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Employment, Exchange Rates and Labour Market Rigidity

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ABSTRACT

Employment, Exchange Rates and Labour Market Rigidity*

There is increasing evidence that the interaction between shocks and labour market institutions is crucial to understanding the dynamics of employment. In this paper, we show that the inclusion of labour adjustment costs in a trade model affects the impact of exchange rate movements on employment. We also explore how labour market rigidities interact with the degree of exposure to international competition and with the technology level. Our model-based predictions are consistent with estimates obtained using panel data for 23 OECD countries. Namely, our estimates suggest that employment in low-technology sectors that have a very high degree of openness to trade and are located in countries with more flexible labour markets are more sensitive to exchange rate changes. Our model and estimates therefore provide additional evidence on the importance of interacting external shocks and labour market institutions.

JEL Classification: J23, F16, F41

Keywords: exchange rates, international trade, job flows, employment protection

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1 Introduction

Globalization has increased the exposure of open economies to external shocks. The almost instantaneous collapse of international trade in most developed and developing countries in the last quarter of 2008, caused by the international financial crisis, is an instance of how fast the transmission of shocks in the world economy can be. But the world economy has been afflicted by global shocks before. In the 1970s and in the 1980s, when the industrialized countries were hit by oil shocks and by the turbulence in exchange rate markets, following the demise of Bretton Woods, policymakers were vocal about the impact of external shocks on competitiveness. The steady decline in manufacturing employment and the increase in unskilled workers' unemployment contributed to keep this issue in the headlines ever since. However, policymakers and scholars — see, e.g., Nickell (1997), Nickell *et al.* (2002), Blanchard (1999), Blanchard and Wolfers (2000) and Blanchard and Portugal (2001) — have come to realize that the economic impact of these and other shocks depends, among other factors, on labour market institutions, a realization that has led many to urge for the implementation of labour reforms.[1]

The aim of this paper is thus to investigate, both theoretically and empirically, the impact of exchange rate shocks on employment and the relation between this impact and labour market institutions. Our approach brings together two strands of the literature on international trade. One is composed of the studies, mainly empirical, that find a significant effect, positively related to the degree of openness to trade, of exchange rate movements on employment (e.g., Branson and Love, 1988, Revenga, 1992, Gourinchas, 1999, Campa and Goldberg, 2001, and Klein *et al.*, 2003). The other is the new literature on international trade that builds on the seminal paper by Melitz (2003) and highlights the relationship between international trade and productivity. A recent example of this literature is Berman *et al.* (2009), who add distribution costs to the Melitz model. By doing that, they are able to show that heterogeneity in productivity across firms produces differentiated price and output responses to exchange rate depreciations. Using the same framework, Alexandre *et al.* (2009a) go one step further and show how the degree of openness to trade and the level of productivity interact to determine the impact of exchange rate movements on employment.

On the theoretical front, the present text provides a link between these international trade models and the analysis of labour market institutions, and shows how labour market rigidities, alongside openness and productivity, mediate the impact of exchange rates

[1] Calmfors and Driffill (1988) were among the first to discuss the implications of different labour market institutions for macroeconomic performance, namely the relationship between employment and the bargaining structure. Driffill (2006) updates that study and surveys the recent literature on labour market institutions and macroeconomic performance.

movements on employment. The development of our theory rests on the introduction of labour market frictions, in the form of hiring and firing costs, in a trade model with heterogeneous firms and distribution costs of the type developed in Berman *et al.* (2009). Our results suggest that higher labour adjustment costs decrease the employment exchange rate elasticity, i.e., an increase in labour adjustment costs attenuates the impact of exchange rate movements on labour demand. In our model, this result is robust to different degrees of openness to trade, productivity and exchange rate persistence.

The themes of labour market institutions and international trade have already appeared together in the new trade literature following Melitz (2003). For example, Felbermayr *et al.* (2008) added wage bargaining and search frictions to the Melitz model. Even more recently, Helpman and Itskhoki (2010) presented a two-sector version of the Melitz model that also includes wage bargaining and search frictions. However, the focus of these papers is on the comparative statics analysis of the economic implications of trade liberalization. In fact, the exchange rate is not even mentioned in such papers. We aim at filling part of this theory gap.

On the empirical side, we estimate the response of employment to exchange rate movements. We take into account the theoretical results and interact the exchange rate with measures of openness, productivity and labour adjustment costs. Our proxy for labour adjustment costs is the Employment Protection Legislation (*EPL*) index computed by OECD, which has previously been shown (see, among other, Cingano *et al.*, 2009) to be related to labour adjustment costs. We use sector-level data from 23 OECD countries covering the years 1988-2006. The results seem to corroborate the predictions of the theoretical model: very open sectors, using a lower level of technology and facing less labour rigidity are more sensitive to exchange rate movements.

The remainder of the paper is organized as follows. In section 2 we develop a trade model with labour market rigidities that take the form of labour adjustment costs. Section 3 sets the stage for our empirical test of the model's predictions. There we describe the main trends and patterns in manufacturing employment, exchange rates and employment legislation protection in OECD countries since the late 1980s. Section 4 presents econometric evidence on the effect of exchange rate changes on employment, in a panel of OECD countries, and its interaction with openness, technology and labour market rigidity. Section 5 concludes.

2 A trade model with labour adjustment costs

It has been shown (e.g., Bertola, 1990, 1992) that labour adjustment costs affect firms' optimal decisions, preempt an efficient allocation of resources and, in particular (Bertola, 1992, and Hopenhayn and Rogerson, 1993), that labour adjustment costs imply lower job flows.[2] In this section we show that in an international trade model one manifestation of this sort of effect is that higher labour adjustment costs reduce the size of the labour demand elasticity with respect to the exchange rate. Our presentation follows Melitz (2003) and Berman *et al.* (2009), but we introduce labour adjustment costs into the framework.

We start by describing the behaviour of the demand for the good that is exported. To simplify, we assume that the exporting firm only sells in market i. An alternative interpretation is that the revenues and costs associated with exporting to country i are separable from the rest of the firm's activities. We also assume, as is common in the related literature – namely, Melitz (2003) and Berman *et al.* (2009) – and, more generally, in modern macroeconomics, that the firm is a monopolistic competitor. Therefore, the price and quantity the firm will set will depend on the size of a finite price-elasticity of demand for the good that the firm produces. In our interpretation of the model's implications, this elasticity will also represent the degree of openness of country i. The motivation for this interpretation is that, in a more open market, competition from similar goods produced by other exporters to market i will be more intense, i.e., the price-elasticity will be higher. Another paper that also makes this assumption explicitly is Klein *et al.* (2003).

2.1 Demand

We assume that the representative consumer in country i maximizes a standard inter-temporal utility function:

$$U = E_0 \sum_{t=0}^{\infty} \theta^t u(C_{it}) \tag{1}$$

where θ is the discount factor.

The period utility flow is given by the Dixit-Stiglitz functional:

$$u(C_{it}) = C_{it} = \left[\int_{\Phi} x_{it}(\varphi)^{1-\frac{1}{\sigma}} \, \mathrm{d}\varphi \right]^{\frac{1}{1-\frac{1}{\sigma}}} \tag{2}$$

where σ is the elasticity of substitution between any two varieties (besides being the symmetric of the own price-elasticity) and $x_{it}(\varphi)$ is the consumption of variety φ, i.e., φ indexes, over the set Φ, the goods available to the consumer. Below, we will also use φ to represent the level of productivity of the firm that produces variety φ. Given the form

[2] These theoretical predictions have found empirical support in several studies – see, e.g., Haltiwanger *et al.* (2006) and Gómez-Salvador *et al.* (2004).

of the utility function, the demand for variety φ will be given by:

$$x_{it}(\varphi) = C_{it}\left[\frac{p_{it}(\varphi)}{P_{it}}\right]^{-\sigma} \tag{3}$$

For our purposes, we do not need to detail any more the behaviour of the representative consumer in country i. We will assume C_{it} to be an exogenous element in the firm's problem, to which we now turn.

2.2 Exporting firm

As we said before, the firm that produces variety φ, and exports it to country i, is a monopolistic competitor in country i, the sole destination of its output. The price that it charges in country i's currency ($p_{it}(\varphi)$) is given by:

$$p_{it}(\varphi) = \frac{p_t}{\varepsilon_{it}} + \eta_i w_{it} \tag{4}$$

where p_t is the period t price of the good in the domestic currency, ε_{it} is the period t price of a foreign unit of currency in units of the domestic currency, η_i are the distribution costs in country i, measured in units of country i's labour, and w_{it} is the wage in country i, in period t. The introduction of these distribution costs is the main innovation in Berman *et al.* (2009) relatively to the trade model proposed by Melitz (2003). The presence of distribution costs makes the elasticities of demand for variety φ with respect to the price (p_t) and with respect to the exchange rate functions of σ and of other parameters in the model, as we shall see below.

