}$	-	0.3084*	-	-
		(0.1050)		
$\ln RER_{2year-ma}$	-	-	0.0760	-
			(0.0623)	
$\ln RER_{3year-ma}$	-	-	-	0.1580**
				(0.0731)
$\ln WorldGDP_t$	0.2896*	0.4655*	0.3851*	0.4898*
	(0.0861)	(0.1097)	(0.1017)	(0.1165)
Long-run Elasticity[b]	-0.0096	0.3101*	0.0763	0.1576**

[a]The specification is the equation (3.14) from the Section 3.2. All the regressions were estimated in log forms. *,** and *** indicate significance at 1, 5 and 10 percent level, respectively. Bootstrapped standard errors (LSDVC) and robust standard errors (OLS) are presented in parentheses.

[b]The Long-run Elasticity is the coefficient of the real effective exchange rate divided by one minus the coefficient of the lagged labour input.

Table 5.11: Hours Worked and Net Exposure to International Trade - A

Dependent variable is the log of hours worked[a]

Number of observations = 378 (sample period: 1987-2006)

	All Industries	**High Exposure**	**Low Exposure**
$\ln H_{i,t-1}$	0.9254*	0.9357*	1.4143
	(0.0272)	(0.0260)	(0.0034)
$\ln RPL_{i,t}$	-0.1484*	-0.3865*	-0.0105
	(0.0299)	(0.0630)	(0.0591)
$\ln RUC_{i,t}$	0.02099*	0.0172**	0.0055
	(0.0069)	(0.0081)	(0.0122)
$\ln RPE_{i,t}$	0.0145	0.0477***	-0.0442
	(0.0222)	(0.0277)	(0.0545)
$\ln RPM_{i,t}$	0.0575*	0.0611**	0.0202
	(0.0222)	(0.0270)	(0.0791)
$\ln RPS_{i,t}$	-0.2399*	-0.2194*	0.1931
	(0.0651)	(0.0696)	(0.2717)
$\ln RER_t$	-0.1644*	-0.2298*	-0.0888
	(0.0333)	(0.0467)	(0.0856)
$\ln WorldGDP_t$	0.1228**	0.2359*	-0.0091
	(0.0561)	(0.0806)	(0.1766)
Long-run Elasticity[b]	-2.2038**	-3.5739***	-0.2143
Speed of Adjustment[c]	0.0746*	0.0643**	-0.4143*

[a]The specification is the equation (3.12) from the Section 3.2. All the regressions were estimated in log forms. *,** and *** indicate significance at 1, 5 and 10 percent level, respectively. Bootstrapped standard errors (LSDVC) and robust standard errors (OLS) are presented in parentheses.

[b]The Long-run Elasticity is the coefficient of the real effective exchange rate divided by one minus the coefficient of the lagged labour input.

[c]The Speed of Adjustment is one minus the coefficient of the lagged labour input.

Table 5.12: Hours Worked and Net Exposure to International Trade - B

Dependent variable is the log of hours worked[a]

Number of observations = 378 (sample period: 1987-2006)

	All Industries	**High Exposure**	**Low Exposure**
$\ln H_{i,t-1}$	0.9295*	0.9360*	1.5000
	(0.0284)	0.0296)	(0.0007)
$\ln RUC_{i,t}$	0.0199*	0.0177**	0.0041
	(0.0072)	(0.0088)	(0.0112)
$\ln RPE_{i,t}$	0.0038	0.0313	-0.0479
	(0.0225)	(0.0294)	(0.0456)
$\ln RPM_{i,t}$	0.0605*	0.0685**	0.0035
	(0.0226)	(0.0292)	(0.0591)
$\ln RPS_{i,t}$	-0.2928*	-0.3352*	0.2793
	(0.0667)	(0.0741)	(0.1566)
$\ln RER_{t}$	-0.1567*	-0.2233*	-0.0827
	(0.0340)	(0.0491)	(0.0717)
$\ln WorldGDP_{t}$	0.0480	-0.0053	-0.0381
	(0.0545)	(0.0742)	(0.1382)
Long-run Elasticity[b]	-2.2227**	-3.4890***	-0.1654
Speed of Adjustment[c]	0.0705**	0.064**	-0.500*

[a] The specification is the equation (3.13) from the Section 3.2. All the regressions were estimated in log forms. *,** and *** indicate significance at 1, 5 and 10 percent level, respectively. Bootstrapped standard errors (LSDVC) and robust standard errors (OLS) are presented in parentheses.

