Exchange rates, employment and labour market rigidity*

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Abstract

In this paper we study the effect of labour market rigidity on the impact of exchange rate shocks on employment. We use a panel dataset comprising 22 manufacturing sectors across 23 OECD countries. In our econometric model, the impact of exchange rate fluctuations on sectoral employment is mediated by the degree of openness and by a measure of labour market rigidity: the OECD's employment protection legislation index. Our results suggest that greater labour market rigidity reduces the impact of exchange rate shocks on employment. This effect is statistically significant for low-technology sectors.

Keywords: exchange rates, international trade, labour market, employment protection.

JEL-codes: J23, F16, F41.

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1 Introduction

The aim of this paper is to investigate the importance of labour market institutions in the transmission of exchange rate shocks to employment. The impact of exchange rate shocks on the domestic economy has always been a cause of anxiety, especially as manifested in political speeches. 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 and employment — see the discussion in Tatom (1995). In the 1990s, exchange rates became less volatile and, as a result, exchange rate fluctuations caused only moderate and intermittent concerns. However, globalization has increased the exposure of open economies to external shocks. The rampant US trade deficit, the international financial crisis and the sovereign debt crisis in the Euro area have revived concerns about exchange rate volatility, its effects on global trade, the need for international policy coordination and the use of the exchange rate as an economic policy instrument.

Nevertheless, there is growing awareness of the fact that the impact of shocks depends on institutions. In an important contribution to this theme, Blanchard and Wolfers (2000) identify two key facts about European unemployment: the rise since the 1960s and the different evolution across countries. According to Blanchard and Wolfers, the rise in European unemployment is the outcome of three shocks: a decline in productivity growth, the evolution of the real exchange rate and adverse shifts in labour demand. However, these shocks have different effects in unemployment across European countries. Blanchard and Wolfers relate this heterogeneity to the design of labour market institutions in each country and to their evolution over time. These authors argue that it is the interaction between the shocks and the institutions that is important to account for the two key facts of European unemployment. We follow this approach in this paper and apply it to the study of the reaction of employment to exchange rate shocks.

Although labour market institutions have been cited as possible additional influences, previous papers on the impact of exchange rate movements on employment — reviewed in section 2 — have emphasized the role of openness to trade in the evaluation of that impact. The contribution of this paper is to provide econometric evidence on the role of labour market institutions in the determination of the impact of the exchange rates on employment. We carry out our analysis at the sector level, focusing on 22 manufacturing sectors across 23 OECD countries in the period 1988-2006. To this end we computed sector-specific real exchange rate indexes for each country. The evolution of labour market institutions is captured by the OECD's employment protection legislation index. Our results lead us to the conclusion that labour market institutions do mediate the impact of exchange rates; however, they are more important in the case of low-technology sectors.

The remainder of the paper is organized as follows. In section 2 we briefly survey the literature on the channels through which the exchange rate may affect employment. Section 3 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 4 concludes.

2 Manufacturing employment in an open economy

The reasoning leading from exchange rate movements to employment fluctuations is usually presented in a very simple way: an appreciation of the national currency, in the absence of compensating changes in domestic and/or foreign prices, will lead to domestically produced goods becoming more expensive relatively to foreign produced goods, i.e., domestic producers will become less competitive. Lower sales and production will then be followed by the destruction of jobs in domestic companies. However, this "import competition" channel is not the only possible mechanism linking employment and exchange rate fluctuations. The effect of exchange rates on domestic employment should be larger in industries that are more open to foreign competition, not only in the domestic market, but also in foreign markets, i.e., in industries that are more "export oriented." A third channel that has received attention in the literature works through imported inputs. While the two previous channels are associated with negative impacts of an exchange rate appreciation on domestic employment, in this third channel an appreciation of the national currency will benefit domestic companies that rely on (now cheaper) imported inputs.

Typically, concerns about the working of this mechanism were associated with concerns regarding the evolution of employment in manufacturing sectors, which were usually viewed as the tradable sectors *par excellence*. It is a fact that there have been large changes in manufacturing employment. Between 1988 and 2006, manufacturing employment in OECD countries decreased from around 20% to 15% of total employment, according to the OECD STAN database. Nevertheless, 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%. 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 one looks at the evolution of manufacturing employment by technology level, using the OECD technology level classification, the conclusion is 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.

Can these fluctuations in manufacturing employment be linked to exchange rate movements? Several papers have reported empirical evidence in favour of this hypothesis. One of the first to do so was the paper by Branson and Love (1988). Using US data from 1970 to 1986, Branson and Love regress, separately for each manufacturing sector, the log of employment on the real exchange rate and variables that control for other sources of change in demand. Branson and Love then use their estimates to compute the effect of the US dollar appreciation between 1980 and 1985 on manufacturing employment in the USA. Branson and Love conclude that the appreciation of the dollar cost around one million manufacturing jobs, i.e., over 5% of the manufacturing jobs that existed in 1980. Revenga (1992) reached conclusions that are very similar to those of Branson and Love: the appreciation of the dollar between 1980 and 1985 reduced employment between 4.5% and 7.5% in US manufacturing sectors, i.e., the estimated elasticity of employment with respect to the exchange rate is between 0.24 and 0.39. Revenga also estimates the appreciation of the dollar to have reduced wages between 1% and 2%.

Campa and Goldberg (2001) report lower elasticities than those found by Branson and Love (1988) and Revenga (1992). Campa and Goldberg attribute this difference to the fact that they allow for an additional channel, besides import competition, through which exchange rate movements may impact on domestic employment, which is the export orientation of industries. The theoretical framework of Campa and Goldberg includes the third channel mentioned above, imported inputs, but in the estimation only the export orientation and import competition are actually accounted for. In a previous paper — Campa and Goldberg (1999) — these authors had already shown that this third channel was important for explaining the reaction of investment to exchange rate shocks in the Canada, Japan, the UK and the USA. Ekholm et al. (2012) have been able to include that channel in a study of the effect of the real appreciation of the Norwegian Krone in the early 2000s. They identify the impact, via export-orientation and imported-inputs channels, of exchange rate movements on firm-level employment by means of the "net currency exposure" of firms, i.e., the difference between the share of exported outputs and the share of imported inputs. Their results regarding employment indicate that the 14% real appreciation of the Norwegian Krone between 2000 and 2004 is responsible for a 2% reduction in employment. Therefore, empirically it seems that taking into account the impact of an exchange rate appreciation on the cost of imported inputs is not enough to compensate for the negative effects of the two other channels discussed above.