As in the related literature, the production function is assumed to be linear in the labour input:

$$y_t(\varphi) = \varphi L_t \tag{5}$$

where φ, as mentioned above, is a measure of productivity. The production costs include labour costs (given the wage in the firm's country, w_t), fixed costs and labour adjustment costs:

$$c_t(\varphi) = w_t L_t + F_t(\varphi) + w_t A(\Delta L_t) \tag{6}$$

The focus of this paper is on labour adjustment costs, $w_t A(\Delta L_t)$. For $A(\Delta L_t)$ — labour adjustment costs measured in units of labour — we adopt the formulation proposed by Pfann and Verspagen (1989):

$$A(\Delta L_t) = -1 + \exp(\beta \Delta L_t) - \beta \Delta L_t + \frac{\gamma}{2}(\Delta L_t)^2 \tag{7}$$

In this formulation, when $\beta \neq 0$, labour adjustment costs are asymmetric: if $\beta > 0$, then hiring costs are higher than firing costs; if $\beta < 0$, then the opposite is true. The other parameter, γ, reflects the symmetric component of the costs of adjusting labour.

The firm chooses how much to produce and sets the price so as to maximize its present value:

$$\max E_0 \sum_{t=0}^{\infty} \tilde{\delta}_t \left[p_t y_t(\varphi) - c_t(\varphi) \right] \tag{8}$$

where $\tilde{\delta}_t$ is the current period discount factor for the cash flow in period t. To simplify the derivations below, we shall assume that $\tilde{\delta}_t = \delta^t$.

Given our setup, the optimal choices for price and quantity are given by:

$$p_t = \frac{\sigma}{\sigma - 1} \left(1 + \frac{q_{it} \eta_i \varphi}{\sigma} + B_t \right) \frac{w_t}{\varphi} \tag{9}$$

and

$$y_t = C_{it} P_i^{\sigma} w_{it}^{-\sigma} \left(\frac{\sigma - 1}{\sigma} \right)^{\sigma} \left(\frac{1 + B_t}{q_{it} \varphi} + \eta_i \right)^{-\sigma} \tag{10}$$

where

$$q_{it} = \frac{\varepsilon_{it} w_{it}}{w_t} \tag{11}$$

denotes the real exchange rate and B_t includes current and future marginal costs of adjusting labour:

$$B_t = M_t - \delta E_t \left[\frac{w_{t+1}}{w_t} M_{t+1} \right] \tag{12}$$

with

$$M_t = \beta \left[\exp\left(\beta \Delta L_t \right) - 1 \right] + \gamma \Delta L_t \tag{13}$$

The non-linear nature of the model and the fact that B_t includes current and future marginal costs of adjusting labour make the analysis of the relation between firm behaviour and exchange rate movements more complex. To proceed we resort to log-linearization of equation (10).

2.3 Log-linearization

We begin by writing (10) as:

$$y_t = X_t \left(\frac{1 + B_t}{q_{it} \varphi} + \eta_i \right)^{-\sigma} \tag{14}$$

i.e., we collect in X_t the exogenous variables that are not directly related to the focus of our study.[3] We then log-linearize the resulting equation, obtaining:

$$\begin{aligned} \hat{y}_t &\approx \hat{X}_t + \frac{\sigma}{zq}\hat{q}_{it} - \frac{\sigma}{zq}\frac{(1+\delta)y}{\varphi}(\beta^2+\gamma)\hat{y}_t \\ &+ \frac{\sigma}{zq}\frac{y}{\varphi}(\beta^2+\gamma)\hat{y}_{t-1} + \frac{\sigma}{zq}\frac{\delta y}{\varphi}(\beta^2+\gamma)E_t\hat{y}_{t+1} \end{aligned} \tag{15}$$

where the hats denote log-deviations from the steady-state. Note that the parameters related to labour adjustment costs appear together in the factor $\beta^2 + \gamma$. Therefore, in the log-linearized version of the model, one of them is irrelevant: we chose to set $\beta = 0$.

We assume that the exogenous variables ($\hat{X}_t$ and $\hat{q}_{it}$) follow first-order autoregressive processes:

$$\hat{X}_t = \rho_X \hat{X}_{t-1} + \epsilon_t^X \tag{16}$$

$$\hat{q}_{it} = \rho_q \hat{q}_{it-1} + \epsilon_t^q \tag{17}$$

With these assumptions, the solution of the model is of the form:

$$\hat{y}_t = \alpha_0 \hat{X}_t + \alpha_1 \hat{q}_{it} + \alpha_3 \hat{y}_{t-1} \tag{18}$$

The parameter that we are interested in is α_1, which measures the sensitivity of output and labour demand to exchange rate movements. It is given by:

$$\alpha_1 = \frac{\alpha_3}{\left[1 + \alpha_3 \frac{\gamma y(1+\delta)}{\varphi}\right]\left[1 - \kappa(\alpha_2 + \rho_q)\right]} \tag{19}$$

where

$$\alpha_3 = \frac{\sigma}{1 + \eta\varphi q} \tag{20}$$

$$\kappa = \frac{\alpha_3 \frac{\delta\gamma y}{\varphi}}{1 + \alpha_3 \frac{(1+\delta)\gamma y}{\varphi}} \tag{21}$$

$$\alpha_2 = \frac{1 - \sqrt{1 - 4\kappa^2\delta^{-1}}}{2\kappa} \tag{22}$$

Though not immediately visible, these formulas lead to four conclusions that interest us:

[3] One simplification we shall make is that the growth rate of wages is zero, which allows us to ignore the ratio w_{t+1}/w_t in equation (12) and to delete a constant slightly different from 1 multiplying γ in the results presented below. It also saves us from having to assume a stochastic process for wages, which would, in any case, end up merged with the corresponding process for X_t.

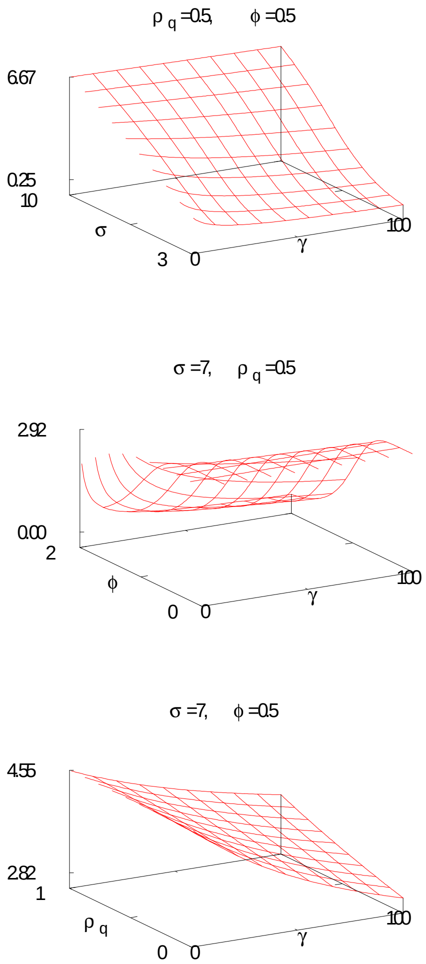

Figure 1: Employment exchange rate elasticity

1. an increase in labour adjustment costs (parameters β and γ) reduces the reaction of labour demand to exchange rate movements;

2. an increase in openness (σ) increases the reaction of labour demand to exchange rate movements;

3. an increase in productivity (φ) reduces the reaction of labour demand to exchange rate movements;

4. an increase in exchange rate persistence (ρ_q) increases the reaction of labour demand to exchange rate movements.

These conclusions may be gleaned from figure 1.[4] In these figures we plot the value

[4]Figures with additional calibrations are shown in the Appendix, Figures 7, 8 and 9. The plots are organized in three figures in order to facilitate the evaluation of the effect of labour adjustment costs

of α_1 for different parameterizations and using different variables in the axis so that the robustness of the patterns enumerated above may be verified. The model parameters were calibrated assuming $\delta = 0.96$, $\beta = 0$ and $s = 0.3$, as do Berman *et al.* (2009) in one version of their computations. s represents the share of distribution costs in the good's price. This share has been estimated to represent between 40% and 60% of goods' prices — see, e.g., Burstein *et al.* (2003) and Campa and Goldberg (2008). Setting $s = 0.5$ would not change the plots, only the scale: increasing the share of distribution costs would reduce the size of the elasticity α_1.

Our model suggests that empirical analyses of the reaction of employment to exchange rate movements should find that low-productivity firms, very open to trade and less affected by labour market rigidities should be more sensitive to the exchange rate. In the empirical section of this paper we will use sector-level data. One of the drawbacks of using this dataset is that it does not allow us to distinguish between firms that do and do not export. However, a similar model for non-exporting firms would also lead to the conclusion that the size of the impact of exchange rate movements on labour demand declines when labour adjustment costs increase. Therefore, we expect that the same will happen at the sector level. Note that we do not address the issue of firm entry and exit (the "extensive margin"). In Berman *et al.* (2009) fixed costs – $F_t(\varphi)$ in Equation (6), assumed to depend on the productivity level – are viewed as a payment that allows the firm to export to country i. Thus, in that setup fixed costs are important for the study of firms' entry and exit decisions concerning the destination market. Berman *et al.* show that at the aggregate level these costs will influence the extensive margin elasticity of exports with respect to the exchange rate. This is estimated to represent around 20% of the elasticity of French exports with respect to the exchange rate. We therefore believe that our model should be able to explain the bulk of the effect of exchange rate changes on employment.