[b] The Long-run Elasticity is the coefficient of the real effective exchange rate divided by one minus the coefficient of the lagged labour input.

[c] The Speed of Adjustment is one minus the coefficient of the lagged labour input.

Table 5.13: Employment and Net Exposure to International Trade - C

Dependent variable is the log of employment[a]

Number of observations = 378 (sample period: 1987-2006)

	All Industries	**High Exposure**	**Low Exposure**
$\ln H_{i,t-1}$	0.9252*	0.9452*	0.8539*
	(0.0398)	(0.0411)	(0.1481)
$\ln RPL_{i,t}$	-0.1816*	-0.1618	-0.2413**
	(0.0688)	(0.1574)	(0.0950)
$\ln RUC_{i,t}$	0.0182	0.0215	-0.0066
	(0.0156)	(0.0193)	(0.0217)
$\ln RPE_{i,t}$	0.0094	-0.0494	0.1307***
	(0.0508)	(0.0704)	(0.0739)
$\ln RPM_{i,t}$	0.0446	0.0479	0.0145
	(0.0536)	(0.0699)	(0.0889)
$\ln RPS_{i,t}$	-0.2672***	-0.3102***	-0.2349
	(0.1445)	(0.1750)	(0.2602)
$\ln RER_{t}$	-0.2725*	-0.2334**	-0.2691**
	(0.0758)	(0.1079)	(0.1181)
$\ln WorldGDP_{t}$	0.1189	0.2095	0.0715
	(0.1251)	(0.1957)	(0.2258)
Long-run Elasticity[b]	-3.6430***	-4.2591	-1.8419
Speed of Adjustment[c]	0.0748***	0.0548	0.1461

[a]The specification is the equation (3.12) from the Section 3.2. All the regressions were estimated in log forms. *,** and *** indicate significance at 1, 5 and 10 percent level, respectively. Bootstrapped standard errors (LSDVC) and robust standard errors (OLS) are presented in parentheses.

[b]The Long-run Elasticity is the coefficient of the real effective exchange rate divided by one minus the coefficient of the lagged labour input.

[c]The Speed of Adjustment is one minus the coefficient of the lagged labour input.

Table 5.14: Employment and Net Exposure to International Trade - D

Dependent variable is the log of employment[a]

Number of observations = 378 (sample period: 1987-2006)

	All Industries	**High Exposure**	**Low Exposure**
$\ln H_{i,t-1}$	0.9276*	0.9418*	0.9466*
	(0.0412)	(0.0414)	(0.2009)
$\ln RUC_{i,t}$	0.0170	0.0223	-0.0120
	(0.0160)	(0.0193)	(0.0236)
$\ln RPE_{i,t}$	-0.0042	-0.0564	0.0925
	(0.0502)	(0.0692)	(0.0860)
$\ln RPM_{i,t}$	0.0478	0.0524	0.0064
	(0.0535)	(0.0697)	(0.0893)
$\ln RPS_{i,t}$	-0.3323**	-0.3646**	-0.3159
	(0.1451)	(0.1709)	(0.3374)
$\ln RER_t$	-0.2618*	-0.2318**	-0.2313***
	(0.0763)	(0.1066)	(0.1354)
$\ln WorldGDP_t$	0.0288	0.1104	0.0281
	(0.1192)	(0.1680)	(0.2720)
Long-run Elasticity[b]	-3.6160	-3.9828	-4.3315
Speed of Adjustment[c]	0.0724***	0.0582	0.0534

[a] The specification is the equation (3.13) from the Section 3.2. All the regressions were estimated in log forms. *,** and *** indicate significance at 1, 5 and 10 percent level, respectively. Bootstrapped standard errors (LSDVC) and robust standard errors (OLS) are presented in parentheses.

