Manufacturing employment and exchange rates in the Portuguese economy: the role of openness, technology and labour market rigidity*

Fernando Alexandre† Pedro Bação‡ João Cerejeira§
Miguel Portela¶

1st October 2010

Abstract

In this paper, we explore empirically the role of openness, technology and labour market rigidity in the determination of the effect of the exchange rate on employment in Portugal. We develop an index that allows us to measure labour market flexibility at the sector level. This index shows that labour market flexibility has been increasing in all manufacturing sectors and that the labour market of high technology sectors are more flexible than in low technology sectors. We use this index in the estimation of an employment regression, focusing on the effect of exchange rate movements. Our estimates indicate that employment in low-technology sectors, with a high degree of trade openness and facing less rigidity in the labour market are more sensitive to movements in exchange rates.

Keywords: exchange rates, international trade, job flows, labour market rigidity, technology.

JEL-codes: J23, F16, F41

*We are grateful for insightful comments and suggestions from Nicolas Berman, Miguel Lebre de Freitas, João Amador, Colin Cameron and other participants at NIPE's seminar, and at the conferences "International Workshop on Firm and Product Heterogeneity in International Trade", held in Brussels, Royal Economic Society Conference held at University of Surrey, the Portuguese Economic Journal Conference held at University of Algarve and the ETSG 2010 12th Annual Conference held at University of Lausanne.

†Corresponding author: Escola de Economia e Gestão and NIPE, University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal. Email: falex@eeg.uminho.pt.

‡University of Coimbra and GEMF. Email: pmab@fe.uc.pt.

§University of Minho and NIPE. Email: jccsilva@eeg.uminho.pt.

¶University of Minho, NIPE and IZA. Email: mangelo@eeg.uminho.pt.

1 Introduction

Portugal is a small open economy, specialized in low-technology products and with a very rigid labour market. In this paper, we explore the role of these features of the Portuguese economy in explaining changes in manufacturing employment. In particular, we aim at evaluating how the degree of openness to trade, the technology level and labour market rigidities have mediated the impact of exchange rate shocks on manufacturing employment in the period 1988-2006. The role of labor market flexibility is evaluated by means of a novel index of sectoral flexibility.

We believe the focus on the impact of exchange rate movements is warranted because of the central role that currency management has played in shaping macroeconomic policy and outcomes since the mid-1970s. In particular, the adherence to the Exchange Rate Mechanism (in 1992) and the participation in the Economic Monetary Union (in 1999) implied a regime change in the behaviour of the Portuguese nominal and real effective exchange rates, putting an end to the competitive devaluations which were a hallmark of the Portuguese economic policy in the first half of the 1980s[1] – see, for example, Blanchard and Giavazzi (2002), Fagan and Gaspar (2007), Lopes (2008) and Macedo (2008). As a result of these changes, between 1988 and 2006, the effective real exchange rate appreciated more than 20% (Alexandre, Bação, Cerejeira and Portela, 2009a).

In the same period, manufacturing employment followed a declining trend: in 2006 manufacturing sectors accounted for 18.1% of total employment, down from 24.4% in 1988. Over this period, total employment in these sectors declined 15%, representing a loss of almost 160,000 jobs. This reduction of manufacturing sectors' share in the labour force partly reflects the deindustrialization trend that has affected advanced countries since the 1980s: for example, between 1988 and 2006 it decreased by approximately 40% and 20% in the UK and in the USA, respectively. In 2006, manufacturing employment represented approximately 10% of the workforce in those countries.[2] The main explanations for these decreasing trends in manufacturing employment in most industrialised countries highlight the influence of skill-biased technological change (e.g., Machin and Van Reenen, 1998), the increasing competition from emerging countries (e.g., Auer and Fischer, 2008) or oil shocks (e.g., Davis and Haltiwanger, 2001). For the Portuguese economy, Amador, Cabral and Opromolla (2009) stress the rise of Eastern European competitors in medium-high and high technology sectors and the competition from China in low-technology sectors.

Another strand of the literature has been focusing on an alternative explanation, namely the impact of movements in exchange rates. Economic theory suggests that changes in real exchange rates may have an impact on the reallocation of resources between sectors of

[1] Between August 1977 and May 1990 a 'crawling peg' exchange rate regime was followed.
[2] Data from the OECD STAN database.

the economy as they reflect changes in relative prices of domestic and foreign goods.[3] In fact, several authors have shown that exchange rate movements had a strong impact on manufacturing employment – see, for example, Branson and Love (1988), Revenga (1992), Gourinchas (1999), Campa and Goldberg (2001) and Klein, Schuh and Triest (2003). These papers conclude that sectors with a higher degree of openness to trade are more affected by exchange rate movements. The appreciation of the Portuguese real effective exchange rate, mentioned above, is therefore expected to be part of the explanation for the declining trend in manufacturing employment, as these sectors are very exposed to international competition. In fact, the degree of openness has increased substantially since accession to the European Community – see Amador *et al.* (2009).

The new literature in international trade theory, following Melitz (2003), has been focusing on the relation between international trade and productivity. In this vein, a recent study by Berman, Martin and Mayer (2009) looks at the effects of exchange rate movements on export firms in a trade model with heterogeneous firms and distribution costs. They conclude that heterogeneity in productivity across firms implies different responses to exchange rate movements. According to their conclusions, high productivity firms use their markups to adjust to exchange rate shocks; on the other hand, low productivity firms adjust to exchange rate movements by changing quantities. Again, extrapolating to the Portuguese economy, these results suggest that shocks in real exchange rates might have had sizable effects on manufacturing employment, given that the Portuguese economy is specialized in low-technology sectors, which tend to be less productive. Alexandre, Bação, Cerejeira and Portela (2009b) explore the role of the interaction between openness and technology level in the determination of the impact of exchange rate movements on employment. These authors conclude that very open low-technology sectors should be the most affected by exchange rate movements, whereas less open and high-technology sectors should be the least affected by changes in exchange rates.

More recently, several papers have been exploring the importance of labour market institutions to the impact of openness to international trade on employment – see, for example, Helpman and Itskhoki (2010) and Felbermayr, Prat and Schmerer (2008). Alexandre, Bação, Cerejeira and Portela (2010a) follow some of the insights produced by this new international trade literature. Namely, these authors introduce labour market frictions, in the form of hiring and firing costs, in a trade model of the type developed in Berman *et al.* (2009). Their theoretical and empirical results (using sectoral data for 23 OECD countries) suggest that higher labour adjustment costs reduce the impact of exchange rate shocks on employment. According to these results the high rigidity of the Portuguese labour market (one

[3] The effect on firms' competitiveness of an exchange rate movement may be linkened to that of a change in tariffs – see Feenstra (1989).

of the most rigid among OECD countries) may have protected manufacturing employment from exchange rate shocks. This conclusion is in accordance with Bertola (1990, 1992) and Hopenhayn and Rogerson (1993) – who have shown that adjustment costs in labour markets affect firms' optimal decisions, implying lower job flows[4] – and with the more general view that the impact of shocks on employment and unemployment hinges on labour market institutions – see, e.g., Blanchard and Wolfers (2000), Blanchard and Portugal (2001) and Varejão (2003).