Further evidence on the impact of exchange rates on employment is provided by Gourinchas (1999), for France, and by Klein et al. (2003) for the USA. Differently from the previous papers, Klein and co-authors and Gourinchas study the effects of exchange rates on job flows rather than on just the level of employment. Both studies find that (sectoral) real exchange rates have a significant impact on job reallocation. Nevertheless, Klein and co-authors emphasize the fact that exchange rate effects depend on the industry's degree of openness, which is interacted with the real exchange rate in their regressions. Gourinchas, on the other hand, studies a subset of sectors characterized by high openness levels, measured by either the export-share or the import-penetration ratio — the imported inputs channel is mentioned but data limitations prevent Gourinchas from including it in the regressions.

The papers mentioned above conclude that exchange rates do matter for the behaviour of labour markets. However, the impact of exchange rate movements may be mediated by other economic dimensions. Klein et al. (2003) placed the emphasis on the degree of openness. Burgess and Knetter (1998) explain their finding of different reactions to exchange rate shocks among the G7 countries as the result of, not only unequal degrees of openness to international trade, but also differences in labour adjustment costs across countries and different degrees of market power. Campa and Goldberg (2001) also find that employment and wages are more sensitive to exchange rates in lower-markup industries. Additional evidence of differentiated price and output responses across firms to exchange rate depreciations is provided by Berman et al. (2012). According to their results, high-productivity firms react to exchange rate shocks by adjusting their markup, whereas low-productivity firms react by adjusting quantity. In the same vein, Alexandre et al. (2011) present estimations that suggest that both the degree of openness and the technology level mediate the impact of exchange rate movements on employment fluctuations. In particular, these authors conclude that employment in more open sectors that use low technology levels is more sensitive to exchange rate variations.

The contribution of the present paper to this debate is the evaluation of the role of labour market institutions in the determination of the impact of exchange rate shocks on employment. Our analysis is related to the literature that has been stressing the fact that the economic impact of shocks, such as those that work through the exchange rate, depends on labour market institutions, among other factors — see, e.g., Nickell (1997), Nickell et al. (2002), Blanchard (1999), Blanchard and Wolfers (2000) and Blanchard and Portugal (2001).[1] The realization of the importance of labour market institutions, together with a rapidly changing environment, due to increasing competition from emerging countries and to the acceleration in the pace of technological change, has led many to urge industrialized countries to reform labour markets, with a view to making them more flexible — these concerns have been specially strong in European countries. The European Commission, in particular, has recommended on several instances the reform of labour markets 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). The memoranda of understanding that the Troika (European Commission, European Central Bank and the International Monetary Fund) has signed with Eurozone countries affected by the sovereign debt crisis also include a commitment to reduce labour market rigidities.

One feature of labour market rigidity 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 Addison and Teixeira (2003). Therefore, one popular measure of labour market rigidity has been the OECD's Employment Protection Legislation (*EPL*) index. This measure of employment protection gathers three different types of indicators: indicators on the protection of regular workers against individual dismissal; indicators of specific requirements for collective dismissals; and indicators of the regulation of temporary forms of employment — for more details see OECD (1999) and OECD (2004). As shown in Figure 1, in the last 20 years there has been a downward trend in this 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. Figure 1 also shows that countries with more stringent labour markets regulations, namely Germany and Denmark, converged to lower *EPL* 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, with the US, the UK and Canada appearing as the countries with the most flexible labour markets.[2]

Labour market rigidity is usually viewed as a synonym for hiring and specially firing costs. The importance of labour adjustment costs to macroeconomic outcomes was investigated by, among others, Bertola (1990, 1992). This research showed that labour adjustment costs affect firms' optimal decisions, preempt an efficient allocation of re-

[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.

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

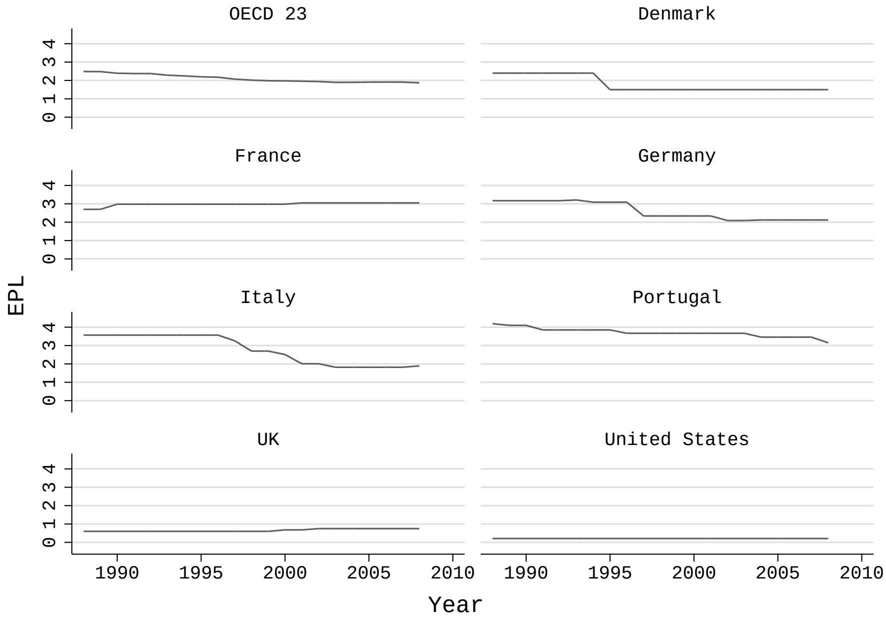

Figure 1: OECD's employment protection legislation index

sources and, in particular, that labour adjustment costs imply lower job flows — see, e.g., Bertola (1992) and Hopenhayn and Rogerson (1993). These theoretical predictions found empirical support in several studies — see, e.g., Haltiwanger et al. (2006) and Gómez-Salvador et al. (2004). An important result concerning the EPL index is that it has been shown — see, among other, Cingano et al. (2009) — to be related to labour adjustment costs, which justifies its use as a measure of labour market rigidity.