3 Labour market institutions, employment and exchange rates

In this section, we describe very briefly the main trends in manufacturing employment per technology level (3.1), aggregate and sectoral exchange rates and openness (3.2) and employment protection in OECD countries (3.3). We do this to motivate our empirical analysis that aims at evaluating how employment protection has affected the impact of

(γ) on the labour demand elasticity with respect to the exchange rate. In each figure the patterns are similar regardless of the calibration. The plots reveal that adjustment costs have a larger effect on the value of α_1 when the persistence of exchange rate shocks is low and when productivity is high.

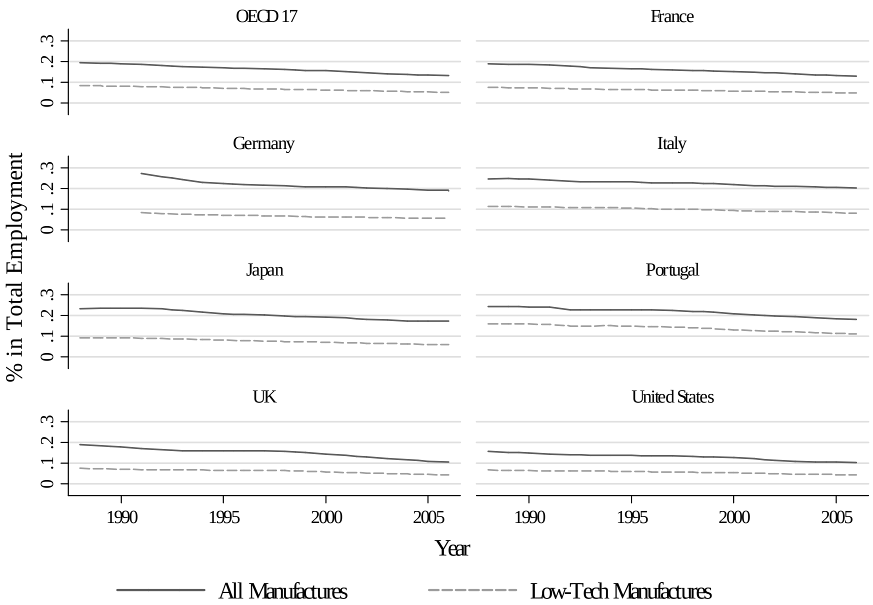

Figure 2: Employment Share in Manufacturing

exchange rate movements on employment.

3.1 Declining trends in manufacturing employment

Since the beginning of the 1980s there has been a very significant decrease in manufacturing employment. In our empirical analysis we use data for 22 manufacturing sectors and 23 OECD countries (see Tables 8 and 7 in the Appendix for the description of the sectors and countries, respectively). Between 1988 and 2006, manufacturing employment in OECD countries decreased from around 20% to 15% of total employment. However, trends in manufacturing employment have been very diverse across countries and sectors. The decrease in manufacturing employment was more pronounced in the US and in the UK, where it decreased, respectively, from 15.5% to 10.1% and from 18.8% to 10.4% – see Figure 2. On the other hand, manufacturing employment in countries like Italy and Germany decreased only slightly, remaining close to 20% of total employment in 2007.

When we look at the evolution of manufacturing employment by technology level, using the OECD technology level classification, we conclude that low-technology sectors have been the most affected by the downward trend in manufacturing employment: their share in total manufacturing employment declined from 46.3% in 1988 to 39.7% in 2006. The OECD technology classification ranks industries according to indicators of technology intensity based on R&D expenditures (OECD, 2005). Therefore, we use the OECD technology classification as a proxy for the productivity parameter in the production function of our theoretical model, φ, which can be understood as a total productivity factor (or a Solow residual). In fact, a simple OLS regression of labour productivity, measured as sectoral value added per employee, on OECD's technology classes and capital per employee, shows that high-technology sectors are more productive than low technology sectors. Given that data on value added and on the stock of capital are available just for a small sample of countries and years, we develop our analysis using the OECD's technology classification.[5]

3.2 Exchange rates and openness

In the 1990s, exchange rates became less volatile than they had been in the 1970s and in the first half of the 1980s. As a result, exchange rate fluctuations in the 1990s caused only moderate and intermittent concerns. However, the first decade of the 21st century has revived concerns about exchange rate volatility, its effects on global trade and the need for international policy coordination. In the first place, the rampant US trade deficit and China's surplus raised doubts on the exchange rate between the dollar and the renminbi. US policymakers have been accusing Chinese authorities of managing the exchange rate policy to keep the renminbi undervalued to boost China's exports. The devaluation of the dollar since 2002 against its main trade partners (see Figure 3) has also raised concerns about its future role in the international monetary system. Finally, significant swings in exchange rates followed the international financial crisis, either because high levels of debt raised concerns about the value of certain currencies (e.g., Poland, Hungary and Iceland) or because governments sought to use the exchange rate to stimulate the economy through exports (e.g., UK and US).

In Figures 3 and 4, we can observe the evolution of aggregate and sector-specific effective real exchange rates for a group of countries included in our empirical analysis. These exchange rates were computed as trade-weighted rates that include information to take into account sectoral third-party competition, a procedure described in Alexandre *et al.* (2009b), following Turner and Van't dack (1993).[6]

Figure 5 presents the evolution of openness in the same set of countries, measured as the ratio of exports plus imports over gross output plus exports and imports. It shows

[5] Running the following regression $\log(productivity) = \beta_0 + \beta_1 MHT + \beta_2 MLT + \beta_3 LT + \beta_4 \log(capital) + \theta_i + \gamma_t + \varepsilon$, we conclude that high-technology sectors are the ones with highest productivity and that productivity decreases for lower levels of technology (MHT: medium-high tech; MLT: medium-low tech; LT: low tech). Furthermore, the estimated coefficient on capital is about 0.41 with a standard error of 0.01. This implies that higher levels of capital are associated with higher levels of productivity. The R^2 is 0.78.

[6] See the Appendix for details.