In this paper, we make use of the insights of Alexandre *et al.* (2009b) and Alexandre *et al.* (2010a) to evaluate the role of the degree of openness, productivity and labour market rigidity in the determination of the effect of exchange rates on manufacturing employment in the Portuguese economy. As a first step, we computed sector-specific exchange rates and an index of sectoral labour market flexibility. Our estimates, using employment data for 20 manufacturing sectors, for the period 1988-2006, are consistent with the predictions derived from the models of Alexandre *et al.* (2009b) and Alexandre *et al.* (2010a). Namely they suggest that employment in low-technology sectors with a high degree of openness to trade and less labour market rigidities is more sensitive to exchange rate changes.

The remainder of the paper is organized as follows. Section 2 discusses the main trends in labour market rigidity and develops an index of sectoral labour market flexibility. Section 3 describes the behaviour of aggregate and sector-specific exchange rate indexes, of manufacturing employment and of the main trends in Portuguese international trade. Section 4 estimates a set of models to evaluate how the degree of openness to trade, productivity and labour market rigidity have mediated the impact of exchange rate shocks on Portuguese manufacturing employment. Section 5 summarizes the main results.

2 Labour market rigidity: the Employment Protection Legislation index and a sectoral index

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). In fact, several authors, namely Blanchard and Wolfers (2000), have been emphasiz-

[4] These theoretical predictions have found empirical support in several studies – see, e.g., Haltiwanger, Scarpeta and Schweiger (2006) and Gómez-Salvador, Messina and Vallanti (2004).

ing the importance of the interaction between shocks and labour market institutions to the understanding of the dynamics of employment and unemployment. For example, Blanchard and Portugal (2001) focus on the differences in labour market institutions when comparing the unemployment rates in Portugal and in the US and conclude that employment protection institutions affect job reallocation and the unemployment duration. Almeida, Castro and Félix (2009), using a DSGE model for a small economy in a monetary union, calibrated to reproduce the main features of the Portuguese economy, evaluate the impact of a set of shocks for different levels of rigidity in non-tradable goods and in the labour market. From their simulations they conclude that increasing the flexibility of labour markets may be very beneficial for the competitiveness of the Portuguese economy.

In this section we propose an index of labour market flexibility at the sector level, which will be used in our empirical estimates. This index is presented in section 2.2. Before that, in section 2.1, we will discuss the evolution of the Employment Protection Legislation index (EPL), a widely used measure of labour market rigidity at the national level, computed by the OECD, and to which we will compare our sectoral index.

2.1 The Employment Protection Legislation index

One feature of labour market rigidity is employment protection, that is, the legislation on individual 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. The OECD measure of employment protection, EPL, 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 (OECD, 1999 and 2004). This measure of labour market rigidity allows us to describe the evolution of rigidity in the Portuguese labour market over time and to compare it with other countries.

As shown in Figure 1, in the last 20 years there was a downward trend in the EPL index for OECD countries as a group: it decreased from 2.49, in 1988, to 1.91, in 2006, indicating an easing of hiring and/or firing conditions. The United States has the lowest value among OECD countries for the EPL index, and it has remained unchanged throughout the whole period. Although converging to the average EPL levels, Portugal has been one of the countries with more stringent labour markets regulations. As we can see from Figure 1, the reduction from 4.19, in 1988, to 3.46, in 2006, was achieved through the increase in fixed-term (temporary) contracts. This new contractual arrangement increased flexibility and became a very important contractual form in the Portuguese labour market, leading to

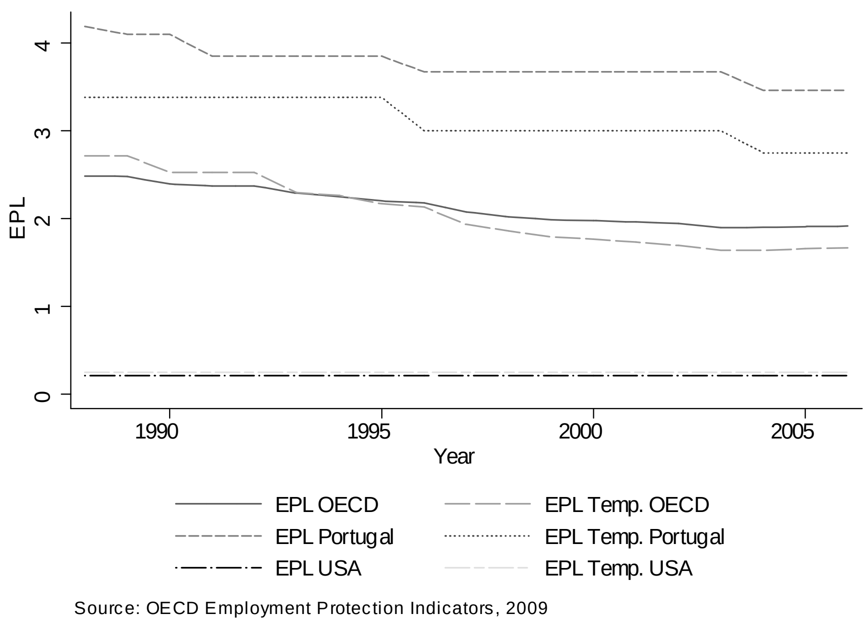

Figure 1: Employment Protection Legislation index

its increasing segmentation.[5] The introduction of this type of contract coincided with much higher job and worker flows (Centeno, Maria and Novo, 2009).

Whereas the EPL index is computed on a country basis, in this paper we wish to analyse employment at the sectoral level. In the next sub-section we present an index of labour market flexibility computed at the sector level, using Portuguese data.

2.2 An index of sectoral labour market flexibility

While the EPL index is based on the analysis of labour market legislation, which should affect all sectors, our index will be based on the behaviour observed in the actual data, which is available at the firm level in the database "*Quadros de Pessoal*". As described above, the EPL index includes the following components: 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. In the construction of our sectoral labour market flexibility index we tried to mimic these indicators under the constraint given by the information available in "*Quadros de Pessoal*" database. As a measure of flexibility concerning collective bargaining we chose the share of workers not covered by a collective agreement. We argue that the greater the share of contracts not regulated by a collective agreement the lower is the bargaining power accrued to unions,

[5] According to OECD (2004), the regulation of temporary employment is crucial for understanding differences across countries.

which implies a higher vulnerability of workers towards dismissals. This way, firms should find it easier to implement labour quantity adjustments. As a measure of flexibility concerning the hiring of temporary workers we used the share of workers without a full-time contract, as the dismissal costs associated with this type of workers are lower. As "*Quadros de Pessoal*" database does not provide an adequate measure of protection against individual dismissals we chose to include an alternative indicator of labour market flexibility. Babecký *et al.* (2009) show that hiring cheaper workers to replace those who leave the firm is the dominant strategy for reducing labour costs in Portugal (this is also true for manufacturing within Europe). Given this evidence we suggest as a measure of labour market flexibility the share of workers earning above minimum wage. When the share of workers earning above minimum wage is higher, the capacity for firms to adapt the labour costs in face of external shocks should also be higher. For example, when facing a negative demand shock firms can adjust the employment level by firing current workers receiving more than the minimum wage and hiring similar workers from the unemployment pool at a lower wage. This strategy can be followed until the wage reaches the minimum wage, which should take longer when the firm employs a high proportion of workers earning above minimum wage.