The present paper contributes to the literature on exchange rates and employment by investigating quantitatively how labour market institutions affect the impact of exchange rate shocks on employment. In order to find evidence of the connection between labour market institutions and the impact of exchange rate shocks on employment, we estimate a model in which the elasticity of employment with respect to the exchange rate depends on a measure of labour market rigidity. Our measure of labour market rigidity is the EPL index. The EPL index allows us to use information about differences in labour market rigidity over time and across the countries used in our analysis.

3 Econometric analysis

3.1 Econometric model and data

Following our discussion in section 2, in this section we investigate empirically the role of labour market rigidity in the determination of the elasticity of employment with respect to the exchange rate. To this end, we estimate a model in which this elasticity depends on our measure of labour market rigidity, EPL. Given the importance assigned to it by previous theoretical and empirical papers, the elasticity will also depend on the degree of openness. Our econometric model is the following:

$$\begin{aligned}\Delta y_{jct} &= \beta_0 + \beta_1 \Delta ExRate_{jc,t-1} + \beta_2 Open_{jc,t-1} + \beta_3 EPL_{c,t-1} \\ &+ \beta_4 \Delta ExRate_{jc,t-1} \times Open_{jc,t-1} + \beta_5 \Delta ExRate_{jc,t-1} \times EPL_{c,t-1} \\ &+ \beta_6 \Delta ULC_{c,t-1} + \beta_7 \Delta GDP_{c,t-1} + \beta_8 \Delta IntRate_{c,t-1} + \lambda_t + \eta_{jc} + \varepsilon_{jct}, \quad (1)\end{aligned}$$

where Δ is the first-difference operator, j indexes sectors, c indexes countries and t indexes years. The dependent variable, Δy_{jct}, is the change in log employment, with employment measured as total workers. $ExRate_{jc,t-1}$ is the lagged sectoral real effective exchange rate (in logs) smoothed by the Hodrick-Prescott filter,[3] which filters out the transitory component of the exchange rate. An increase in $ExRate$ corresponds to a real depreciation of the domestic currency. $Open_{jc,t-1}$ is the openness of sector j in country c, measured as the ratio, for sector j in country c, of exports plus imports to gross output, all measured at the sector level.[4] $EPL_{c,t-1}$ stands for the OECD's Employment Protection Legislation (*EPL*) index regarding country c.

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, namely, real unit labour costs, $ULC_{c,t-1}$, and the long-term real interest rate, $IntRate_{c,t-1}$. Aggregate real shocks at the country level are also captured by the real Gross Domestic Product (in logs), $GDP_{c,t-1}$. All the regressions reported below include specific dummies for each sector-country pair (η_{jc}) and time dummies, λ_t, which account for aggregate shocks common to all countries and sectors. The final element in equation (1), ε_{jct}, is the error term.

We use data from the OECD's Structural Analysis Database (STAN) — see OECD (2008a) — to compute the degree of openness (*Open*). We also retrieve from it data on employment (y), real unit labour costs (*ULC*), real Gross Domestic Product (*GDP*), long-term real interest rates (*IntRate*), the share of imports from Eastern Asia[5] (*ShareEastAsia*), the weighted average of the share of Eastern Asia imports on OECD countries (*ShareEastAsiaW*) and real gross output by industry within countries (*Production*). The last three variables will be used later in robustness checks.

Exchange rates (*ExRate*) are computed using data from the IMF's International Financial Statistics — IMF (2008) — and the OECD's STAN Bilateral Trade Database — OECD (2008a). The computation procedure is presented in the Appendix — see Alexandre et al. (2009) for further details. Finally, the employment protection legislation index (*EPL*) comes from the Indicators on Employment Protection provided by OECD (2008b). Summary statistics concerning the variables are presented in Table 1, while Table 9 in the Appendix contains a detailed description of the variables and their sources.

We use data on 22 industries, which are listed in Table 2. Due to data availability, this is an unbalanced sample of sectors across the 23 countries. The most represented

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

[4] This indicator of openness tends to produce outliers, which in this case are associated with high levels of entrepôt trade, i.e., re-export of imported goods. We thus decided to exclude the observations corresponding to the top 1% of this variable. Had we included these observations the coefficients would continue to be very similar to those reported in Table 4 below.

[5] This includes the following countries: Cambodia, China, Chinese Taipei, Hong Kong, India, Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam.

economic activities are "Food products, beverages and tobacco", "Textiles, textile products, leather and footwear", "Wood and products of wood and cork", "Pulp, paper, paper products, printing and publishing", "Other non-metallic mineral products" and "Manufacturing n.e.c. [*not elsewhere classified*] and recycling", each with a share of 5.29% of the total observations. The least represented sectors include "Iron and steel" (3.62%), "Non-ferrous metals" (3.62%), "Office, accounting and computing machinery" (3.92%), "building and repairing of ships and boats" (3.76%), "Railroad equipment and transport equipment n.e.c." (3.76%) and "Aircraft and spacecraft" (3.15%).