[b] The Long-run Elasticity is the coefficient of the real effective exchange rate divided by one minus the coefficient of the lagged labour input.

[c] The Speed of Adjustment is one minus the coefficient of the lagged labour input.

Table 5.15: Wages and Net Exposure to International Trade - E

Dependent variable is the log of relative price of labour[a]

Number of observations = 357 (sample period: 1988-2006)

	All Industries	**High Exposure**	**Low Exposure**
$\ln H_{i,t-1}$	0.0076	0.0136	-0.1935
	(0.0325)	(0.1807)	(0.1381)
$\ln RUC_{i,t}$	0.0052	0.0064	0.0366
	(0.0104)	(0.0357)	(0.0302)
$\ln RPE_{i,t}$	0.0415	-0.0549	0.0858
	(0.0353)	(0.1088)	(0.1042)
$\ln RPM_{i,t}$	-0.0115	0.00260	0.0717
	(0.0327)	(0.2060)	(0.1207)
$\ln RPS_{i,t}$	0.1795***	-0.1565	0.5123
	(0.1020)	(0.4274)	(0.3608)
$\ln RER_t$	-0.0096	0.1230	-0.0737
	(0.0530)	(0.1958)	(0.1489)
$\ln WorldGDP_t$	0.2896*	-0.0198	-0.0230
	(0.0861)	(0.3453)	(0.2890)
Long-run Elasticity[b]	-0.0096	0.1247	-0.0914

[a]The specification is the equation (3.14) from the Section 3.2. All the regressions were estimated in log forms. *,** and *** indicate significance at 1, 5 and 10 percent level, respectively. Bootstrapped standard errors (LSDVC) and robust standard errors (OLS) are presented in parentheses.

[b]The Long-run Elasticity is the coefficient of the real effective exchange rate divided by one minus the coefficient of the lagged labour input.

Chapter 6

Conclusion

In this paper, we examined the effects of exchange rate movements on employment, hours worked and wages in Canadian manufacturing industries. Theoretically, the shift in an industry's demand for labour due to a change in exchange rate depends on the external exposure of that industry. Exchange rate is expected to affect the labour demand through two channels. While devaluation increases the demand for products of that industry, thus providing a competitive edge to domestic firms either in foreign markets or competing foreign products in domestic market, it may also diminish the competitiveness of the industry to the extent that its uses foreign inputs. Moreover, the substitution between labour and capital can play a role. Eventually which factor will play a dominant role becomes an empirical question. This paper tests whether increases in the value of domestic currency had positive or negative effects on employment, hours worked and wages in Canada.

The main finding of this paper is that appreciation of the Canadian dollar hurts employment, hours worked and wages in Canada significantly. The elasticity of the labour inputs and wages also shows significant variation across industries depending on their net exposure to international trade. Furthermore, hours worked are found to be more sensitive to movements in exchange rate than employment. Considering the high dependency of the Canadian economy on foreign inputs and export, the results found for the labour inputs and wages should not be surprising.