Our index of labour market flexibility at the sector level is a composite measure of these three dimensions of labour market flexibility. The three dimensions are aggregated in the same way as in the skill index developed by Portela (2001):

$$flex_{jt} = \left(0.5 + \frac{\exp(f_{1,jt})}{1+\exp(f_{1,jt})}\right) \cdot \left(0.5 + \frac{\exp(f_{2,jt})}{1+\exp(f_{2,jt})}\right) \cdot \left(0.5 + \frac{\exp(f_{3,jt})}{1+\exp(f_{3,jt})}\right) \qquad (1)$$

In our labour market flexibility index, $f_{1,jt}$ is the share of workers in sector j and period t not covered by some form of collective agreement; $f_{2,jt}$ is the share of workers without a full-time contract; and $f_{3,jt}$ is the share of workers earning above minimum wage within those with a full-time contract. We standardise each measure by subtracting the mean and dividing by the standard deviation over its entire distribution.[6]

In our formulation the dimensions of flexibility are interacted using the logistic formulation, corrected by the factor 0.5. This is done in order to guarantee that each index is bounded between 0.5, in case a specific standardized index goes to minus infinity, and 1.5, when the same index goes to infinity.[7] By using the logistic distribution we ensure that the main changes occur around the mean of each index, while changes far from the mean have smaller impacts on the index.

In Figure 2 we show the aggregate behaviour of our index, measured as a weighted average of our sectoral indexes, using as weights the share of employment in each sector,

[6] As we do not have data in "*Quadros de Pessoal*" for the years 1990 and 2001 we impute the values of f_1, f_2 and f_3 using a linear interpolation between the previous and the following year.

[7] Our proposed measure, $flex$, is bounded between $0.125\,(=0.5^3)$ and $3.375(=1.5^3)$.

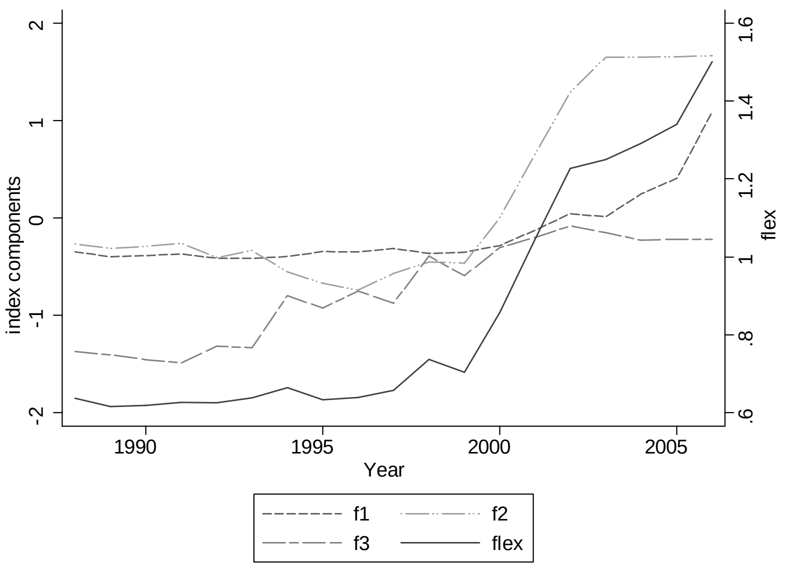

Figure 2: Aggregate flexibility index and its components

and which we call $flex$ – the data is available in Table 8 in the Appendix. The same figure also displays the aggregate behaviour of the three components of the index described above. The aggregate flexibility index exhibits an increasing trend that becomes more pronounced after 1999. This trend is common to the three components of the index. Nevertheless, the sharp increase in the aggregate index appears to be driven by the evolution of the first two components, f_1 and f_2. In particular, the jump in the aggregate index around 2000 seems to be explained by the rise in the share of workers without a full-time contract.

In order to test for the validity of our measure of labour market flexibility, we compare the aggregate behaviour of our index, $flex$, to the OECD's EPL index, described above – see Figure 3. Both measures show an increase in labour market flexibility over time. Since EPL is a rigidity measure and $flex$ is a flexibility measure, we expect their correlation to be negative. In fact, the overall correlation between $flex$ and EPL is -0.73.

Table 8 in the Appendix presents the values for the labour market flexibility index for the 20 manufacturing sectors used in our econometric analysis. All the sectors display the trend towards increased flexibility described above for the aggregate flexibility index and the EPL. In fact, the correlation between the flexibility index at the sector level and the EPL index varies between -0.83, in "Office, accounting and computing machinery", and -0.49, in "Chemicals excluding pharmaceuticals".[8]

Since our analysis highlights the role of the technology level it is of interest to see how our flexibility index varies across technology levels. The values of the index aggregated by

[8]The working paper version (Alexandre et al., 2010b) presents additional evidence, from regression analysis, of the strong relation between our index and the EPL index.

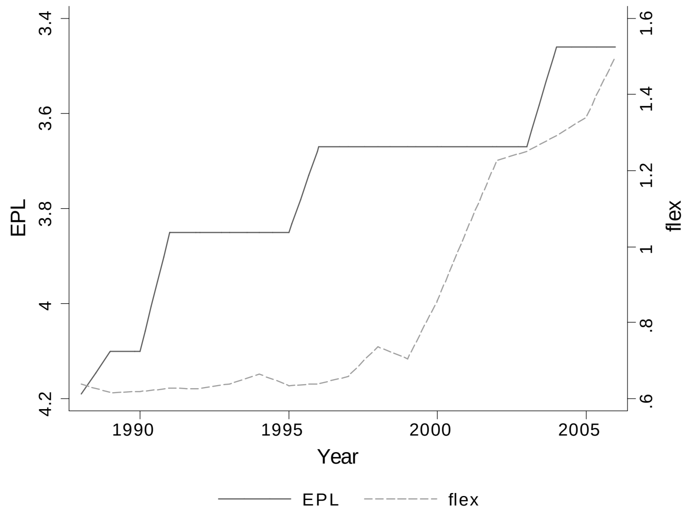

Figure 3: Time pattern: EPL vs. flex

technology level are also available in Table 8 in the Appendix and are represented in Figure 4. Both series present an increasing trend towards more flexibility and, according to our index, there is greater flexibility in high technology sectors.

These results suggest that our index may be useful for characterising labour market flexibility. We will use it as a measure of labour market flexibility in the empirical analysis presented in the section 4. Before that we describe the main patterns in employment and trade per technology level and in exchange rates.

3 Employment, exchange rates, trade and technology

We start this section by describing briefly the main trends in Portuguese international trade, between 1988 and 2006. Next, in section 3.2, we discuss the behaviour of aggregate and sector-specific exchange rate indexes. The behaviour of the exchange rate will be contrasted with that of manufacturing employment. In both sections, the discussion will highlight the evolution of employment and international trade per technology level, defined according to the OECD classification system, which divides sectors into four classes of technology: low, medium-low, medium-high and high. The OECD technology classification ranks industries according to indicators of technology intensity based on R&D expenditures (OECD, 2005).

Data on Portuguese international trade comes from OECD STAN bilateral trade database (OECD, 2008).[9] We focus on 20 manufacturing sectors, as they are more exposed to foreign trade – the list of sectors is presented in Table 7 in the Appendix. The sectors

[9] The STAN bilateral trade database is available at www.oecd.org/sti/stan/.