Table 1: Descriptive statistics

Variable	Mean	Std. Dev.	Min.	Max.	Obs.
y	10.8612	1.6769	4.9345	14.7722	5747
$ExRate$	-0.0315	0.1051	-0.5012	0.4882	5747
$Open$	1.2809	1.8296	0.0362	25.259	5747
EPL	2.1779	0.9547	0.2100	4.1000	5747
ULC	1.0259	0.0593	0.8835	1.2300	5747
GDP	14.0238	2.1352	10.4258	20.6290	5747
$IntRate$	3.5915	1.9686	-3.5641	10.0059	5747
$Production$	23.0548	1.7094	16.9732	27.2188	5747
$ShareEastAsia_j$	0.1023	0.1294	0.0000	0.7962	5450
$ShareEastAsiaW_{j,c,t}$	0.0904	0.0849	0.0007	0.5971	5450
Δy	-0.0116	0.0820	-1.4663	1.2054	5311
$\Delta ExRate$	0.0007	0.0251	-0.1006	0.0947	5747
$\Delta Open$	0.0436	0.6534	-21.7606	18.8334	5311
ΔEPL	-0.0374	0.1576	-1.0200	0.5000	5311
ΔULC	-0.006	0.0186	-0.0810	0.0586	5311
ΔGDP	0.0243	0.0180	-0.0645	0.0816	5311
$\Delta IntRate$	-0.2571	1.1755	-7.3470	6.3962	5311
$\Delta Production$	0.0181	0.1642	-2.4948	1.0673	5311
$\Delta ShareEastAsia_j$	0.0049	0.0288	-0.5203	0.5126	5035
$\Delta ShareEastAsiaW_{j,c,t}$	0.0037	0.0122	-0.1193	0.1288	5035

Notes: For the descriptive statistics we use the sample with valid information on all relevant variables. This corresponds to the sample used in regression (1) shown in Table 4 below. In this sample we have 23 countries, 22 industries, 435 industry/country combinations and 17 years running from 1990 to 2006 (the original data runs for 19 years from 1988 to 2006; two periods are lost due to first differencing and lagged variables in our models). For a description of the variables and data sources see Table 9 in the Appendix.

The sectors are classified according to the OECD technology classification: low- and medium-low-technology industries (LT, hereafter low-technology sectors) and high- and medium-high-technology industries (HT, hereafter high-technology sectors). This classification ranks industries according to indicators of technology intensity based on R&D expenditures — see OECD (2005). We will use the information on the technology level of each sector to estimate equation (1) separately for low- and high-technology sectors.

The objective is to investigate whether the reaction to exchange rate movements does depend on the level of technology, as previous papers have argued — recall section 2. In Alexandre et al. (2011), the technology level is viewed as a proxy for productivity, with low-technology sectors associated to lower productivity levels on average. Nevertheless, an alternative interpretation is that the technology level is also a good proxy for market structure: depending on how one views the direction of causation, firms in concentrated markets generate more R&D, or high technology grants market power to the firms that use it — see the discussion in Sutton (1998). In fact, if we regress the birth rate of firms on a constant and a dummy for high-technology sectors, besides country and year dummies, the high-technology dummy has a significantly negative coefficient, suggesting that it is easier for new competitors to enter low-technology sectors. Likewise, a simple OLS regression of labour productivity, measured as sectoral value added per employee, on OECD's technology classes and capital per employee — which is a necessary control in regressions involving value added per employee —, shows that high-technology sectors are on average more productive than low technology sectors. Given that data on market structure is unavailable to us and that data on the stock of capital is available just for a small sample of countries and years, we carry out our analysis using only the OECD's technology classification, distinguishing between low-technology and high-technology sectors. Regardless of the interpretation, we should expect high-technology firms to be less responsive to exchange rate shocks — see the discussion in Burgess and Knetter (1998). Table 3 provides the list of the 23 countries used in our analysis, as well as the number of observations within countries by technology level.

Table 2: Industries and observations used in the analysis

ISIC Rev. 3	Description	OECD Technology Classification	Observations
15-16	Food products, beverages and tobacco	Low and Medium Low Technology	304(5.29%)
17-19	Textiles, textile products, leather and footwear	Low and Medium Low Technology	304(5.29%)
20	Wood and products of wood and cork	Low and Medium Low Technology	304(5.29%)
21-22	Pulp, paper, paper products, print. and publish.	Low and Medium Low Technology	304(5.29%)
23	Coke, refined petroleum products and nuclear fuel	Low and Medium Low Technology	283(4.92%)
24 less 2423	Chemicals excluding phamaceuticals	High and Medium High Technology	241(4.19%)
2423	Pharmaceuticals	High and Medium High Technology	258(4.49%)
25	Rubber and plastics products	Low and Medium Low Technology	303(5.27%)
26	Other non-metallic mineral products	Low and Medium Low Technology	304(5.29%)
271+2731	Iron and steel	Low and Medium Low Technology	208(3.62%)
272+2732	Non-ferrous metals	Low and Medium Low Technology	208(3.62%)
28	Fabricated metal prod., except machin. and equip.	Low and Medium Low Technology	268(4.66%)
29	Machinery and equipment, n.e.c.	High and Medium High Technology	296(5.15%)
30	Office, accounting and computing machinery	High and Medium High Technology	225(3.92%)
31	Electrical machinery and apparatus, n.e.c.	High and Medium High Technology	256(4.45%)
32	Radio, television and communication equipment	High and Medium High Technology	256(4.45%)
33	Medical, precision and optical instruments	High and Medium High Technology	240(4.18%)
34	Motor vehicles, trailers and semi-trailers	High and Medium High Technology	268(4.66%)
351	Building and repairing of ships and boats	Low and Medium Low Technology	216(3.76%)
352+359	Railroad equip. and transport equip. n.e.c.	High and Medium High Technology	216(3.76%)
353	Aircraft and spacecraft	High and Medium High Technology	181(3.15%)
36-37	Manufacturing n.e.c. and recycling	Low and Medium Low Technology	304(5.29%)

Notes: Percentage of total observations (5747) concerning each industry in parentheses. ISIC Rev. 3: International Standard Industrial Classification of All Economic Activities, Revision 3.