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Appendix A

Industries by type of net exposure to international trade

Table A.1: List of industries by type of net exposure to international trade

NAICS	Manufacturing Industries	Net Trade Exposure
311	Food	Low
312	Beverage and tobacco product	Low
313	Textile mills	High
314	Textile product mills	High
315	Clothing	High
316	Leather and allied product	High
321	Wood product	High
322	Paper	High
323	Printing and related support activities	Low
324	Petroleum and coal product	Low
325	Chemical	High
326	Plastics and rubber product	High
327	Non-metallic mineral product	Low
331	Primary metal	Low
332	Fabricated metal product	High
333	Machinery	High
334	Computer and electronic product	High
335	Electrical equipment, appliance and component	High
336	Transportation	High
337	Furniture and related product	High
339	Miscellaneous	High

Appendix B

Definitions and data sources

B.1 INDUSTRY-SPECIFIC DATA - KLEMS

Hours worked

1987 to 2006 data

Hours worked by manufacturing industries at the NAICS 3-digit level from 1987 to 2003, completed by the growth in hours worked for the durable and non-durable goods (aggregations of 3-digit level industries by type of goods) for the period 2004-2005 and by the growth in hours worked in manufacturing sector (all the manufacturing industries) for 2006, based on KLEMS data. The number of hours worked in all jobs is the number of all jobs times the annual average hours worked in all jobs. According to the retained definition, hours worked means the total number of hours that a person spends working, whether paid or not. In general, this includes regular and overtime hours, breaks, travel time, training in the workplace and time lost in brief work stoppages where workers remain at their posts. On the other hand, time lost due to strikes, lockouts, annual vacation, public holidays, sick leave, maternity leave or leave for personal needs are not included in total hours worked.
Source: Statistics Canada (Cansim Table 383-0012, 383-0021 and 383-0022), Internal Calculations

Relative price of labour

1987 to 2006 data

Chained Fisher index of prices calculated as the ratio of labour compensation index

to the Fisher volume index of labour input by manufacturing industries at the NAICS 3-digit level from 1987 to 2003, completed by average growth for the period 1990 to 2003 by manufacturing industries at the NAICS 3-digit level, based on KLEMS data.
Source: Statistics Canada (Cansim Table 383-0022), Internal Calculations

Relative price of capital

1987 to 2006 data

Chained Fisher index of prices calculated as the ratio of capital compensation index to the Fisher volume index of capital input by manufacturing industries at the NAICS 3-digit level from 1987 to 2003, completed by the growth in the Machinery and Equipment Prices Indexes by manufacturing industries at the NAICS 3-digit level, based on KLEMS data and Capital Expenditure Price Statistics data.
Source: Statistics Canada (Cansim Table 383-0022 and 327-0042), Internal Calculations

Relative price of energy

1987 to 2006 data

Chained Fisher index of prices calculated as the ratio of energy cost index to the Fisher volume index of energy input by manufacturing industries at the NAICS 3-digit level from 1987 to 2003, completed by the growth in the Bank of Canada's Energy Commodity Prices Index for all the manufacturing industries from 2004 to 2006, based on KLEMS data and the Bank of Canada's Commodity Prices Indexes.
Source: Statistics Canada (Cansim Table 383-0022 and 176-0001), Internal Calculations

Relative price of materials

1987 to 2006 data

Chained Fisher index of prices calculated as the ratio of materials cost index to the Fisher volume index of materials input at the NAICS 3-digit level from 1987 to 2003, completed by the growth in the Bank of Canada's Industrial Material Commodity Prices Index for all the manufacturing industries from 2004 to 2006, based on KLEMS data and the Bank of Canada's Commodity Prices index.
Source: Statistics Canada (Cansim Table 383-0022 and 176-0001), Internal Calculations

Relative price of services

1987 to 2006 data

Chained Fisher index of prices calculated as the ratio of cost of services index to the Fisher volume index of services input at the NAICS 3-digit level from 1987 to 2003, completed by the growth in the All-item Consumer Price Index for all the manufacturing industries from 2004 to 2006, based on KLEMS data and the Statistics Canada Consumer Price Indexes.
Source: Statistics Canada (Cansim Table 383-0022 and 326-0020), Internal Calculations

B.2 INDUSTRY-SPECIFIC DATA - Labour Force Survey

Employment in Manufacturing Industries

1987 to 2006 data

Total employment by manufacturing industries at the NAICS 3-digit level based on the Labour Force Survey 2006.
Source: Statistics Canada (Labour Force Survey), Internal Calculations