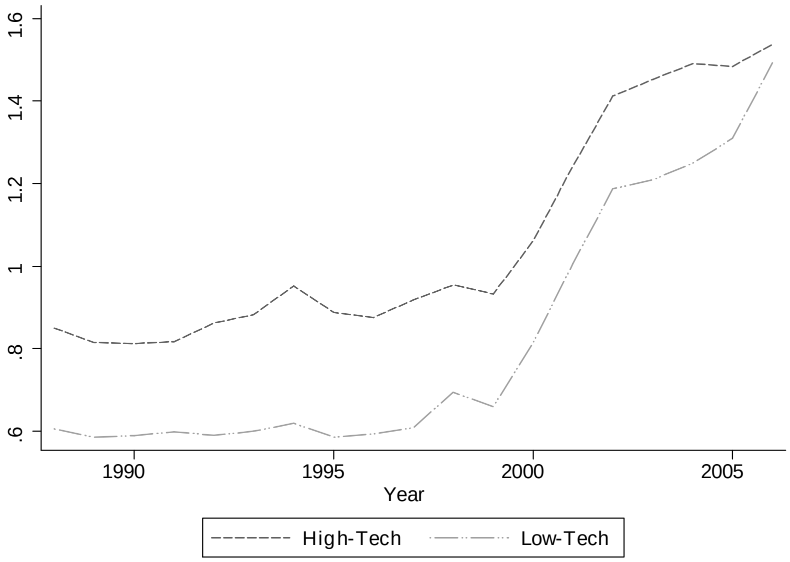

Figure 4: Aggregate flexibility index for high and low technology sectors

were selected to match the International Standard Industrial Classification of all economic activities, Revision 3 (ISIC Rev. 3). Data on employment comes from the *"Quadros de Pessoal"* dataset provided by the Portuguese Ministry of Labour and Social Solidarity (Portugal, MSSE, 1988-2006). This dataset is based on a compulsory survey that matches all firms and establishments with at least one employee with their workers. In 1988, it included 122,774 firms and 1,996,933 workers, covering 44.6% of total employment. In 2006, it included 344,024 firms and 3,099,513 workers, covering 60.5% of total employment.

3.1 Trade patterns and technology level

The most noteworthy trend in Portugal's trade patterns in recent decades is the change in trade shares according to sectors' technology level. In Table 1 we present the evolution of the shares in total exports and in total imports according to the OECD classification system. From the analysis of the data it stands out the steady decrease in the share of low-technology sectors' exports, from 62% in 1988 to 33% in 2006. Despite this, in 2006, low-technology sectors still constituted the main exporting sector. Among low-technology sectors, the OECD class "Textiles, textile products, leather and footwear" registered the largest decrease, from 38.5% in 1988 to 15.6% in 2006. However, throughout the 1988-2006 period this sector remained the leading export sector.

In contrast, in the same period, medium-low, medium-high and high technology sectors have increased their shares in exports from 11.5%, 18.2% and 5.7% to 20.9%, 29% and 11%, respectively (see Table 1). The higher share of medium-high technology sectors in exports reflects the increase in the OECD class "Motor vehicles, trailers and semi-trailers" from 7% to 13%.[10] The share of high technology sectors in exports remained low by world standards, but similar to Greece and Spain (Amador, Cabral and Maria, 2007: Table 3, pp. 16).

Table 1: Trade shares and openness for the Portuguese economy

	1988	2006	$\Delta p.p.$
Share in total exports (%)			
High-technology manufactures	5,7	11,03	5,33
Medium-high technology manufactures	18,23	28,97	10,74
Medium-low technology manufactures	11,49	20,88	9,39
Low-technology manufactures	62,01	32,78	-29,23
Share in total imports			
High-technology manufactures	10,85	14,40	3,55
Medium-high technology manufactures	40,24	28,39	-11,85
Medium-low technology manufactures	12,92	16,05	3,13
Low-technology manufactures	20,44	20,68	0,24
Openess = (X + M) / (GO + X + M)			
High-technology manufactures	69,2	74,4	5,2
Medium-high technology manufactures	62,5	68,3	5,8
Medium-low technology manufactures	33,5	46,6	13,1
Low-technology manufactures	37,1	44,4	7,3

Notes: Authors' computations based on STAN, OECD Bilateral Trade database. $\Delta p.p.$ stands for percentage points change between 1988 and 2006.

The results presented in Table 1 show that the degree of openness increases with the level of technology.[11] Our openness measure, which we will use in our estimations, is: $(X+M)/(GO+X+M)$, where X stands for exports, M stands for imports and GO stands for gross output.[12]

The picture that these numbers provide is that of a country that has been losing low-qualification jobs and trying to upgrade its manufacturing sector. This paper attempts to

[10] For a detailed description of exports and imports by technology level see Tables 19 and 20 in Alexandre et al. (2010b).

[11] In STAN bilateral trade database this result holds for other industrialised countries such as France, Germany, Italy, Spain, UK and US.

[12] Amador *et al.* (2009) provide a detailed description of the increase in the degree of trade openness of the Portuguese economy in the last two decades.

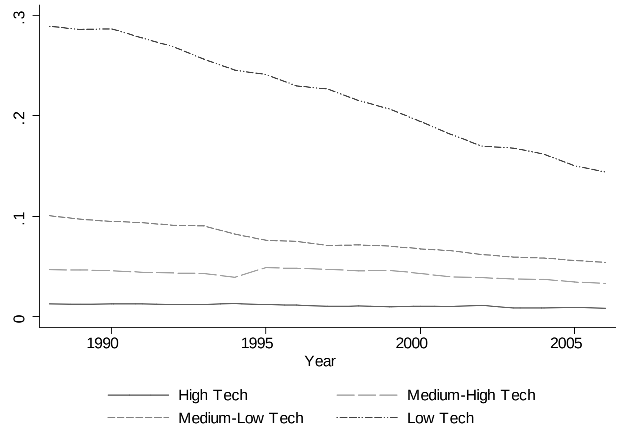

Figure 5: Share of employment by technology level

assess the role of the exchange rate in this evolution, while taking also into consideration the part played by labour market rigidities. We discuss the behaviour of the exchange rate in the next section.

3.2 Employment and exchange rates

The Portuguese manufacturing labour force followed the declining trend described in the Introduction for industrialized countries.[13] This reduction of manufacturing sectors' share in the labour force partly reflects the deindustrialization trend mentioned in the Introduction. Figure 5 shows the evolution of the share of employment in the 20 manufacturing sectors, grouped by OECD level of technology, according to *"Quadros de Pessoal"*. There are clear decreasing trends in low and medium-low technology sectors. Low and medium-low technology sectors accounted for over 80% of total manufacturing employment: 86.6% in 1988 and 82.4% in 2006. These sectors also accounted for all the manufacturing jobs lost in this period. In particular, more than 80% of these lost jobs were in Textiles, textile products, leather and footwear. Nevertheless, this sector stands throughout the period as the largest employer among the 20 sectors. On the other hand, medium-high and high technology sectors increased the number of jobs slightly over the same period. Within these sectors, "Motor vehicles, trailers and semi-trailers" and "Machinery and equipment nec" were the largest employers and increased significantly in relative terms between 1988 and 2006.[14]

As mentioned above, one explanation given in the literature for these trends in manufacturing employment is the effect of movements in exchange rates. In fact, the period

[13] However, the decrease in manufacturing employment was accompanied by a 15% increase in the labour force.