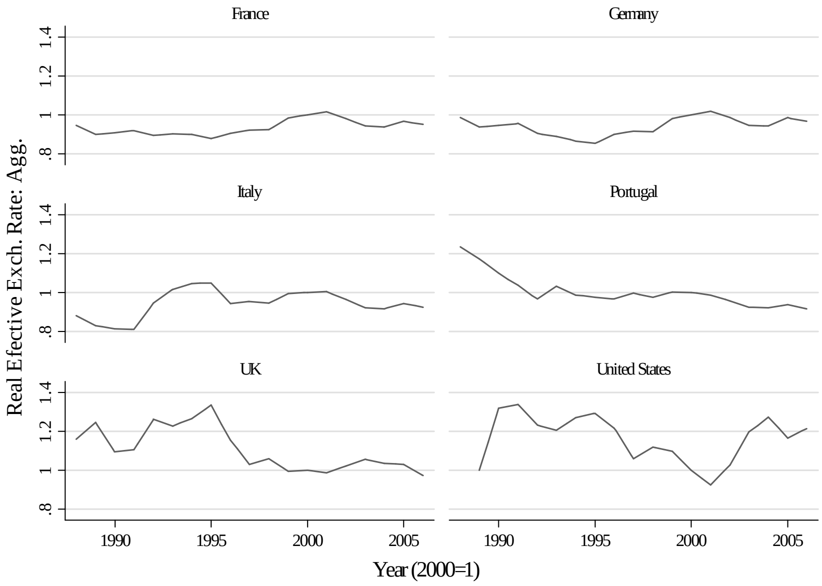

Figure 3: Aggregate Real Effective Exchange Rates

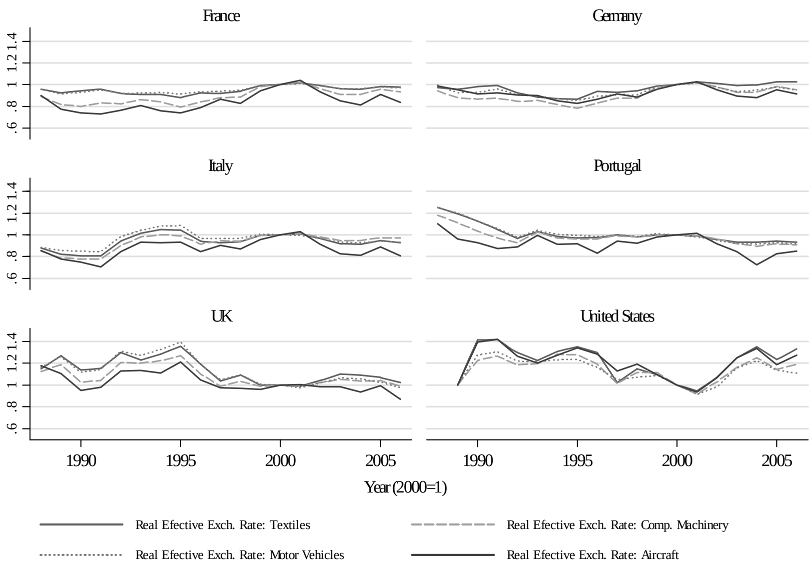

Figure 4: Sectoral Real Effective Exchange Rates

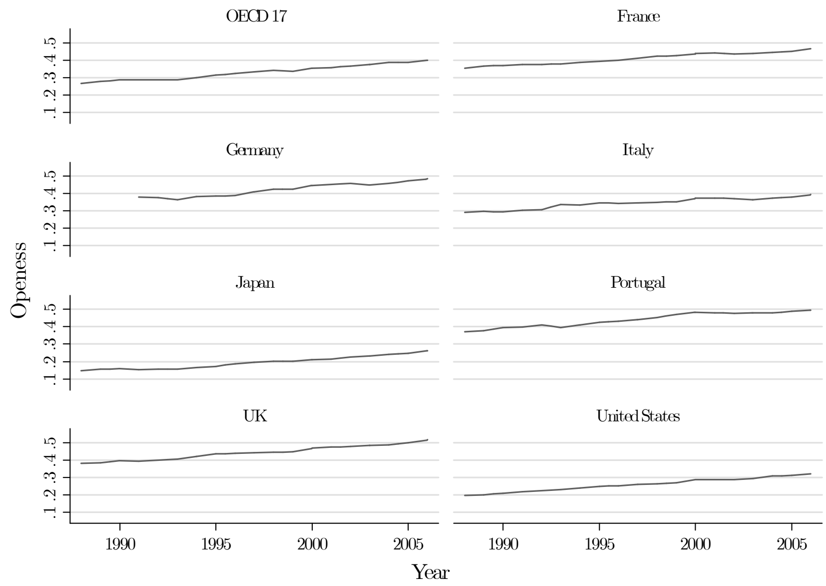

Figure 5: Openness

that between 1988 and 2006 the openness to trade has increased steadily.

3.3 Employment protection legislation

A rapidly changing environment due to increasing competition from emerging countries and to the acceleration in the pace of technological change has urged industrialized countries to introduce more flexibility in labour markets – these concerns have been specially strong in European countries. The European Commission, in particular, has recommended on several instances the reform of labour markets, namely of the excessively restrictive employment legislation, as a necessary condition for making the European Union the world's most competitive economy as stated in the Lisbon Strategy (see, for example, European Commission, 2003).

One feature of labour market rigidities is employment protection, that is, the legislation and collective bargaining agreements that regulate the hiring and firing – for a survey of the literature on employment protection see, for example, Addison and Teixeira (2003). This employment protection represents an additional labour cost for employers of the type that the model described in the previous section attempts to capture in the term $A(\Delta L_t)$. In our empirical analysis, we use the OECD Employment Protection Legislation (*EPL*) index which allow us to compare the labour market rigidities over time and across the 23 OECD countries. The OECD measure of employment protection, *EPL*, gathers three different types of indicators: indicators on the protection of regular workers

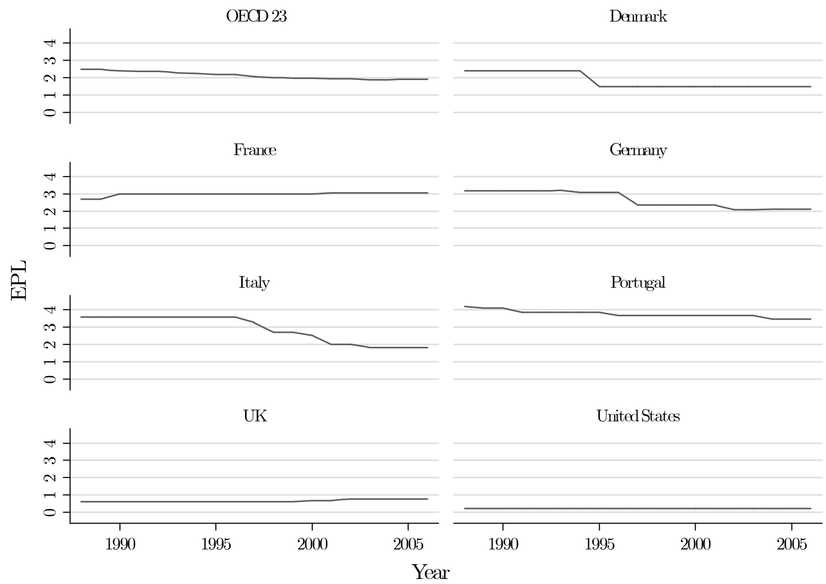

Figure 6: Employment Protection Legislation

against individual dismissal; indicators of specific requirements for collective dismissals; and indicators of the regulation of temporary forms of employment (OECD, 1999 and 2004).

As shown in Figure 6, in the last 20 years there was a downward trend in the OECD *EPL* index: it decreased from 2.49, in 1988, to 1.91, in 2006, indicating an easing of hiring and/or firing conditions. France and the UK are among the exceptions; in these countries the *EPL* index has increased slightly in the period under analysis. From the analysis of Figure 6, we can also see that countries with more stringent labour markets regulations, namely Germany and Denmark, converged to lower *EPL* index levels, from 3.17 and 2.4 in 1988 to 2.12 and 1.5 in 2006, respectively. However, the *EPL* index is still very diverse across countries, and despite the changes mentioned most countries have kept their relative positions.[7] The US, the UK and Canada have the lowest index. The *EPL* index for the US has remained unchanged throughout the whole period.

[7] According to OECD (2004) the regulation of temporary employment is crucial to understanding differences in EPL across countries.

4 Empirical evidence

4.1 Estimation strategy

As shown in section 2, our theoretical model implies that the sensitivity of employment to exchange rate changes should increase with the degree of openness and decrease with labour adjustment costs and productivity. In order to test these implications we use the following empirical specification:

$$\begin{aligned}\Delta y_{jct} \;=\;& \beta_0 + \beta_1 \Delta ExRate_{jc,t-1} + \beta_2 Open_{jc,t-1} + \beta_3 EPL_{c,t-1} \\ & + \beta_4 \Delta ExRate_{jc,t-1} \times Open_{jc,t-1} + \beta_5 \Delta ExRate_{jc,t-1} \times EPL_{c,t-1} \\ & + \beta_6 \Delta ShareChina_{jc,t-1} + \beta_7 \Delta ShareChinaW_{jc,t-1} + \beta_8 \Delta ULC_{c,t-1} \\ & + \beta_9 \Delta GDP_{c,t-1} + \beta_{10} \Delta IntRate_{c,t-1} + \lambda_t + u_{jct}, \end{aligned} \tag{23}$$

where Δ is the first-difference operator, y_{jct} is log employment, measured as total workers, in sector j and country c in year t, and $ExRate_{jc,t-1}$ is the lagged sectoral real effective exchange rate smoothed by the Hodrick-Prescott filter[8], which filters out the transitory component of the exchange rate.[9] $Open_{jc,t-1}$ measures the openness degree and $EPL_{c,t-1}$ stands for the OECD's Employment Protection Legislation index.

We include as additional control regressors the share of China in country c imports of goods belonging to sector j. Similarly, exporters from country c to another OECD country i face competition from Chinese exporters to country i. This type of competition is proxied by the $Share\_ChinaW_{j,c,t-1}$ variable, which is an weighted average of the share of Chinese imports in OECD countries, where weights are defined as the share of each country i in country c exports:

$$Share\_ChinaW_{jc,t} = \left(\frac{X_{c,t}^{i,j}}{\sum_{i=1}^{N(t)} X_{c,t}^{i,j}} \right) \left(\frac{M_{i,t}^{China,j}}{\sum_{k=1}^{N(t)} M_{i,t}^{k,j}} \right). \tag{24}$$

where $X_{c,t}^{i,j}$ ($M_{c,t}^{i,j}$) stands for exports (imports) from country c to country i, in sector j (in year t). In order to control for possible correlation between sectoral exchange rates and aggregate variables that are likely to influence employment growth we include additional controls for production costs such as Unit Labour Costs, $ULC_{c,t-1}$ for labour, and the long term real interest rate, $IntRate_{c,t-1}$ for capital costs. Aggregate real shocks are captured by the real Gross Domestic Product, $GDP_{c,t-1}$, measured in logs[10]. The composite error

[8] The smoothing parameter was set equal to 6.25 following Ravn and Uhlig (2002).

[9] According to our theoretical model, the sensitivity of employment to exchange rate movements increases to persistence of exchange rate shocks.

[10] The data of both variables is from OECD.

term is defined as $u_{jct} = \theta_{jc} + \varepsilon_{jct}$, where θ_{jc} is a set of sector/country specific dummies. Finally, equation (23) also includes time dummies, λ_t, to account for common technology shocks that affect all sectors and countries.

Summary statistics of the variables used in our analysis are presented in Table 1 (variables description is shown in Table 9 in the Appendix). Over the 19 years under analysis, 1988-2006, within manufacturing sectors employment has decreased on average 1.2% per per year, with a median yearly decrease of 0.9%. The percentiles 25 and 75 of annual sectoral employment change are -3.9% and 2.0%. The dispersion across sectors is considerable, as the standard deviation is about 0.0857. These simple descriptive statistics indicate that there have been structural employment shifts. In half of the sectors/years observations across countries we see a depreciation of the exchange rate, with the mean change being 0.0007, although with considerable variation: $\Delta \log ExRate$ fluctuates between -0.0913 and 0.0947, with a standard deviation of 0.0244. The data also shows that industries became more open and that labour markets became more flexible. We also observe that China increased its export share in the countries included in our sample. On average, unit labour costs have decreased over time, the same being true for the interest rate. Finally, GDP has increased at an average rate of 2.4%.