B.3 AGGREGATE DATA

Real Effective Exchange rate

1987 to 2006 data

Nominal Exchange Rate between Canada and its major trade partners (CERI) deflated by the Consumer Price Index from 1987 to 2006. The CERI countries are the United States, European Union, Japan, China, Mexico, the United Kingdom and South Korea. Designed to be a summary measure of the Canadian dollar's movements against the currencies of its important trading partners, the CERI updates the weights and composition of the currency basket based on IMF-calculated trade weights. The weights used to calculate the index from 1996 to the present are based on trade data for 184 countries over the 1999-2001 period and encompass trade in non-energy commodities, manufactured goods, and services. Before 1996, the weights are based on trade data over the 1989-91 period. We also calculated 2-year moving average and the 3-year moving-average of the real effective exchange rate.

Source: Statistics Canada (Cansim Table 176-0064 and 383-0008), Bank of Canada, IMF World Economic Outlook Database (April 2007), Internal Calculations

World Trade-Weighted Real Gross Domestic Product

1987 to 2006 data

World Trade-Weighted Real Gross Domestic Product from 1987 to 2006, computed with the Real GDP of the Canada's major trade partners and the share of their respective trade with Canada. The weights used are the same as the real effective exchange.
Source: IMF World Economic Outlook Database (April 2007), Internal Calculations

Appendix C

Panel Unit Roots

Table C.1: Panel Unit Roots Tests - A

Variable is the log of employment[a]

Number of observations = 420 (sample period: 1987-2006)

	IPS		Fisher (ADF)		Fisher (PP)		Hadri
Lags	**No Trend**	**Common Time Effects**	**No Trend**	**Trend**	**No Trend**	**Trend**	
0	0.936	0.949	0.979	0.519	0.979	0.519	Homo:
1	0.999	0.955	0.995	0.233	0.979	0.437	0.000
2	0.997	0.662	0.731	0.175	0.980	0.459	Hetero:
3	0.999	0.659	0.508	0.001	0.983	0.511	0.000
4	0.998	0.138	0.001	0.000	0.986	0.585	SerDep:
5	0.997	0.771	0.876	0.000	0.989	0.689	0.000
6	1.000	0.870	0.118	0.200	0.993	0.791	

[a]The Panel Unit Roots Tests report in this table are: 1) Im, Pesaran and Shin (IPS), the results report are the p-value and the null hypothesis of this test is the non-stationarity of the variable; 2) Augmented Dickey-Fuller Fisher-type Test (Fisher (ADF)), the results report are the p-value and the null hypothesis of this test is the non-stationarity of the variable; 3) Phillips-Perron Fisher-type Test (Fisher (PP)), the results report are the p-value and the null hypothesis of this test is the non-stationarity of the variable; and 4) Hadri, the results report are the z-score and the null hypothesis of this test is the stationarity of the variable. All the variables have been tested under the log form.

Table C.2: Panel Unit Roots Tests - B

Variable is the log of hours worked[a]

Number of observations = 420 (sample period: 1987-2006)

	IPS		**Fisher (ADF)**		**Fisher (PP)**		**Hadri**
Lags	**No Trend**	**Common Time Effects**	**No Trend**	**Trend**	**No Trend**	**Trend**	
0	0.818	0.703	0.935	0.998	0.935	0.998	Homo:
1	0.879	0.070	0.192	0.261	0.871	0.999	0.000
2	0.858	0.015	0.013	0.000	0.836	0.999	Hetero:
3	0.947	0.163	0.301	0.000	0.812	0.999	0.000
4	0.391	0.158	0.433	0.170	0.775	0.999	SerDep:
5	0.653	0.126	0.121	0.923	0.773	1.000	0.000
6	0.651	0.192	0.330	0.997	0.819	1.000	