Table 3: Observations per country and technology level

Country	LT	HT	Observations	Country	LT	HT	Observations
Austria	120	91	211 (3.67%)	Hungary	40	5	45 (0.78%)
Belgium	198	99	297 (5.17%)	Italy	204	170	374 (6.51%)
Canada	188	144	332 (5.78%)	Japan	192	160	352 (6.12%)
Switzerland	78	54	132 (2.30%)	South Korea	48	40	88 (1.53%)
Czech Republic	40	40	80 (1.39%)	Netherlands	153	108	261 (4.54%)
Germany	176	142	318 (5.53%)	Norway	187	149	336 (5.85%)
Denmark	198	145	343 (5.97%)	Poland	40	5	45 (0.78%)
Spain	192	160	352 (6.12%)	Portugal	158	123	281 (4.89%)
Finland	202	169	371 (6.46%)	Slovakia	45	40	85 (1.48%)
France	204	170	374 (6.51%)	Sweden	204	170	374 (6.51%)
United Kingdom	136	17	153 (2.66%)	United States	192	160	352 (6.12%)
Greece	115	76	191 (3.32%)				
			LT				HT
Total observations			3310				2437

Notes: Percentage of total observations (5747) concerning each country in parentheses. LT: Low- and medium-low-technology industries. HT: High- and medium-high-technology industries.

3.2 Results

In this section we report our main results. Table 4 shows the result of estimating equation (1) on three samples: in column (1) a sample that includes both low- and high-technology sectors (LT+HT); in column (2) a sample that includes only low-technology sectors (LT); and in column (3) a sample that includes only high-technology sectors (HT). All regressions are estimated by OLS. We report robust standard errors, clustered within sectors/countries pairs, in order to allow for intra-group correlation and deal with arbitrary forms of heteroskedasticity.

According to the results in Table 4, the behaviour of employment in low-technology sectors is different from the behaviour of employment in high-technology sectors. In fact, a test of the null hypothesis of equal coefficients for low- and high-technology sector rejects the null hypothesis with a *p-value* of zero.[6] This conclusion corroborates the findings of Alexandre et al. (2011). The model appears to provide a more adequate description of the behaviour of employment in low-technology sectors, as indicated by R^2 and $RMSE$. The main differences between the results for low- and high-technology sectors concern the coefficients on the interactions between the exchange rate, the degree of openness and EPL: for low-technology sectors, these interactions are larger in absolute value and statistically significant. The degree of openness has a positive effect on employment, statistically significant in all samples. Labour market rigidity has a negative impact on employment, and this is also statistically significant in all samples.

However, our interest lies in assessing the role of labour market rigidity in the mediation of the effect of exchange rate movements on employment. To this end, we use

[6]The test statistic is $F(29, 434) = 4.51$.

Table 4: Employment regressions

Sample	(1) LT+HT	(2) LT	(3) HT
$\beta_1 : \Delta ExRate_{jc,t-1}$	0.0574	-0.0624	-0.0089
	(0.0995)	(0.0952)	(0.1836)
$\beta_2 : Open_{jc,t-1}$	0.0079**	0.0099***	0.0077*
	(0.0036)	(0.0024)	(0.0044)
$\beta_3 : EPL_{c,t-1}$	-0.0196***	-0.0131***	-0.0273***
	(0.0042)	(0.0046)	(0.0077)
$\beta_4 : \Delta ExRate_{jc,t-1} \times Open_{jc,t-1}$	0.1912*	0.5704***	0.1753
	(0.1088)	(0.1357)	(0.1250)
$\beta_5 : \Delta ExRate_{jc,t-1} \times EPL_{c,t-1}$	-0.0589	-0.0724*	-0.0445
	(0.0524)	(0.0420)	(0.1053)
$\beta_6 : \Delta ULC_{c,t-1}$	-0.0812	-0.1440**	0.0133
	(0.0668)	(0.0656)	(0.1277)
$\beta_7 : \Delta GDP_{c,t-1}$	0.6140***	0.7808***	0.3593
	(0.1294)	(0.0933)	(0.2719)
$\beta_8 : \Delta IntRate_{c,t-1}$	-0.0002	-0.0007	0.0001
	(0.0011)	(0.0010)	(0.0024)
Industry/Country (jc) dummies	yes	yes	yes
Year (t) dummies	yes	yes	yes
Observations	5,747	3,310	2,437
Number of countries	23	23	23
Number of industries	22	12	10
Number of jc	435	247	188
R^2	0.1729	0.2841	0.1441
RMSE	0.0788	0.0487	0.107
Test F, EPL, $H_0 : \beta_3 = \beta_5 = 0$	18.12***	7.06***	10.29***
Test F, jc dummies	79514***	5417***	15887***
Test F, t dummies	6.76***	3.99***	4.60***

Notes: Significance levels: ***: 1%, **: 5%, * 10%. Robust standard errors in parentheses (clustered at the sector/country level). All regressions are estimated by OLS. The dependent variable in all models is Δy_{jct} (change in log employment). Sample: LT+HT includes all industries; LT includes only low-technology sectors; HT includes only high-technology sectors — see list in Table 2. For a description of the variables and data sources see Table 9 in the Appendix.

the coefficients reported in Table 4 to compute the employment exchange rate elasticity, which, according to equation (1), is given by:

$$\xi = \beta_1 + \beta_4 Open + \beta_5 EPL. \quad (2)$$

The estimates of β_1, β_4 and β_5 presented in columns (1), (2) and (3) of Table 4 were used to compute the employment exchange rate elasticities reported in Tables 5 (sample including all sectors), 6 (sample including only low-technology sectors) and 7 (sample including only high-technology sectors). The elasticity depends on the levels of *Open* and EPL chosen for the computation. The elasticities reported in Tables 5, 6 and 7, were computed for five values of *Open*, corresponding to percentiles 10 (p10), 25 (p25), 50 (p50), 75 (p75) and 90 (p90) of its distribution, and for five values of EPL, corresponding to the same percentiles of the distribution of EPL.

Looking at the results in Table 4, it would appear that labour market rigidity does not affect the response of employment to the exchange rate in the case of high-technology sectors, given that β_5 is not significant in this subsample, although it does in the case of low-technology sectors. However, the results reported in Tables 5, 6 and 7 are more informative on the relation between openness, labour market rigidity and employment. Those tables present not only the computed elasticities but also the associated standard deviations, which allow us to test the significance of the elasticities computed for different combinations of openness and EPL.