Table 1: Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
$Logemp$	5723	10.8519	1.6975	4.0604	14.7722
$LogExRate$	5723	-0.0336	0.0989	-0.4142	0.4043
$Open$	5723	0.4553	0.1898	0.0350	1.0000
EPL	5723	2.2065	0.9638	0.2100	4.1000
$ShareChinaW$	5723	0.0362	0.0447	0.0000	0.4146
$ShareChina$	5723	0.0427	0.0714	0.0000	0.7251
ULC	5723	1.0308	0.0625	0.8835	1.2300
$LogGDP$	5723	14.0023	2.1339	10.3809	20.5785
$IntRate$	5723	3.7687	1.9641	-3.5641	10.0059
$\Delta Logemp$	5723	-0.0120	0.0857	-1.4663	1.2054
$\Delta LogExRate$	5723	0.0007	0.0244	-0.0913	0.0947
$\Delta Open$	5673	0.0053	0.0272	-0.4091	0.3613
ΔEPL	5723	-0.0345	0.1535	-1.0200	0.5000
$\Delta ShareChinaW$	5723	0.0039	0.0083	-0.1347	0.1147
$\Delta ShareChina$	5723	0.0046	0.0193	-0.4770	0.4722
ΔULC	5723	-0.0054	0.0194	-0.0810	0.0586
$\Delta LogGDP$	5723	0.0242	0.0177	-0.0645	0.0691
$\Delta IntRate$	5723	-0.2238	1.2419	-7.3470	6.3962

Table 7 provides the list of 23 countries used in our analysis, as well as the number of observations within countries by technology level. Overall, we have 3295 observations for medium-low- and low-technology industries and 2428 observations for high- and medium-high-technology industries. For some countries the number of observations is relatively low, particularly for Slovakia, Poland, South Korea, Hungary, Czech Republic and Switzerland.

Table 2: Observations per country and technology level

Country	Low-Tech	High-Tech	Country	Low-Tech	High-Tech
Austria*	118	100	Hungary	48	6
Belgium*	198	106	Italy*	202	170
Canada*	195	153	Japan*	192	159
Switzerland	81	54	South Korea*	48	40
Czech Republic	40	39	Netherlands*	153	112
Germany	176	142	Norway*	185	147
Denmark*	193	137	Poland	40	5
Spain*	197	158	Portugal*	151	110
Finland*	202	159	Slovakia	44	40
France*	202	170	Sweden*	202	168
United Kingdom*	136	17	United States*	180	150
Greece*	112	86			
	Low-Tech			High-Tech	
Total observations	3295			2428	

Note: OECD23 refers to all countries presented in tableOECD17 refers to countries marked with *.

The next section presents the results derived from data for 20 manufacturing sectors, in 23 OECD countries, covering the period 1988-2006.

4.2 Main results

Table 3: Employment regressions

		No-EPL		EPL	
	No-Tech	Low-Tech	High-Tech	Low-Tech	High-Tech
Model	(1)	(2)	(3)	(4)	(5)
$\Delta ExRate_{t-1}$	-.2316*	-.2531**	-.4782	-.0920	-.2613
	(.1255)	(.1071)	(.3396)	(.1255)	(.3595)
$\Delta ExRate * Open_{t-1}$	.8851**	1.2085***	1.1815	1.0611***	1.0035
	(.3999)	(.3981)	(.7586)	(.3910)	(.7655)
$\Delta ExRate * EPL_{t-1}$				-.0697	-.0792
				(.0428)	(.0986)
$Open_{t-1}$	.2257***	.0995*	.3426**	.0993*	.3435**
	(.0815)	(.0570)	(.1389)	(.0562)	(.1377)

Continued on next page...

... table 3 continued

		No-EPL		EPL	
	No-Tech	Low-Tech	High-Tech	Low-Tech	High-Tech
Model	(1)	(2)	(3)	(4)	(5)
EPL_{t-1}				-.0158***	-.0227**
				(.0043)	(.0091)
$\Delta ShareChinaWeight_{t-1}$	.0141	-.0626	.2435	-.0638	.2178
	(.2000)	(.1636)	(.4529)	(.1652)	(.4487)
$\Delta ShareChina_{t-1}$	-.1243**	-.0815	-.3486	-.0820*	-.3237
	(.0606)	(.0498)	(.2276)	(.0498)	(.2242)
ΔULC_{t-1}	.0163	-.1323**	.2003	-.1211*	.2128
	(.0879)	(.0626)	(.1786)	(.0627)	(.1750)
ΔGDP_{t-1}	.5959***	.7599***	.3965	.7800***	.4123
	(.1269)	(.0958)	(.2569)	(.0939)	(.2606)
$\Delta InterestRate_{t-1}$	-.0010	-.0013	-.0008	-.0012	-.0005
	(.0012)	(.0009)	(.0026)	(.0009)	(.0026)
Countries	23	23	23	23	23
Observations	5723	3295	2428	3295	2428
Adj. R^2	.0504	.1068	.0422	.1137	.0444
LogLikelihood	6421.615	5417.503	1975.572	5431.425	1979.432

Notes: Significance levels: $*$: 10% $**$: 5% $***$: 1%. Robust standard errors in parenthesis. All regressions are estimated by fixed-effects at the sector/country level, and include time dummies. The dependent variable is $\Delta LogEmployment_{jct}$.

Equation (23) is estimated by the within estimator, with sector/country fixed-effects; standard errors are robust and clustered within sectors/countries pairs in order to allow for intra-group correlation. Table 3 shows the results of our estimations. Our first estimates, column (1), do not distinguish for the level of technology and for labour market rigidities. The results indicate that the employment exchange rate elasticity increases with the degree of openness. The interaction coefficient is 0.8851 and statistically significant at the 5% level (its standard error is 0.3999). The employment exchange rate elasticity for closed sectors, evaluated at the 10^{th} percentile of openness distribution, is not statistically different from zero (the elasticity is -0.032 with a joint significance $F-test$ $p-value$ of 0.591). For open sectors, computed at the 90^{th} percentile of openness distribution, we obtain an elasticity of 0.404 with a corresponding $p-value$ for the joint significance test of 0.028; a 1 percent exchange rate depreciation is associated with a 0.4 percent increase in employment. From our results we can also conclude that more open sectors, on average, create more employment: a 1 point increase in the openness index is associated with an employment increase of 0.23%. Looking to the additional set of regressors, we observe that imports from China have a negative impact on employment growth, while, as expected, positive income variations generate further employment gains. Although not statistically significant, the unit labour costs (ULC) and the real interest rate have the expected impact on employment innovations. Throughout our estimations we are using a sample of 22 industries across 23 countries, as described above, which correspond to 5723 observations. These are divided between 3295 observations in the low technology economic activities, and 2428 observations in the high technology industries.

The estimates in columns (2) and (3) account for different levels of technology and columns (4) and (5) include the labour market rigidity variable. We used these results to quantify the effects of exchange rate movements on employment in different degrees of openness and labour market rigidities (Table 4). We evaluate the employment elasticity at the 90^{th} and 10^{th} percentile of openness, Open (+) and Open (-), respectively. For each degree of openness, and for the models that include employment protection legislation (*EPL*), we further evaluate the elasticity from high to low levels of *EPL*; *i.e.*, at the 95^{th}, 50^{th} and 5^{th} percentiles of *EPL*.

For low technology and open sectors, Table 4, column (1), the employment exchange rate elasticity is positive and statistically significant; *i.e.*, a depreciation induces employment creation: a 1 percent depreciation induces a 0.61% employment change. However, for closed sectors, bottom half of column (1), although we obtain a positive elasticity, it is not statistically significant (the joint significance $F-test$'s $p-value$ is about 0.7).[11]. Looking to the additional controls(column (3), Table 3), imports from China have a negative impact on OECD's manufacturing employment, although marginally not statistically significant. The unit labour costs have a significant impact on employment: a 1 point increase implies a 13% employment decrease. GDP growth has the expected positive and significant effect on employment, while the real interest rate does not interfere with employment movements, once we control for the other explanatory variables. These results show that exchange rate shocks play a role in the determination of employment changes. Furthermore, its effects are higher the higher the degree of openness.

From column (3), Table 3, we conclude that for high technology sectors the employment exchange rate does not vary with the degree of openness: the interaction term is estimated to be about 1.18, with a standard error of 0.76. Altogether, the employment exchange rate elasticity is not statistically significant (Table 4, column (3), top half), with an estimated magnitude of 0.37. Therefore, exchange rate movements seem to play

[11] The null hypothesis under analysis is $H_0 : \beta_1 + \beta_4 Open^{95} = 0$, where $Open^{95}$ is the 95^{th} openness percentile. The F statistic is 9.72.