[14] Table 21 in Alexandre et al. (2010b) presents the sectors' rank in terms of employment.

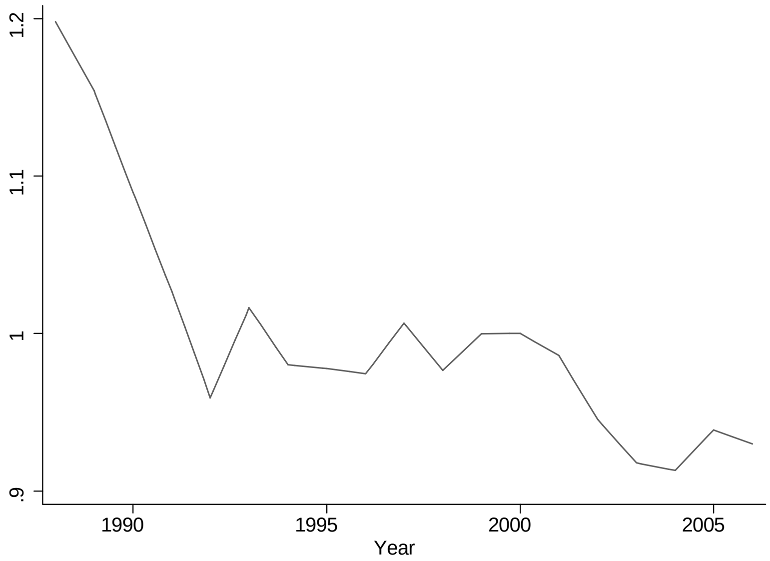

Figure 6: Real effective exchange rate

under study (1988-2006) was characterized by an appreciation of the Portuguese real effective exchange rate by more than 20% – see Figure 6. The bulk of the appreciation took place between 1988 and 1992. This period was followed by marginal variations in the real exchange rate until the Portuguese escudo joined the euro. The period since then has again been characterized by an appreciation of approximately 7%.[15]

The coincidence between the declining trend in manufacturing employment and the real exchange rate appreciation suggests that the links between employment and exchange rates in the Portuguese economy should be investigated. We turn to this in the next section.

4 Employment and exchange rates

4.1 Econometric model

The previous sections provided evidence on five major facts concerning the evolution of the Portuguese economy during the period 1988-2006: manufacturing employment decreased significantly; low and medium-low technology sectors, though declining in importance, were dominant; the degree of openness has increased; labour market rigidity has declined; and the real effective exchange rate has appreciated significantly. We believe that these facts are

[15] The real aggregate exchange rate presented in Figure 6 was computed using as bilateral weights an average of exports and imports' shares of 29 OECD trade partners plus 24 non-OECD trade partners of Portuguese manufacturing industries. Alexandre, Bação, Cerejeira and Portela (2009a) provide a detailed description of the computations for a set of alternative effective exchange rates indexes for the Portuguese economy in the period 1988-2006.

related, as the model developed in Alexandre *et al.* (2010a) suggests. In fact, the timing of those changes suggests that the analysis of the Portuguese experience may improve the understanding of the role that differences in trade openness, technology level and labour market rigidity across sectors have in the determination of the effects of exchange rate movements on economic activity.

According to the trade model presented in Alexandre *et al.* (2010a), the sensitivity of employment to exchange rate changes is expected to increase with the degree of openness to trade and to decrease with both labour market rigidity and productivity. To assess how important these mechanisms have been to employment dynamics in Portugal we use the following empirical model:

$$\begin{aligned}
\Delta y_{jt} = {} & \beta_0 + \beta_1 \Delta ExRate_{j,t-1} + \beta_2 \Delta ExRate_{j,t-1} \times Open_{j,t-1} \\
& + \beta_{1L} \Delta ExRate_{j,t-1} \times Low_j + \beta_{2L} \Delta ExRate_{j,t-1} \times Open_{j,t-1} \times Low_j \\
& + \beta_3 \Delta ExRate_{j,t-1} \times flex_{j,t-1} + \beta_{3L} \Delta ExRate_{j,t-1} \times flex_{j,t-1} \times Low_j \\
& + \beta_4 \Delta ShareImp_{j,t-1} + \beta_5 Open_{j,t-1} + \beta_6 flex_{j,t-1} + \lambda_t + \theta_j + \varepsilon_{jt}, \qquad (2)
\end{aligned}$$

where Δ denotes first-difference, j refers to sectors and t indexes years. The dependent variable y_{jt} is log-employment, measured as total workers. $ExRate_{j,t-1}$ is the lagged real effective exchange rate (in logs) for sector j, where the bilateral weights are given by total trade (exports plus imports) shares.[16] The exchange rate index is defined such that an increase in the index is a depreciation of the currency. This exchange rate is smoothed by the Hodrick-Prescott filter, which filters out the transitory component of the exchange rate.[17] This is the usual procedure in the literature – see, for example, Campa and Goldberg (2001) – as firms, in the presence of hiring and firing costs, are expected to react only to permanent exchange rate variations.

As discussed in Alexandre *et al.* (2009b and 2010a), the effects of exchange rates on employment should differ according to the degree of trade openness. Therefore, we include in equation (2) an interaction term for the exchange rate and our measure of trade openness, $Open_{j,t-1}$ (see section 3.1). Similarly, we include the interaction of the exchange rate with a dummy variable indicating low technology sectors, Low_j – we divide manufacturing sectors into low (which include low and medium-low technology sectors) and high-technology sectors (which include medium-high and high-technology sectors) using the OECD technology

[16] Sector-specific exchange rates may be more informative than aggregate exchange rate indexes as indicators of industries' competitiveness when the importance of trading partners varies across sectors – see, for example, Goldberg (2004), Gourinchas (1999) and Alexandre *et al.* (2009a). Data for exchange rates were computed in Alexandre *et al.* (2009a) and are available at http://www3.eeg.uminho.pt/economia/nipe/docs/2009/DATA_NIPE_WP_13_2009.xls.

[17] Following Ravn and Uhlig (2002), the smoothing parameter was set equal to 6.25.

classification (see section 3).

To evaluate the role of labour market rigidity, we add to the model the variable $flex_{j,t-1}$, which stands for the flexibility of sector j, measured by the sectoral index presented in section 2.2. This sectoral labour market index makes three appearances in our empirical model: alone, interacting with the exchange rate and interacting with the exchange rate and with the dummy variable indicating low technology sectors.

As a control variable, to account for competitors from emerging countries,[18] we include in our regressions the variable $ShareImp_{j,t-1}$, which is the share of these countries in sector j OECD countries' imports.[19] Competition from emerging countries may affect Portuguese firms either directly, through their penetration in the domestic market, or indirectly, by reducing exporting firms' external demand.