[a] The Panel Unit Roots Tests report in this table are: 1) Im, Pesaran and Shin (IPS), the results report are the p-value and the null hypothesis of this test is the non-stationarity of the variable; 2) Augmented Dickey-Fuller Fisher-type Test (Fisher (ADF)), the results report are the p-value and the null hypothesis of this test is the non-stationarity of the variable; 3) Phillips-Perron Fisher-type Test (Fisher (PP)), the results report are the p-value and the null hypothesis of this test is the non-stationarity of the variable; and 4) Hadri, the results report are the z-score and the null hypothesis of this test is the stationarity of the variable. All the variables have been tested under the log form.

Table C.3: Panel Unit Roots Tests - C

Variable is the log of relative price of labour[a]

Number of observations = 420 (sample period: 1987-2006)

	IPS		**Fisher (ADF)**		**Fisher (PP)**		**Hadri**
Lags	**No Trend**	**Common Time Effects**	**No Trend**	**Trend**	**No Trend**	**Trend**	
0	0.000	0.591	0.380	0.012	0.380	0.012	Homo:
1	0.202	0.949	0.979	0.004	0.359	0.004	0.007
2	0.023	0.869	0.139	0.000	0.384	0.002	Hetero:
3	0.420	1.000	1.000	0.000	0.336	0.001	0.000
4	0.419	1.000	1.000	0.000	0.330	0.000	SerDep:
5	0.409	1.000	1.000	0.000	0.229	0.000	0.000
6	0.862	1.000	1.000	0.000	0.133	0.000	

[a]The Panel Unit Roots Tests report in this table are: 1) Im, Pesaran and Shin (IPS), the results report are the p-value and the null hypothesis of this test is the non-stationarity of the variable; 2) Augmented Dickey-Fuller Fisher-type Test (Fisher (ADF)), the results report are the p-value and the null hypothesis of this test is the non-stationarity of the variable; 3) Phillips-Perron Fisher-type Test (Fisher (PP)), the results report are the p-value and the null hypothesis of this test is the non-stationarity of the variable; and 4) Hadri, the results report are the z-score and the null hypothesis of this test is the stationarity of the variable. All the variables have been tested under the log form.

Table C.4: Individual Panel Unit Roots Tests - D

Test performed is the Augmented Dickey-Fuller Fisher-type[a]

Number of observations = 20 by cross-section unit (sample period: 1987-2006)

NAICS codes	**Employment**	**Hours Worked**	**Relative price of labour**
311	0.760	0.394	0.205
312	0.183	0.163	0.641
313	0.302	0.400	0.634
314	0.035	0.400	0.634
315	0.934	0.605	0.821
316	0.088	0.185	0.548
321	0.792	0.572	0.713
322	0.077	0.008	0.517
323	0.489	0.085	0.870
324	0.561	0.000	0.690
325	0.814	0.191	0.636
326	0.757	0.265	0.883
327	0.451	0.282	0.877
331	0.306	0.452	0.691
332	0.646	0.288	0.832
333	0.736	0.743	0.636
334	0.816	0.470	0.594
335	0.423	0.505	0.887
336	0.901	0.688	0.787
337	0.619	0.635	0.812
339	0.082	0.249	0.795
Total Fisher	0.519	0.012	0.999

[a]The Panel Unit Roots Test reports in this table is the Augmented Dickey-Fuller Fisher-type Test (Fisher (ADF)), the results report are the p-value and the null hypothesis of this test is the non-stationarity of the variable. The test performed allows a deterministic trend and was calculated with 0 lags. All the variables have been tested under the log form.