Table 4: Employment exchange rate elasticities

<table>
<tr><th></th><th></th><th colspan="2">Low-Tech</th><th colspan="2">High-Tech</th></tr>
<tr><th></th><th></th><th>(1)</th><th>(2)</th><th>(3)</th><th>(4)</th></tr>
<tr><td rowspan="3">Open(+)</td><td>EPL(+)</td><td rowspan="3">0.6148*** (0.0020)</td><td>0.4259** (0.0499)</td><td rowspan="3">0.3703 (0.1596)</td><td>0.1820 (0.6152)</td></tr>
<tr><td></td><td>0.5221*** (0.0084)</td><td>0.2914 (0.2971)</td></tr>
<tr><td>EPL(-)</td><td>0.6177*** (0.0016)</td><td>0.3999 (0.1089)</td></tr>
<tr><td rowspan="3">Open(-)</td><td>EPL(+)</td><td rowspan="3">0.0193 (0.6981)</td><td>-0.0969 (0.3399)</td><td rowspan="3">-0.2118 (0.2707)</td><td>-0.3124 (0.3119)</td></tr>
<tr><td></td><td>-0.0006 (0.9904)</td><td>-0.2031 (0.3493)</td></tr>
<tr><td>EPL(-)</td><td>0.0949 (0.1030)</td><td>-0.0945 (0.6174)</td></tr>
</table>

Notes: $p - values$ in parenthesis. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

a crucial role in the determination of employment for low productivity and open industries, while it appears insignificant in the high productivity sectors and is in line with the one discussed in Alexandre *et al.* (2009a). The additional control variables shown in Table 3, column (3), are not statistically significant.

The inclusion of the *EPL* information in our regressions brings interesting results. First, for Low-Tech sectors, the effect of the exchange rate on employment is higher for more open industries that face a higher flexibility in the labour market (column (4), Table 3). The coefficient on $\Delta ExRate_{jc,t-1} \times EPL_{c,t-1}$ is marginally non significant, with a magnitude of -0.0697 and a standard error of 0.0428. We reinforce the result discussed above that exchange rate effects are enhanced for higher degrees of openness. On its own, openness is associated with employment creation (a 1 point increase in openness increases employment by 0.1%), while labour market rigidities (higher *EPL*) relates to negative employment variations (a 1 point increase in *EPL* implies a 1.6% employment decrease).[12] The corresponding employment exchange rate elasticities reported in Table 4, column (2), reveal the following: for highly open sectors, top half of column (2), the elasticity is positive and significant and decreases with labour market rigidity. It goes from 0.62, for Low-Tech sectors with a degree of openness equal to its 90^{th} percentile and an *EPL* evaluated at its 5^{th} percentile, to 0.43 with an *EPL* evaluated at the 95^{th} with the same degree of openness. For example, for Low-Tech, very open sectors, facing rigid labour markets, a 1% depreciation of the exchange rate is associated with an average

[12] The annual average change in EPL is -0.023, with a standard deviation of 0.137. The induced employment change would be $-0.023 * (-0.0158) \simeq 0.036\%$.

employment increase of about 0.43%. Turning our attention to closed sectors we observe that in face of flexible labour markets the employment exchange rate elasticity is 0.0949, and marginally non-significant (the standard error is 0.1030). With the increase in the degree of rigidity the exchange rate effects on employment become clearly insignificant. The results for the additional covariates provide a consistent story: (i) competition from China affects negatively employment changes, (ii) an increase in the unit labour costs reduces employment, and (iii) income positive variations are associated with employment creation; a 1% increase in GDP created 0.78% more employment.

For High-Tech industries, column (5), Table 3, both openness and labour market rigidities do not play on the effect of exchange rate innovations on employment variations. At the same time, the employment exchange rate elasticity, Table 4, column (4), is not significant. An interesting result is the one where in very open High-Tech industries with flexible labour markets, the employment exchange rate elasticity is about 0.4, and marginally non-significant at the 10% level (the associated $p - value$ is 0.1089). Such elasticity is still about 2/3 of the one obtained for Low-Tech industries. These results confirm the conclusion that exchange rate movements are particularly relevant for employment determination in low productivity sectors and these effects decrease monotonically with labour market rigidity. Also, openness has an important effect on employment variations; for example, a 1 point increase in the openness index implies a variation of about 0.34% in employment (Table 3, column 5), and labour market rigidities are associated with an employment reductions; a 1 point increase in *EPL* decreases employment by 2.3%. For High-Tech sectors the additional set of regressors does not seem to play a relevant role.

Finally, looking to the overall significance of the regressions presented in Table 3, we conclude that our model is more successful in explaining employment movements for Low-Tech industries. An adjusted R^2 of 11% for Low-Tech (columns 2 and 4) compares to 4% for High-Tech (columns 3 and 5). This conclusion is reinforced by the analysis of the loglikelihood.

4.3 Sensitivity analysis

In what follows we discuss two alternative specifications of equation (23). We extend the estimates presented in columns (4) and (5) of Table 3 by, first, replacing $Open_{jc,t-1}$ and $EPL_{c,t-1}$ by their first-differences counterparts, and, second, eliminating these variables from our specification, while keeping their interactions with the exchange rate. The estimates, and corresponding elasticities, are presented in Tables 5 and 6, respectively.

The new set of estimates indicates that there are no major changes in our results. Some of the estimates, and corresponding elasticities, become statistically significant, reinforcing the results discussed in the previous section. By including both openness and *EPL* in lagged changes, instead of levels, we now observe that for High-Tech the exchange rate effects are also mediated by the degree of openness. This results is valid for both specifications, columns (2) and (4), Table 5. As before, exchange rate effects seem not to be determined by labour market rigidities for High-Tech industries. From column (2), we also conclude in favour of the relevant role of GDP on employment movements in the High-Tech economic activities. Although the estimate on this coefficient has always been positive, only under this particular specification of the model we obtain a statistically significant result. Comparing to the Low-Tech estimate, the estimated coefficient is about 2/3, implying a lower effect of GDP the High-Tech labour market. Excluding both openness and *EPL* on their own from the regression, column (4), GDP is again statistically insignificant, even though positive. One possible interpretation for these results is that the degree of openness might be correlated with income levels. This way, in Table 3, columns (3) and (5), most of the effect is captured by openness. By taking first-differences of openness, as well as of *EPL*, or by eliminating these two variables from the model, we let GDP show its main effect, even for High-Tech.

Table 5: Employment regressions

	Low-Tech	High-Tech	Low-Tech	High-Tech
Model	(1)	(2)	(3)	(4)
$\Delta ExRate_{t-1}$	-.0788	-.3653	-.1248	-.2313
	(.1203)	(.4154)	(.1247)	(.3687)
$\Delta ExRate * Open_{t-1}$	1.2254***	1.6339*	1.3437***	1.4180*
	(.3713)	(.8626)	(.3844)	(.7711)
$\Delta ExRate * EPL_{t-1}$	-.1068**	-.1365	-.0980**	-.1592
	(.0423)	(.1012)	(.0428)	(.1017)
$\Delta Open_{t-1}$	-.0817	-.0328		
	(.0638)	(.0868)		
ΔEPL_{t-1}	-.0033	-.0043		
	(.0065)	(.0199)		
$\Delta ShareChinaWeight_{t-1}$	-.0913	.3057	-.0846	.2868
	(.1599)	(.4552)	(.1645)	(.4568)
$\Delta ShareChina_{t-1}$	-.0745*	-.3050	-.0794*	-.2951
	(.0438)	(.2268)	(.0467)	(.2271)
ΔULC_{t-1}	-.1632***	.0802	-.1582***	.1520
	(.0627)	(.1525)	(.0602)	(.1821)
ΔGDP_{t-1}	.8199***	.5022*	.7653***	.3622

Continued on next page...

... table 5 continued

	Low-Tech	High-Tech	Low-Tech	High-Tech
Model	(1)	(2)	(3)	(4)
	(.0948)	(.2886)	(.0951)	(.2758)
$\Delta InterestRate_{t-1}$	-.0013	.00004	-.0013	-.0007
	(.0009)	(.0024)	(.0009)	(.0025)
Countries	23	23	23	23
Observations	3273	2400	3295	2428
Adj. R^2	.1097	.0286	.1038	.0282
LogLikelihood	5417.134	1954.527	5412.136	1957.976

Notes: Significance levels: $*$: 10% $**$: 5% $***$: 1%. Robust standard errors in parenthesis. All regressions are estimated by fixed-effects at the sector/country level, and include time dummies. The dependent variable is $\Delta LogEmployment_{jct}$.

In Table 6, the regressions used in the estimation of elasticities under (1) use $\Delta Open$ and ΔEPL as explanatory variables - see columns (1) and (2) in Table 5 -, while the regressions used in the estimation of elasticities under (2) do not use openness and *EPL* on their own as explanatory variables - see columns (3) and (4) in Table 5. For very open Low-Tech industries with rigid labour markets the employment exchange rate elasticity is virtually the same presented in Table 4; *i.e.*, 0.43. In this 2^{nd} quadrant of Table 6 the elasticities increase with the exclusion of the testing variables, *Open* and EPL. Moving to the 1^{st} quadrant, very open High-Tech industries, we now get a clearer effect of rigidities on the employment exchange rate elasticities. Once we have at least a median level of flexibility, exchange rate movements do impact on employment changes, even for high productivity industries. We still confirm the previous results that the magnitude of such effect is higher for Low-Tech. For example, excluding Open and *EPL* variables, last column of Table 6, we conclude that a 1% depreciation leads to an increase of 0.67% in employment in High-Tech and 0.77% in Low-Tech, second column of Table 6.