The model also includes a set of time dummies, λ_t, in order to control for any common aggregate time varying shocks that are potentially correlated with exchange rates,[20] and a set of sectoral dummies θ_j. Since we specify a model in first-differences, these dummies represent sector-specific trends. Finally, ε_{jt} is a white noise error term. All variables are in real terms. The model is estimated by OLS, with robust standard errors allowing for within-sector correlation.[21]

4.2 Results

Table 2 summarizes the results for the model specified in equation (2). Our estimation strategy is the following. We start by estimating equation (2) without taking into account the sectors' technology level. These results are presented in columns (1) and (2) under ALL. Next we extend this specification by including the level of technology. These results are presented in columns (3) and (4), under $FULL$. Finally, we estimate equation (2) separately for high- ($HighTech$) and low-technology sectors ($LowTech$) – these results are shown, respectively, in columns (5) and (6) and in columns (7) and (8). Even-numbered columns include sectoral dummies.

Looking at Table 2, the results concerning the control variable $ShareImp_{j,t-1}$ show

[18] The set of emerging countries includes Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic, Slovenia, China, Chinese Taipei, Hong Kong, India, Indonesia, Malaysia, Philippines, Singapore, Thailand.

[19] Alternatively, we have included the share of non-OECD imports in Portuguese manufacturing sectors. However, this was not statistically significant in explaining employment variations. Results are available from the authors upon request.

[20] Since we use time dummies to account for aggregate shocks, our identification strategy relies mainly on the inclusion of the sectoral exchange rates. Other sources of heterogeneity are variations in overall level of trade exposure, $Open_{j,t-1}$, and the labour market flexibility, $flex_{j,t-1}$.

[21] An obvious alternative would be to estimate a dynamic panel data model, using adequate instrumental variables estimators. However, the inclusion of the lagged dependent variable as an additional regressor produced a statistically non-significant coefficient.

that competition from emerging countries has had a negative and statistically significant impact on employment growth. The statistical significance of this effect is independent of the technology level. However, the impact of the competition with emerging countries' imports seems to be stronger for high-technology sectors (estimated coefficients -2.5 and -2.7 in columns (5) and (6)) than for low-technology sectors (estimated coefficients -1.5 and -1.6 in columns (7) and (8)). Nevertheless, a more insightful analysis might attempt to assess the effect of subsets of this group of countries based on their specialization. For example, Amador *et al.* (2009) show that Eastern European countries competition has mainly affected medium-high and high-technology sectors, whereas competition from China has had a strong effect on low-technology sectors. Although these results deserve further research, in this paper we focus instead on the effects of exchange rate movements on manufacturing employment.

Table 2: Employment regressions

Model	ALL		FULL		HighTech		LowTech	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta ExRate_{t-1}$	-2.345	-1.472	-.354	-2.858	-5.457*	-2.859	-3.074*	-2.869
	(2.686)	(2.995)	(2.365)	(2.537)	(2.976)	(4.909)	(1.790)	(2.161)
$\Delta ExRate_{t-1} \times Low$			-4.202**	-.635				
			(1.771)	(1.914)				
$\Delta ExRate_{t-1} \times Open$	2.645**	3.518**	2.057	7.201***	7.949***	8.065***	8.291***	7.227***
	(1.301)	(1.621)	(2.257)	(2.695)	(2.564)	(2.682)	(2.370)	(2.739)
$\Delta ExRate_{t-1} \times Open \times Low$			8.071**	.506				
			(3.478)	(4.121)				
$Open_{t-1}$	.105**	.205	.099**	.299*	.333***	.362*	.034	.148
	(.041)	(.164)	(.039)	(.159)	(.064)	(.214)	(.028)	(.150)
$\Delta ExRate_{t-1} \times Flex$	1.386	.901	-.050	-.784	-2.300	-4.001	2.349***	2.407**
	(1.567)	(1.926)	(1.478)	(2.107)	(2.328)	(2.706)	(.904)	(1.048)
$\Delta ExRate_{t-1} \times Flex \times Low$			2.564*	3.212				
			(1.457)	(2.240)				
$Flex_{t-1}$	-.0005	.021	-.009	.016	-.014	-.037	-.033	-.020
	(.024)	(.050)	(.025)	(.052)	(.054)	(.061)	(.029)	(.048)
$\Delta ShareImp_{t-1}$	-1.482***	-1.839***	-1.723***	-1.969***	-2.502**	-2.722	-1.509***	-1.621***
	(.434)	(.620)	(.490)	(.661)	(1.058)	(1.732)	(.556)	(.493)
Sectoral dummies	no	yes	no	yes	no	yes	no	yes
Observations	360	360	360	360	162	162	198	198
$Adj.R^2$	.068	.069	.084	.078	.092	.051	.196	.201
LogLikelihood	318.472	329.223	323.135	332.566	118.795	120.073	251.423	257.926
RMSE	.103	.103	.103	.103	.126	.129	.073	.072

Notes: Significance levels: $*$: 10% $**$: 5% $***$: 1%. The dependent variable is the difference in the log employment. All regressions are estimated by OLS, and include time dummies. Additionally, even columns include sector dummies. RMSE is root mean squared error. The exchange rate is the average import/export exchange rate.

Looking at the benchmark regressions (ALL), which do not control for the technology level, we observe that the interaction term for the exchange rate and openness is statistically significant and positive. This result seems to corroborate the results of Klein *et al.* (2003), that is, the effect of the exchange rate on employment is magnified by trade openness. To account for the role of technology, the specification $FULL$ (columns (3) and (4) in Table 2) introduces the dummy variable Low in the model via additional interactions with the exchange rate, the degree of openness and the measure of labour market flexibility. Again, the results presented in columns (3) and (4) show that the degree of openness has a positive effect on employment and that it magnifies the effect of exchange rate movements, though not every coefficient is statistically significant. The coefficient associated with the interaction between the exchange rate and openness is positive and clearly significant when we estimate separate regressions for low and high-technology sectors (columns (5) to (8)).

Let us now turn our attention to the role of labour market rigidity. The results in columns (1) and (2) do not show a significant effect of labour market rigidity on employment, i.e., the effect does not exist through its interaction with the exchange rate, nor on its own. Once we account for the level of technology, in column (3), we conclude that the effect of exchange rates is magnified in low-technology sectors with high labour market flexibility. Our results indicate that the employment sensitivity to exchange rate movements is not affected by the degree of labour market rigidity in the case of high-technology sectors. Additionally, flexibility on its own does not explain changes in employment (the estimated coefficient is -0.009, with a standard error of 0.025). Controlling for sector-specific effects, column (4), we loose the statistical significance on $\hat{\beta}_{3L}$, even though the point estimate is actually larger.

Performing the regressions separately by level of technology – columns (5) to (8) –, the conclusion reached with $FULL$ regressions is reinforced, i.e., labour market flexibility is relevant for low-technology industries through its impact on employment exchange rate elasticity. The quality of the adjustment of our model improves significantly when we use only the low-technology set of industries. The root mean squared error is about 0.07, while the R^2 is about 0.2, compared to 0.09 and to 0.05, respectively, for high-technology sectors.

Since our goal is to evaluate how the openness to trade, technology and labour market rigidity mediate the effect of exchange rate movements on employment we computed the elasticity of employment with respect to the exchange rate implied by the different specifications of our empirical model. The elasticity was evaluated at different degrees of trade openness and labour market flexibility, using the results presented in Table 2. In the analysis we consider a low, a median and a high degree of openness and of labour market flexibility, which correspond to the 10^{th}, the 50^{th} and the 90^{th} percentiles, respectively. The employment exchange rates elasticities for the 10^{th}, 50^{th} and the 90^{th} percentiles of openness are shown, respectively, in Tables 3, 4 and 5.