Table C.5: Panel Unit Roots Tests - E

Number of observations = 420 (sample period: 1987-2006)[a]

	IPS		**Fisher (ADF)**		**Fisher (PP)**		**Hadri**
Variables	**No Trend**	**Common Time Effects**	**No Trend**	**Trend**	**No Trend**	**Trend**	
RUC							
0 lag	0.001	0.470	0.237	0.477	0.237	0.477	0.000
1 lag	0.000	0.196	0.268	0.002	0.123	0.275	-
RPE							
0 lag	0.180	1.000	1.000	1.000	1.000	1.000	0.000
1 lag	0.030	1.000	1.000	1.000	1.000	1.000	-
RPM							
0 lag	0.023	1.000	1.000	1.000	1.000	1.000	0.000
1 lag	0.009	1.000	1.000	1.000	1.000	1.000	-
RPS							
0 lag	0.005	0.000	0.000	0.000	0.000	0.000	0.000
1 lag	0.088	0.977	0.999	0.000	0.000	0.000	-
RER							
0 lag	0.999	1.000	1.000	1.000	0.999	1.000	0.000
1 lag	0.054	1.000	0.360	1.000	0.999	1.000	-
WorldGDP							
0 lag	-	1.000	1.000	1.000	1.000	1.000	0.000
1 lag	-	1.000	1.000	0.010	1.000	0.999	-

[a]The Panel Unit Roots Tests report in this table are: 1) Im, Pesaran and Shin (IPS), the results report are the p-value and the null hypothesis of this test is the non-stationarity of the variable; 2) Augmented Dickey-Fuller Fisher-type Test (Fisher (ADF)), the results report are the p-value and the null hypothesis of this test is the non-stationarity of the variable; 3) Phillips-Perron Fisher-type Test (Fisher (PP)), the results report are the p-value and the null hypothesis of this test is the non-stationarity of the variable; and 4) Hadri, the results report are the z-score and the null hypothesis of this test is the stationarity of the variable. All the variables have been tested under the log form.

Appendix D

Cointegration

Table D.1: Cointegration Test

Test performed is the Kao Residual Cointegration Test[a]

Number of observations = 420 (sample period: 1987-2006)

	Employment	**Hours Worked**	**Relative price of labour**
p-value	0.056	0.000	0.000

[a]The Cointegration Test reports in this table is the Kao Residual Cointegration Test, the regression tested is the specification (3.12), the results report are the p-value and the null hypothesis of this test is the absence of cointegration between the variables. All the variables have been tested under the log form.

Appendix E

Common Stochastic Trend

Table E.1: Common Stochastic Trend Test

Test performed is the Nyblom-Harvey Common Stochastic Trend Test[a]

Number of observations = 420 (sample period: 1987-2006)

	Employment	**Hours Worked**	**Relative price of labour**
Short-run	9.45	9.45	9.05
Long-run	82.35	82.35	62.15

[a]The Common Stochastic Trend Test reports in this table is the Nyblom-Harvey Test, the results report are the statistic of the test and the critical value at N=21 is 1.8425. All the variables have been tested under the log form.

Appendix F

Cross-sectional Dependence

Table F.1: Cross-sectional Dependence Tests

Number of observations = 420 (sample period: 1987-2006)[a]

	Employment	**Hours Worked**	**Relative price of labour**
Pesaran	0.020	0.301	0.000
	(0.470)	(0.470)	(0.940)
Frees	4.559	4.548	17.043
	(0.470)	(0.470)	(0.940)
Friedman	0.084	0.125	0.000
	(0.470)	(0.470)	(0.940)

[a]The Cross-sectional Dependence Tests report in this table are: 1) Pesaran Test, the results reports are the p-value and the sum of the cross-correlation in parenthesis, and the null hypothesis is the absence of cross-sectional dependence; 2) Frees Test, the results report are the statistic of the test and the sum of the cross-correlation in parenthesis, the critical value is 0.1294 at a 10-percent level and the null hypothesis is the absence of cross-sectional dependence; 3) Friedman Test, the results report are the p-value and the sum of the cross-correlation in parenthesis, and the null hypothesis is the absence of cross-sectional dependence. All the variables have been tested under the log form.