There is one result that deserves an additional comment. As we can see in Table 6, columns (1) and (2) under Low-Tech, the employment exchange rate elasticity is negative for Low-Tech closed sectors in face of a rigid labour market. A possible explanation might be related with input costs – see, for example, Ekholm *et al.* (2008). However, we cannot test such explanation as we lack appropriate data.

From our sensitivity analysis we confirm the previous conclusion that exchange rate impacts on the labour market depends on the degree of labour market rigidity and the industry's openness and productivity.

Table 6: Employment exchange rate elasticities

		Low-Tech		High-Tech	
		(1)	(2)	(1)	(2)
Open(+)	EPL(+)	0.4273** (0.0404)	0.4970** (0.0220)	0.3304 (0.3888)	0.2299 (0.5175)
		0.5747*** (0.0024)	0.6323*** (0.0013)	0.5188** (0.0795)	0.4496* (0.0939)
	EPL(-)	0.7211*** (0.0001)	0.7666*** (0.0001)	0.7057*** (0.0065)	0.6676*** (0.0054)
Open(-)	EPL(+)	-0.1765* (0.0759)	-0.1650* (0.0972)	-0.4746 (0.1167)	-0.4688 (0.1237)
		-0.0291 (0.6022)	-0.0297 (0.5905)	-0.2863 (0.1921)	-0.2491 (0.2373)
	EPL(-)	0.1173** (0.0385)	0.1046* (0.0657)	-0.0993 (0.6358)	-0.0310 (0.8697)

Notes: $p-values$ in parenthesis. Significance levels: $*$: 10% $**$: 5% $***$: 1%. The regressions used in the estimation of elasticities under (1) use $\Delta Open$ and ΔEPL as explanatory variables - see columns (1) and (2) in Table 5. The regressions used in the estimation of elasticities under (2) do not use $\Delta Open$ and ΔEPL as explanatory variables - see columns (3) and (4) in Table 5.

5 Conclusion

This paper studies the role of labour adjustment costs in the determination of the impact of exchange rates on employment. The model of exporting firm behaviour developed here suggests that higher labour adjustment costs reduce the influence of exchange rate movements on employment. This prediction receives support from our econometric analysis based on a sample of 23 OECD countries.

Although there are some aspects that require further research, we believe we can draw two conclusions from our work so far. First, the difference in labour market institutions is another variable that helps to understand the different impact of exchange rates on economic variables, such as employment (the focus of this paper), output and prices, across countries. Second, the fact that higher labour adjustment costs appear to reduce the elasticity of employment with respect to the exchange rate may have contradictory macroeconomic implications. On the one hand, it may smooth unemployment variations and, consequently, prevent some social costs associated with sharp increases in unemployment, and even social unrest. However, it may also hinder efficient reallocation of resources. An assessment of these benefits and costs is needed to help guide labour market reforms.

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6 Appendix

Countries and Sectors

Table 7: Observations per country and technology level

Country	Low-Tech	High-Tech	Country	Low-Tech	High-Tech
Austria*	118	100	Hungary	48	6
Belgium*	198	106	Italy*	202	170
Canada*	195	153	Japan*	192	159
Switzerland	81	54	South Korea*	48	40
Czech Republic	40	39	Netherlands*	153	112
Germany	176	142	Norway*	185	147
Denmark*	193	137	Poland	40	5
Spain*	197	158	Portugal*	151	110
Finland*	202	159	Slovakia	44	40
France*	202	170	Sweden*	202	168
United Kingdom*	136	17	United States*	180	150
Greece*	112	86			
	Low-Tech			High-Tech	
Total observations	3295			2428	

Note: OECD23 refers to all countries presented in tableOECD17 refers to countries marked with *.

Table 8: List of sectors used in the analysis

ISIC Rev. 3	Descritpion	Technology Classification
15-16	Food products, beverages and tobacco	Low and Medium Low Technology
17-19	Textiles, textile products, leather and footwear	Low and Medium Low Technology
20	Wood and products of wood and cork	Low and Medium Low Technology
21-22	Pulp, paper, paper products, printing and publishing	Low and Medium Low Technology
23	Coke, refined petroleum products and nuclear fuel	Low and Medium Low Technology
24 less 2423	Chemicals excluding phamaceuticals	High and Medium High Technology
2423	Pharmaceuticals	High and Medium High Technology
25	Rubber and plastics products	Low and Medium Low Technology
26	Other non-metallic mineral products	Low and Medium Low Technology
271+2731	Iron and steel	Low and Medium Low Technology
272+2732	Non-ferrous metals	Low and Medium Low Technology
28	Fabricated metal products, except machinery and equipment	Low and Medium Low Technology
29	Machinery and equipment, n.e.c.	High and Medium High Technology
30	Office, accounting and computing machinery	High and Medium High Technology
31	Electrical machinery and apparatus, n.e.c.	High and Medium High Technology
32	Radio, television and communication equipment	High and Medium High Technology
33	Medical, precision and optical instruments	High and Medium High Technology
34	Motor vehicles, trailers and semi-trailers	High and Medium High Technology
351	Building and repairing of ships and boats	Low and Medium Low Technology
352+359	Railroad equipment and transport equipment n.e.c.	High and Medium High Technology
353	Aircraft and spacecraft	High and Medium High Technology
36-37	Manufacturing n.e.c. and recycling	Low and Medium Low Technology

Variables

Table 9: Variables description

Variable	Descritpion	Source
y	Number of employees (full and part-time)	OECD STAN: EMPN
$ExRate$	See next sub-section	
$Open$	exports plus imports over gross output plus exports and imports; all variables measured in national currency, current prices	OECD STAN: EXPO, IMPO and PROD
EPL	OECD's employment protection legislation index	OECD Indicators on Employment Protection - annual time series data 1985-2008: Unweighted average of version 1 sub-indicators for regular contracts (EPR_{v1}) and temporary contracts (EPT_{v1})
$ShareChina_j$	Share of imports from China in sector j own country' imports	OECD STAN Bilateral Trade Database

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... table 9 continued

Variable	Descritpion	Source
$Share\_ChinaW_{j,c,t-1}$	weighted average of the share of Chinese imports in OECD countries, where weights are defined as the share of each country i in c exports ($X^{i,j}_{c,t}$ ($M^{i,j}_{c,t}$) stands for exports (imports) from country c to country i, in sector j (in year t)): see note	OECD STAN Bilateral Trade Database
ULC	Unit labour costs: measure the average cost of labour per unit of output and are calculated as the ratio of total labour costs to real output	OECD STAN Database, variable: "ULC - total economy, annual". ULC was deflated using OECD's consumer price indexes (2005=100)
GDP	Gross domestic product, constant prices	OECD STAN Database
$IntRate$	Long-term interest rates, per cent per annum	OECD STAN Database, variable: "Interest Rates, Long-term government bond yields"

Note: $Share\_ChinaW_{jc,t} = \left(\frac{X^{i,j}_{c,t}}{\sum_{i=1}^{N(t)} X^{i,j}_{c,t}}\right)\left(\frac{M^{China,j}_{i,t}}{\sum_{k=1}^{N(t)} M^{k,j}_{i,t}}\right)$.

Exchange rate computation

$ExRate_{jc,t-1}$ is the lagged real sectoral effective exchange rate computed as a trade-weighted rate where:

$$ExRate_{jc,t} = \prod_{c=1}^{N(t)} \left(rer^{i}_{c,t}\right)^{w^{i,j}_{c,t}} \tag{25}$$

and

$$rer^{i}_{c,t} = \frac{e_{i,t} \cdot p_{i,t}}{p_{c,t}} \tag{26}$$

is the bilateral real exchange rate between country c and country i, $e_{i,t}$ is the price of foreign currency i in terms of country c currency at time t, $p_{c,t}$ and $p_{i,t}$ are consumer price indexes for the country c economy and for economy i, $N(t)$ is the number of foreign currencies in the index at time t and $w^{i,j}_{c,t}$ is the weight of currency i in the index of country c at time t, with $\sum_i w^{i,j}_{c,t} = 1$. An increase in the value of this index corresponds to a real depreciation of the country c currency. The base of the index is the year 2000. The nominal exchange rates (national currency per US dollar at the end of the period) and consumer price indexes were collected from IMF International Financial Statistics database.