Table 3: Elasticity of employment (total workers) with respect to the exchange rate

Model		ALL		FULL		HighTech		LowTech	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Flexibility, percentile			Openness, percentile 10					
ExRate Elasticity	10	.355	.830						
	50	.569	.970						
	90	1.203	1.382						
HighTech Elasticity	10			.201	-1.746	-6.192*	-5.888		
	50			.194	-1.867	-6.548*	-6.507		
	90			.171	-2.225	-7.600	-8.336*		
LowTech Elasticity	10			1.959	2.169			2.658*	2.619
	50			2.348*	2.545			3.021**	2.991**
	90			3.497**	3.655**			4.095***	4.092**
F-test: equal elasticities	10			1.707	2.947				
	50			1.946	2.867				
	90			2.366	2.683				

Notes: see notes to Table 2.

Table 4: Elasticity of employment (total workers) with respect to the exchange rate

Model		ALL		FULL		HighTech		LowTech	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Flexibility, percentile	Openness, percentile 50							
	10	.951	1.623						
ExRate Elasticity	50	1.165	1.763						
	90	1.799	2.175						
	10			.665	-.122	-4.400	-4.070		
HighTech Elasticity	50			.658	-.243	-4.756	-4.688		
	90			.634	-.602	-5.808	-6.518		
	10			4.243**	3.907*			4.527**	4.249*
LowTech Elasticity	50			4.631**	4.283*			4.890**	4.621*
	90			5.781***	5.393**			5.965***	5.722**
	10			5.563**	3.630*				
F-test: equal elasticities	50			5.383**	3.459*				
	90			4.903**	3.095*				

Notes: see notes to Table 2.

Table 5: Elasticity of employment (total workers) with respect to the exchange rate

Model		ALL		FULL		HighTech		LowTech	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Flexibility, percentile			Openness, percentile 90					
ExRate Elasticity	10	1.449	2.285						
	50	1.663	2.425						
	90	2.297	2.837						
HighTech Elasticity	10			1.052	1.232	-2.905	-2.552		
	50			1.044	1.111	-3.260	-3.171		
	90			1.021	.753	-4.312	-5.001		
LowTech Elasticity	10			6.148**	5.357*			6.087**	5.608*
	50			6.536***	5.732**			6.450**	5.980**
	90			7.686***	6.843**			7.524***	7.081**
F-test: equal elasticities	10			7.112**	3.281*				
	50			10.398***	4.500**				
	90			6.394**	3.126*				

Notes: see notes to Table 2.

The results shown in Tables 3 to 5, columns (3) and (4) (specification $FULL$), indicate that, regardless of the degree of openness and labour market flexibility, employment in high-technology sectors does not seem to be sensitive to exchange rate movements. However, for low-technology sectors a 1% depreciation of the exchange rate is associated with an increase in employment that varies between 1.96% and 7.7%, though the lower values, associated with less labour market flexibility, are not all statistically significant. The elasticities estimated for low-technology sectors by estimating the model on this data alone are very similar to these (cf. columns (7) and (8)). Moreover, the $F-$statistics shown in these tables indicate that exchange rate elasticities are different for low- and high-technology sectors, except perhaps for less open sectors.

What stands out in columns (5) and (6), concerning high-technology sectors, is the negative exchange rate elasticity of employment, which is statistically significant for the less open sectors (percentile 10). For higher degrees of openness the absolute magnitude of the elasticity decreases and becomes statistically insignificant. From a theoretical perspective this result may be explained by the effect of the exchange rate variation on the price of imported inputs, that is, firms that rely heavily on imported inputs may have their competitiveness negatively affected by a depreciation of the exchange rate. Empirically we cannot test this hypothesis as we do not have data on firms foreign trade.[22]

Overall, our results show that the magnitude of the elasticity increases with both the degree of openness and the level of labour market flexibility, and is larger for low-technology sectors than for high-technology sectors. These results are summarised in Table 6, which shows the employment exchange rate elasticities for low-tech and high-tech sectors, for a high and a low degree of openness, measured, respectively, by the 90^{th} and 10^{th} percentiles, and for the three levels of labour market rigidity considered in our estimates. Once we control for sectoral dummies, as in columns (6) and (8) of Tables 3 to 5, the results remain similar, but with slightly smaller elasticities.

We should highlight that the estimated elasticities for the Portuguese economy are larger than those reported in the literature for other countries, namely for the US (Revenga, 1992, Campa and Goldberg, 2001) and France (Gourinchas, 1998). Although Alexandre *et al.* (2010), analysing 23 OECD countries, also using sector level data and an identical estimation procedure, found similar patterns regarding the importance of openness, technology and labour market rigidity, the magnitude of the elasticities therein is much smaller than the ones we found. In this paper, an elasticity of 7.1 for Low-Tech, highly open and highly flexible (Table 3, column 8), compares to the cross-country elasticity of 0.62 found in Alexandre *et al.* (2010). The within country figure for Portugal is considerably larger than the cross-

[22] For an empirical analysis of the effect of exchange rate movements on employment, through its effect on the cost of imported inputs, see, for example, Ekholm, Moxnes and Ulltveit-Moe (2008).

Table 6: Elasticity of employment (total workers) with respect to the exchange rate

		Low-Tech	High-Tech
Open(+)	$flex$(+)	7.524***	-4.312
		6.450**	-3.260
	$flex$(-)	6.087**	-2.905
Open(-)	$flex$(+)	4.095***	-7.600
		3.021**	-6.548*
	$flex$(-)	2.658*	-6.192*

Notes: Significance levels: $*$: 10% $**$: 5% $***$: 1%.

country counterpart. This difference may be explained by differences in the composition of low-technology sectors and by specific characteristics of the sectors that belong to that category, which are not captured by the OECD technology classification. This is an issue that deserves further research.

As a further robustness check, equation (2) was estimated using hours worked, job creation, job destruction and job reallocation as the dependent variable instead of total workers. The results are presented in Alexandre et al. (2010). Using hours as a measure of employment confirms the results described above. In what concerns job flows we found the following results. The degree of market flexibility seems to mediate the effect of exchange rate innovations on job creation in low-technology sectors, but it does not seem to have a role for high-technology sectors. This suggests that for low-technology sectors a rigid labour market insulates the job creation process from external shocks. When we look at job destruction our estimates suggest that a higher degree of flexibility in the labour market magnifies the negative impact of an exchange rate appreciation. When we focus on job reallocation our results show that its elasticity with respect to the exchange rate increases with the degree of labour market flexibility, both for low-technology sectors and high-technology sectors. Summing up, our results suggest that higher labour market flexibility makes job flows more responsive to exchange rate movements.

5 Conclusions

In this paper the degree of labour market rigidity is measured at the sector level by means of a novel index. This index shows that labour market flexibility has displayed an increasing trend that became more pronounced after 1999. This increasing trend was shared by all manufacturing sectors included in our analysis. According to this index, high-technology sectors face less labour market rigidity on average. These sectors are also the most exposed to international competition. However, the bulk of employment destruction has occurred in low-technology sectors. This suggests that technology may be the key variable to reduce the economy's exposure to external shocks.