Appendix G

Serial Correlation

Table G.1: Serial Correlation Test

Test performed is the Arellano-Bond Test[a]

Number of observations = 420 (sample period: 1987-2006)

	Employment	**Hours Worked**	**Relative price of labour**
First-order	0.0000	0.0000	0.0000
Second-order	0.2350	0.6605	0.2315

[a]The Serial Correlation Test reports in this table is the Arellano-Bond Test, the results report are the p-value, and the null hypothesis is the absence of serial correlation. All the variables have been tested under the log form.

Appendix H

Specification

Table H.1: Hausman Specification Test

Number of observations = 420 (sample period: 1987-2006)[a]

	Employment	**Hours Worked**	**Relative price of labour**
p-value	0.8646	-0.78	0.0000

[a]The Specification Test reports in this table is the Hausman Specification Test, the results report are the p-value, and the null hypothesis is the absence of systematic difference between the coefficients. All the variables have been tested under the log form.

Appendix I

Over-Identification

Table I.1: Sargan Test of Over-Identifying Restrictions - A

Variable is the log of employment[a]

Number of observations = 420 (sample period: 1987-2006)

Lags	**Employment**	**Real Exchange Rate**	**Sargan Test**
1	0.7817	-0.2478	0.0033
	(0.0713)	(0.1181)	
2	0.7108	-0.2835	0.0243
	(0.0537)	(0.1061)	
3	0.6987	-0.2479	0.3671
	(0.0471)	(0.0994)	
4	0.7532	-0.2737	0.7870
	(0.0392)	(0.0978)	
8	0.7993	-0.2740	1.0000
	(0.0366)	(0.0984)	
OLS	0.8178	-0.2269	-
	(0.0507)	(0.0893)	

[a]The Specification Test reports in this table is the Sargan Test of Over-identifying restrictions, the results report are the coefficients of the variables estimated and the p-value of the Sargan Test is reported in the last column. The OLS is estimated as a benchmark. All the variables have been tested under the log form.

Table I.2: Sargan Test of Over-Identifying Restrictions - B

Variable is the log of hours worked[a]

Number of observations = 420 (sample period: 1987-2006)

Lags	**Hours Worked**	**Real Exchange Rate**	**Sargan Test**
1	0.7662	-0.1318	0.0000
	(0.0355)	(0.0478)	
2	0.7661	-0.1427	0.0002
	(0.0298)	(0.0450)	
3	0.7856	-0.1295	0.0028
	(0.0260)	(0.0433)	
4	0.8477	-0.1528	0.0169
	(0.0209)	(0.0426)	
8	0.8492	-0.1503	1.0000
	(0.0205)	(0.0422)	
OLS	0.8609	-0.1337	-
	(0.0187)	(0.0418)	

[a]The Specification Test reports in this table is the Sargan Test of Over-identifying restrictions, the results report are the coefficients of the variables estimated and the p-value of the Sargan Test is reported in the last column. The OLS is estimated as a benchmark. All the variables have been tested under the log form.

Table I.3: Sargan Test of Over-Identifying Restrictions - C

Variable is the log of relative price of labour[a]

Number of observations = 420 (sample period: 1987-2006)

Lags	**Hours Worked**	**Real Exchange Rate**	**Sargan Test**
1	-0.3210	0.0805	0.0000
	(0.0859)	(0.0592)	
2	-0.2638	0.0590	0.0000
	(0.0774)	(0.0581)	
3	-0.2769	0.0315	0.0507
	(0.0720)	(0.0587)	
4	-0.2485	0.0329	0.9501
	(0.0695)	(0.0586)	
8	-0.2481	0.0320	1.000
	(0.0695)	(0.0586)	
OLS	-0.0146	-0.0401	-
	(0.0251)	(0.0463)	

[a] The Specification Test reports in this table is the Sargan Test of Over-identifying restrictions, the results report are the coefficients of the variables estimated and the p-value of the Sargan Test is reported in the last column. The OLS is estimated as a benchmark. All the variables have been tested under the log form.