We computed exchange rate weights in order to include information that would allow us to take into account for sectoral third-party competition. We followed Turner and Van't dack (1993) and defined the weight $w_{c,t}^{j,i}$ given to i's country currency in the double-weighted effective index as

$$w_{c,t}^{j,i} = \left(\frac{M_{c,t}^{i,j}}{X_{c,t}^{i,j} +_j M_{c,t}^{i,j}} \right) w_{M,c,t}^{i,j} + \left(\frac{X_{c,t}^{i,j}}{X_{c,t}^{i,j} + M_{c,t}^{i,j}} \right) w_{X,c,t}^{i,j} \tag{27}$$

where $w_{X,c,t}^{i,j}$ is defined as

$$w_{X,c,t}^{i,j} = \left(\frac{X_{c,t}^{i,j}}{\sum_{i=1}^{N(t)} X_{c,t}^{i,j}} \right) \left(\frac{\gamma_{i,t}^{j}}{\gamma_{i,t}^{j} + \sum\limits_{h \neq i,c} X_{i,t}^{h,j}} \right) + \sum_{k \neq i} \left(\frac{X_{c,t}^{k,j}}{\sum_{k=1}^{N(t)} X_{c,t}^{k,j}} \right) \left(\frac{X_{i,t}^{k,j}}{\gamma_{k,t}^{j} + \sum\limits_{h \neq k,c} X_{h,t}^{k,j}} \right) \tag{28}$$

In the formulas, $X_{c,t}^{i,j}$ ($M_{c,t}^{i,j}$) stands for exports (imports) from country c to country i, in sector j (in year t).

Data on trade is from OECD STAN Bilateral Trade Database (OECD, 2008).

Figures

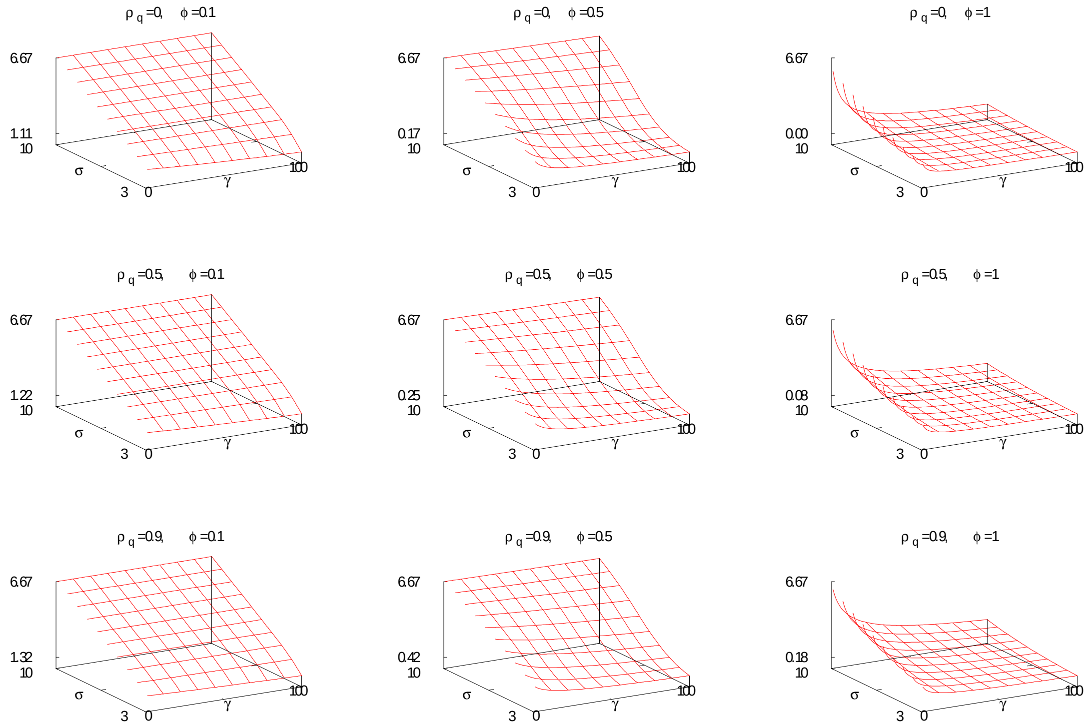

Figure 7: Employment exchange rate elasticity: labour adjustment costs and openness

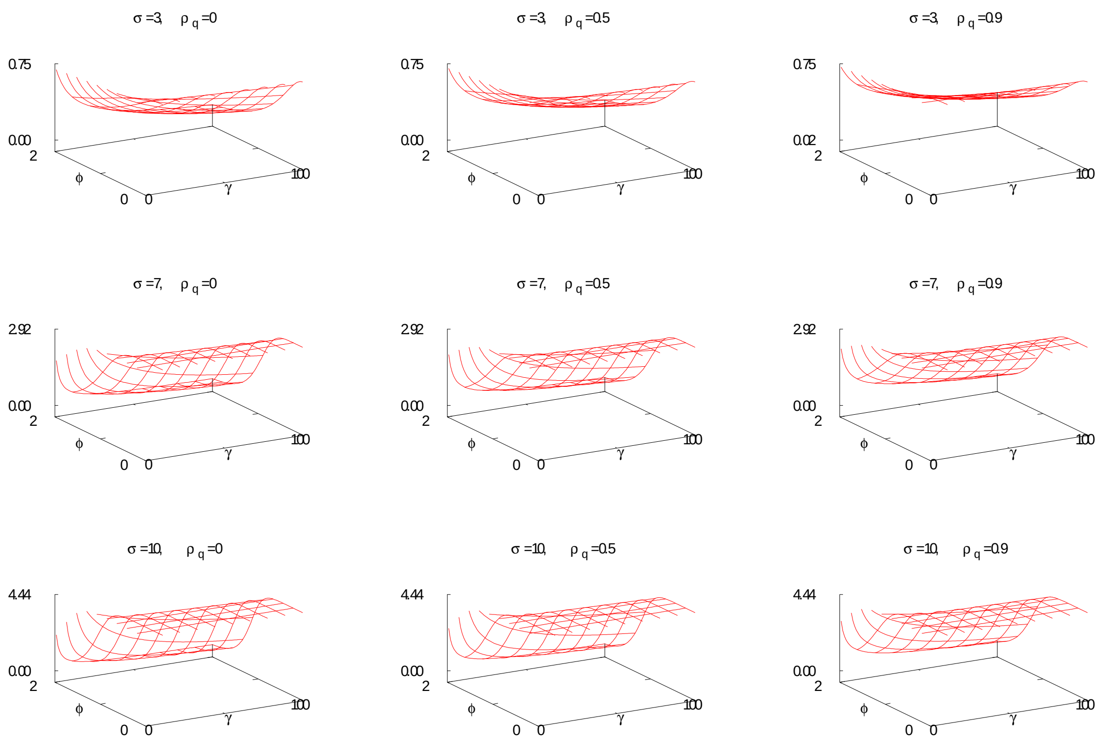

Figure 8: Employment exchange rate elasticity: labour adjustments costs and productivity

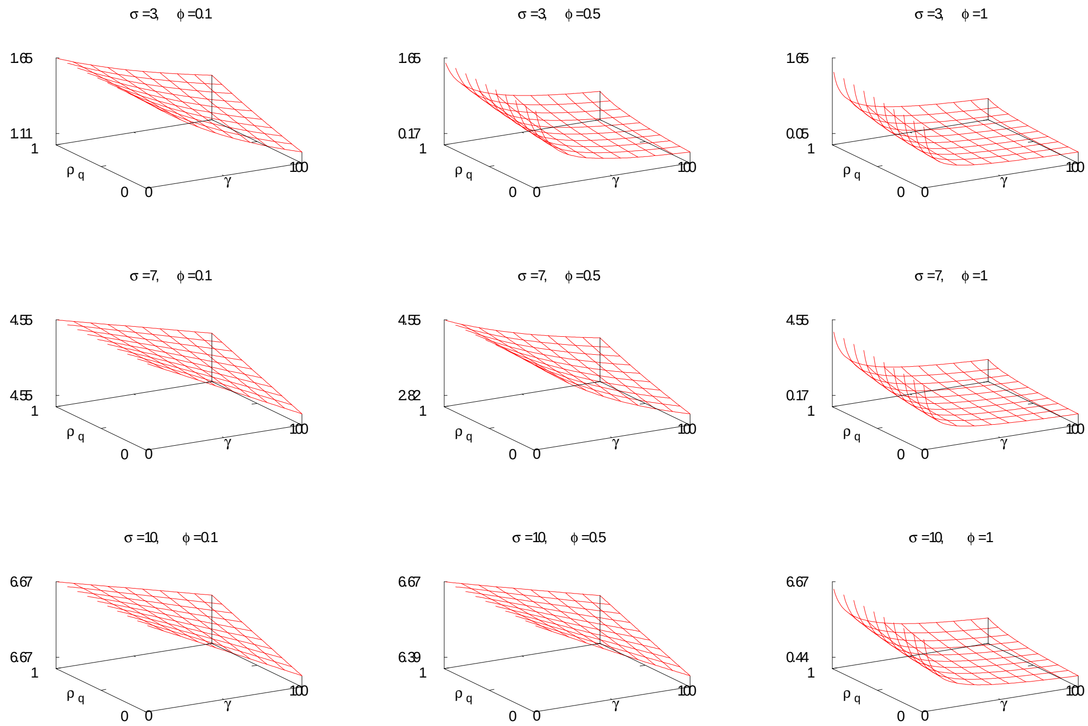

Figure 9: Employment exchange rate elasticity: labour adjustment costs and exchange rate persistence