A common feature of Tables 5, 6 and 7 is that employment exchange rate elasticities are higher and statistically significant for larger degrees of openness and lower values of EPL. Nevertheless, the values in Tables 6 and 7 also suggest that employment in low-technology sectors is more sensitive to exchange rate fluctuations, despite lower degrees of openness. In fact, employment exchange rate elasticities for low-technology sectors (Table 6), computed at percentile 75 of openness, vary between 0.1968 and 0.3358, while the corresponding elasticities for high-technology sectors vary between 0.1754 and 0.2978. Using percentile 90 of openness, the elasticity varies between 0.489 and 0.6881 for low-technology sectors and between 0.4214 and 0.5438 for high-technology sectors. Therefore, in very open industries (percentile 90 of *Open*), operating in very flexible labour markets (percentile 10 of EPL), a 1% exchange rate depreciation leads to a 0.69% increase in employment in low-technology sectors and to a 0.54% increase in employment in high-technology sectors.

In order to illustrate our main findings, we depict in Figure 2 the behaviour of the employment exchange rate elasticity, together with 95% confidence intervals, as a function of EPL for the case of low-technology sectors. Figure 2 is composed of three panels: in the top panel the elasticity is computed at percentile 90 of *Open*; in the middle panel it is computed at percentile 50; and in the bottom panel it is computed at percentile 10. The plots show the elasticity declining with labour market rigidity and increasing with the degree of openness. The elasticity is statistically different from zero for low values of EPL in the top and middle panels, i.e., for sectors that are more exposed to international trade.

To conclude, our results lend support to the view that exchange rate movements are relevant for employment determination. According to our estimates, labour market rigidity appears to influence the impact of exchange rates on employment. This result corroborates the conclusion presented in Nickell et al. (2008), which shows that higher

Table 5:Employment exchange rate elasticities: all sectors

		Degree of openness				
		[p10] 0.2809	[p25] 0.4446	[p50] 0.8026	[p75] 1.3568	[p90] 2.3217
EPL	[p10] 0.75	0.0669 (0.0717)	0.0982 (0.0604)	0.1667*** (0.0509)	0.2726*** (0.0832)	0.4571** (0.1784)
	[p25] 1.50	0.0228 (0.0823)	0.0541 (0.0696)	0.1225** (0.0535)	0.2284*** (0.0759)	0.4129** (0.1678)
	[p50] 2.21	-0.0191 (0.1056)	0.0122 (0.0940)	0.0807 (0.0772)	0.1866** (0.0867)	0.3711** (0.1660)
	[p75] 2.98	-0.0644 (0.1380)	-0.0331 (0.1276)	0.0353 (0.1116)	0.1412 (0.1119)	0.3257* (0.1732)
	[p90] 3.50	-0.0951 (0.1619)	-0.0638 (0.1521)	0.0047 (0.1367)	0.1106 (0.1333)	0.2951 (0.1830)

Notes: the employment exchange rate elasticities are computed using the coefficients reported in column (1) of Table 4 and different values of *Open* (by column) and EPL (by row). The values of *Open* and EPL corresponding to the percentiles in square brackets are given below the square brackets. Delta-method standard-errors are reported in parentheses. Significance levels: ***: 1%, **: 5%, * 10%.

employment protection leads to slower adjustment of sectoral shares in output. Nevertheless, labour market rigidity appears to be less important as a determinant of the elasticity of employment with respect to the exchange rate than the degree of openness. Our results also show that low-technology sectors are more sensitive to exchange rate fluctuations.

3.3 Sensitivity analysis

Given that our main findings concern the behaviour of employment in low-technology industries, the sensitivity analysis will focus on this sample.

The sensitivity analysis will address three issues. First, could our measure of openness, which includes both exports and imports, be contaminated by the import channel, which is omitted from our baseline regression? Second, should one control for sector-level variables that may be correlated with labour supply and demand, such as sectoral output? Finally, are the results affected by the importance that Eastern Asia gained in international trade in recent decades?

To deal with the first question, we modified the measure of openness to exclude imports. The results are presented in column (1) of Table 8. We find that the estimates are almost unchanged relatively to those reported in column (2) of Table 4.

Concerning the second question, on the need to control for sector-level drivers of employment, we added to our regression the change in the logarithm of real gross output by industry. Again, the estimates in column (2) of Table 8 are almost the same as those

Table 6:Employment exchange rate elasticities: low-technology

		Degree of openness				
		[p10] 0.2235	[p25] 0.3474	[p50] 0.5664	[p75] 0.8986	[p90] 1.4110
	[p10] 0.75	0.0107 (0.0632)	0.0814 (0.0572)	0.2064*** (0.0579)	0.3959*** (0.0828)	0.6881*** (0.1423)
	[p25] 1.50	-0.0436 (0.0600)	0.0271 (0.0531)	0.1521*** (0.0531)	0.3416*** (0.0788)	0.6338*** (0.1392)
EPL	[p50] 2.21	-0.0950 (0.0710)	-0.0243 (0.0650)	0.1006 (0.0644)	0.2902*** (0.0861)	0.5824** (0.1429)
	[p75] 2.98	-0.1507 (0.0929)	-0.0800 (0.0881)	0.0449 (0.0872)	0.2344** (0.1036)	0.5267* (0.1535)
	[p90] 3.50	-0.1884* (0.1106)	-0.1177 (0.1064)	0.0072 (0.1054)	0.1968* (0.1190)	0.4890*** (0.1638)

Notes: the employment exchange rate elasticities are computed using the coefficients reported in column (2) of Table 4 and different values of *Open* (by column) and *EPL* (by row). The values of *Open* and *EPL* corresponding to the percentiles in square brackets are given below the square brackets. Delta-method standard-errors are reported in parentheses. Significance levels: ***: 1%, **: 5%, * 10%.

Table 7:Employment exchange rate elasticities: high-technology

		Degree of openness				
		[p10] 0.5039	[p25] 0.8171	[p50] 1.2315	[p75] 1.9404	[p90] 3.3437
	[p10] 0.75	0.0460 (0.1260)	0.1009 (0.1042)	0.1736* (0.0943)	0.2978** (0.1342)	0.5438** (0.2871)
	[p25] 1.80	-0.0007 (0.1664)	0.0542 (0.1409)	0.1268 (0.1190)	0.2511* (0.1299)	0.4971* (0.2619)
EPL	[p50] 2.21	-0.0190 (0.1974)	0.0359 (0.1732)	0.1086 (0.1511)	0.2328 (0.1518)	0.4788* (0.2643)
	[p75] 2.98	-0.0532 (0.2649)	0.0017 (0.2431)	0.0743 (0.2218)	0.1986 (0.2115)	0.4446 (0.2868)
	[p90] 3.50	-0.0764 (0.3141)	-0.0215 (0.2936)	0.0512 (0.2729)	0.1754 (0.2585)	0.4214 (0.3131)

Notes: the employment exchange rate elasticities are computed using the coefficients reported in column (3) of Table 4 and different values of *Open* (by column) and *EPL* (by row). The values of *Open* and *EPL* corresponding to the percentiles in square brackets are given below the square brackets. Delta-method standard-errors are reported in parentheses. Significance levels: ***: 1%, **: 5%, * 10%.

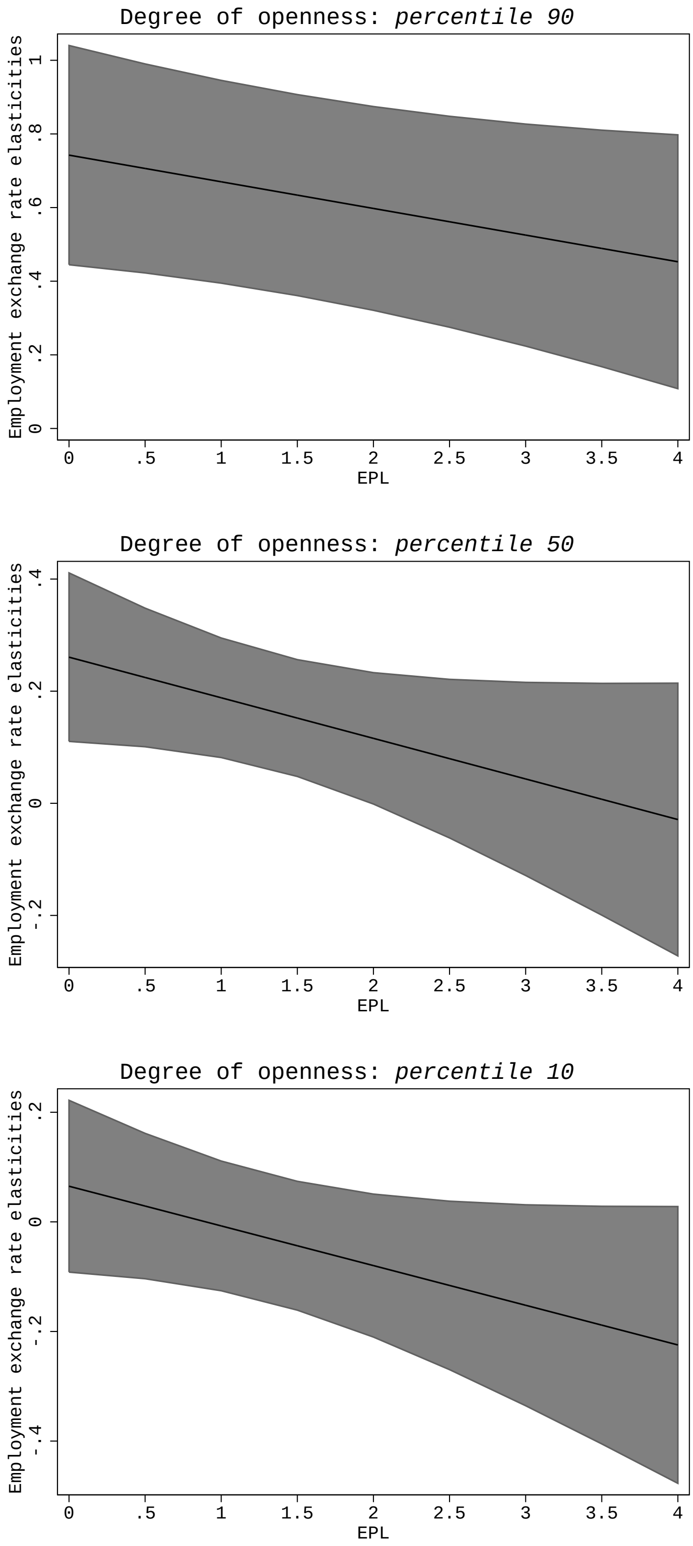

Figure 2: Employment exchange rate elasticities for low-technology and different degrees of openness and EPL.

in column (2) of Table 4.

To address the issue of Eastern Asia competition, we added to our list of regressors the share of imports from Eastern Asia (*ShareEastAsia*) and the weighted average of the share of Eastern Asia imports on OECD countries (*ShareEastAsiaW*). The estimated coefficients — in column (3) of Table 8 — are still very close to those found in column (2) of Table 4. However, the coefficient on the interaction between the exchange rate and EPL now becomes marginally insignificant — it is significant at a level of significance of 11%.

This sensitivity analysis leads us to conclude that our results are robust, i.e., that the exchange rate has a significant impact on employment and that this effect depends on labour market rigidity and on the degree of openness.

4 Conclusion

Several papers have related the decline in manufacturing employment to movements in exchange rates. However, the effect of exchange rates on employment depends on other variables. In particular, research in this area has highlighted the importance of the degree of openness to international trade, productivity and market power. The contribution of this paper is to evaluate the role of labour market institutions in the determination of the impact of exchange rates on employment.

To this end, we estimated a model in which the elasticity of employment with respect to the exchange rate depends on the degree of openness and on a measure of labour market ridigity, the OECD's EPL index. Our results, based on a sample of 22 industries across 23 OECD countries in the period 1988-2006, show that the employment exchange rate elasticity decreases with labour market rigidity. However, this effect is stronger in the case of sectors that the OECD technology classification ranks as low- and medium-low-technology sectors.

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Table 8: Sensitivity analysis

	(1)	(2)	(3)
$\beta_1 : \Delta ExRate_{jc,t-1}$	0.0076	-0.0122	-0.1069
	(0.0945)	(0.0970)	(0.0924)
$\beta_2 : Open_{jc,t-1}$	0.0278***	0.0105***	0.0113***
	(0.0055)	(0.0039)	(0.0023)
$\beta_3 : EPL_{c,t-1}$	-0.0123***	-0.0108**	-0.0157***
	(0.0045)	(0.0046)	(0.0050)
$\beta_4 : \Delta ExRate_{jc,t-1} \times Open_{jc,t-1}$	0.9606***	0.5354***	0.7005***
	(0.3239)	(0.1451)	(0.0985)
$\beta_5 : \Delta ExRate_{jc,t-1} \times EPL_{c,t-1}$	-0.0768*	-0.0772*	-0.0701
	(0.0428)	(0.0401)	(0.0431)
$\beta_6 : \Delta ULC_{c,t-1}$	-0.1441**	-0.1367**	-0.1512**
	(0.0662)	(0.0651)	(0.0675)
$\beta_7 : \Delta GDP_{c,t-1}$	0.7887***	0.7489***	0.7701***
	(0.0927)	(0.0939)	(0.0937)
$\beta_8 : \Delta IntRate_{c,t-1}$	-0.0006	-0.0008	-0.0004
	(0.0010)	(0.0010)	(0.0010)
$\beta_9 : \Delta Production_{jc,t-1}$		0.0413***	
		(0.0136)	
$\beta_{10} : \Delta ShareEastAsia_{jc,t-1}$			-0.0469
			(0.0448)
$\beta_{11} : \Delta ShareEastAsiaW_{jc,t-1}$			-0.1850***
			(0.0665)
Industry/Country (jc) dummies	yes	yes	yes
Year (t) dummies	yes	yes	yes
Observations	3310	3288	3100
Number of countries	23	23	22
Number of industries	12	12	12
Number of jc	247	247	235
R^2	0.2827	0.2899	0.3001
RMSE	0.0488	0.0481	0.0487
Test F, EPL, $H_0 : \beta_3 = \beta_5 = 0$	6.88***	5.80***	7.69***
Test F, jc dummies	25615***	6265***	11105***
Test F, t dummies	3.96***	4.32***	3.52***

Notes: Significance levels: ***: 1%, **: 5%, * 10%. Robust standard errors in parentheses (clustered at the sector/country level). All regressions are estimated by OLS. The dependent variable in all regressions is Δy_{jct} (change in log employment). (1): the degree of openness is computed as the ratio of exports to gross output. (2): the regression includes as an additional regressor gross production by sector. (3): the regression includes additional regressors concerning the weight of Eastern Asia imports. The sample includes only low-technology sectors — see list in Table 2. For a description of the variables and data sources see Table 9 in the Appendix.

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Appendix

Exchange rate computation

$ExRate_{jc,t-1}$ is the lagged real sectoral effective exchange rate (in logs) computed using trade-weights:

$$ExRate_{jc,t} = \log \left[\prod_{c=1}^{N(t)} \left(rer_{c,t}^{i} \right)^{w_{c,t}^{i,j}} \right] \tag{3}$$

where

$$rer_{c,t}^{i} = \frac{e_{i,t} \cdot p_{i,t}}{p_{c,t}} \tag{4}$$

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 $w_{c,t}^{i,j}$ is the weight of currency i in the index of country c at time t, with $\sum_i w_{c,t}^{i,j} = 1$. 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 country i's currency in the double-weighted effective index as

$$w_{c,t}^{j,i} = \left(\frac{M_{c,t}^{i,j}}{X_{c,t}^{i,j} +_j M_{c,t}^{i,j}} \right) w_{M,c,t}^{i,j} + \left(\frac{X_{c,t}^{i,j}}{X_{c,t}^{i,j} + M_{c,t}^{i,j}} \right) w_{X,c,t}^{i,j} \tag{5}$$

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

$$w_{X,c,t}^{i,j} = \left(\frac{X_{c,t}^{i,j}}{\sum_{i=1}^{N(t)} X_{c,t}^{i,j}} \right) \left(\frac{\gamma_{i,t}^{j}}{\gamma_{i,t}^{j} + \sum\limits_{h \neq i,c} X_{i,t}^{h,j}} \right) + \sum_{k \neq i} \left(\frac{X_{c,t}^{k,j}}{\sum_{k=1}^{N(t)} X_{c,t}^{k,j}} \right) \left(\frac{X_{i,t}^{k,j}}{\gamma_{k,t}^{j} + \sum\limits_{h \neq k,c} X_{h,t}^{k,j}} \right) \tag{6}$$

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).

Variable description and data sources

Table 9: Description of the variables and data sources

Variable	Description	Source
y	Number of employees (full and part-time) in logs.	OECD STAN: EMPN.
$ExRate$	See the next subsection in this Appendix.	
$Open$	Exports plus imports over gross output; 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}).
ULC	Real 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 (in logs), constant prices.	OECD STAN Database.
$Production$	Gross output, constant prices.	OECD STAN Database.
$IntRate$	Long-term real interest rates, per cent per annum.	OECD STAN Database, variable: "Interest Rates, Long-term government bond yields".
$ShareEastAsia$	Share of imports from Eastern Asia in sector j's own country imports. "Eastern Asia" includes: Cambodia, China, Chinese Taipei, Hong Kong, India, Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam.	OECD STAN Structural Analysis Database.
$ShareEastAsiaW$	Weighted average of the share of Eastern Asia imports in OECD countries, where the weights are defined as the share of each country i in country c exports: $ShareEastAsiaW_{jc,t} = \left(\frac{X_{c,t}^{i,j}}{\sum_{i=1}^{N(t)} X_{c,t}^{i,j}}\right)\left(\frac{M_{i,t}^{EasternAsia,j}}{\sum_{k=1}^{N(t)} M_{i,t}^{k,j}}\right)$, where $X_{c,t}^{i,j}$ $\left(M_{c,t}^{i,j}\right)$ stands for exports (imports) from country c to country i, in sector j.	OECD STAN Structural Analysis Database.