In fact, our results show that the degree of openness to trade, technology and labour market rigidity affect the impact of exchange rate movements on Portuguese manufacturing employment. In particular, we estimate that employment in low-technology sectors, with a high degree of trade openness and facing less rigidity in the labour market have been the most affected by the evolution of the exchange rate since the late 1980s.

6 References

Addison, J. and P. Teixeira (2003). The economics of employment protection. Journal of Labour Research, 24(1), 85-129.

Alexandre, F., P. Bação, J. Cerejeira and M. Portela (2009a). Aggregate and sector-specific exchange rates for the Portuguese economy. Notas Económicas, 30.

Alexandre, F., P. Bação, J. Cerejeira and M. Portela (2009b). Employment and exchange rates: the role of openness and technology. IZA Discussion Paper No. 4191. Institute for the Study of Labor, Bonn.

Alexandre, F., P. Bação, J. Cerejeira and M. Portela (2010a). Employment, exchange rates and labour market rigidities. IZA Discussion Paper, No. 4891, IZA – Institute for the Study of Labour, Bonn.

Alexandre, F., P. Bação, J. Cerejeira and M. Portela (2010b). Manufacturing employment and exchange rates in the Portuguese economy: the role of openness, technology and labour market rigidity. NIPE Working Paper No. 22/2010, Universidade do Minho.

Almeida, V., G. Castro and R. Félix (2009). The Portuguese economy in the European context: structure, shocks and policy. In Banco de Portugal. The Portuguese Economy in the Context of Economic, Financial and Monetary Integration. Economics and Research Department, Banco de Portugal.

Amador, J., S. Cabral and J.R. Maria (2007). International trade patterns over the last four decades: how does Portugal compare with other cohesion countries? Working Papers, 14/2007, Banco de Portugal.

Amador, J., S. Cabral and L. D. Opromolla (2009). A portrait of Portuguese international trade. In Banco de Portugal. The Portuguese Economy in the Context of Economic, Financial and Monetary Integration. Economics and Research Department, Banco de Portugal.

Auer, R. and A. Fischer (2008). The effect of trade with low-income countries on U.S. industry. CEPR Discussion Paper Series # 6819. Centre for Economic Policy Research.

Babecký, Jan, P. Du Caju, T. Kosma, M. Lawless, J. Messina and T. Rõõm, (2009). The Margins of Labour Cost Adjustment: Survey Evidence from European Firms. Research Technical Paper 12/RT/09, Central Bank and Financial Services Authority of Ireland, Dublin.

Berman, N., P. Martin and T. Mayer (2009). How do different exporters react to exchange rate changes? Theory, empirics and aggregate implications. CEPR Discussion Paper Series No. 7493. Centre for Economic Policy Research.

Bertola, G. (1990). Job security, employment and wages. European Economic Review, 34, June, 851-86.

Bertola, G. (1992). Labor turnover costs and average labor demand. Journal of Labor Economics, 10(4), 389–411.

Blanchard, O. and F. Giavazzi (2002). Current account deficits in the Euro Area: The end of the Feldstein-Horioka puzzle? Brooking Papers on Economic Activity, 2, 147-209.

Blanchard, O. and J. Wolfers (2000). The role of shocks and institutions in the rise of European unemployment: the aggregate evidence. The Economic Journal, 110, March, C1-C33.

Blanchard, O. and P. Portugal (2001). What hides behind an unemployment rate: Comparing Portuguese and U.S. labor markets, American Economic Review 91(1), 187-207.

Branson, W. and J. Love (1988). U.S. manufacturing and the real exchange rate. In R. Marston, ed., Misalignments of exchange rates: effects on trade and industry. Chicago University Press.

Campa, J. and L. Goldberg (2001). Employment versus wage adjustment and the US dollar. Review of Economics and Statistics, 83 (3), 477-489.

Centeno, M., J. Maria and A. Novo (2009). Unemployment: supply, demand and institutions. In Banco de Portugal. The Portuguese Economy in the Context of Economic, Financial and Monetary Integration. Economics and Research Department, Banco de Portugal.

Davis, S. and J.C. Haltiwanger (2001). Sectoral job creation and destruction: responses to oil price changes. Journal of Monetary Economics, 48(3), 465-512.

Ekholm, K., A. Moxnes and K.H. Ulltveit-Moe (2008). Manufacturing restructuring and the role of real exchange rate shocks: a firm level analysis. CEPR Discussion paper no. 6904.

European Comission (2003). 2003 Adopted employment guidelines. Available at http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_197/l_19720030805en00130021.pdf.

Fagan, G. and V. Gaspar (2007). Adjusting to the euro, Working paper 2007-03, Banco de Portugal.

Feenstra, R. (1989). Symmetric pass-through of tariff and exchange rates under imperfect competition: an empirical test. Journal of International Economics. February, 27, 25-45.

Felbermayr, G., J. Prat and H. Schmerer (2008). Globalization and Labor Market Outcomes: Wage Bargaining, Search Frictions, and Firm Heterogeneity, IZA Discussion Papers No. 3363, Bonn.

Goldberg, L. (2004). Industry-specific exchange rates for the United States. Federal Reserve Bank of New York Economic Policy Review, May.

Gómez-Salvador, R., J. Messina and G. Vallanti (2004). Gross job flows and institutions in Europe. Labour Economics, 11, 469-485.

Gourinchas, P. (1998). Exchange Rates and Jobs: What do we Learn from Job Flows? In NBER Macroeconomics Annual, B. Bernanke and J. Rotemberg eds. The MIT Press.

Gourinchas, P. (1999). Exchange rates do matter: French job reallocation and exchange rate turbulence, 1984-1992. European Economic Review, 43, 1279-1316.

Haltiwanger, J., S. Scarpeta and H. Schweiger (2006). Assessing job flows across countries: the role of industry, firm size and regulations. IZA Discussion Paper No. 2450.

Helpman, E. and O. Itskhoki (2010). Labour market rigidities, trade and unemployment. Review of Economic Studies, Forthcoming.

Hopenhayn, H. and R. Rogerson (1993). Job turnover and policy evaluation: A general equilibrium analysis. Journal of Political Economy, 101(5), 915–938.

Klein, M.K., S. Schuh and R. Triest (2003). Job creation, job destruction, and the real exchange rate. Journal of International Economics, 59, 239-265.

Lopes, Silva (2008). Introduction, In Franco, Francesco, org., Challenges Ahead for the Portuguese Economy. Imprensa de Ciências Sociais, Lisboa.

Macedo, Jorge Braga de (2008). Economic advice and regime change in Portugal, In Franco, Francesco, org., Challenges Ahead for the Portuguese Economy. Imprensa de Ciências Sociais, Lisboa.

Machin, S. and J. Van Reenen (1998). Technology and changes in the skill structure: evidence from seven OECD countries. Quarterly Journal of Economics, 113(4), 1215-1244.

Melitz, M.J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. Econometrica. 71(6), 1695-1725.

OECD (1999). Employment Outlook. OECD, Paris.

OECD (2004). Employment Outlook. OECD, Paris.

OECD (2005). OECD Science, Technology and Industry Scoreboard, Annex 1. OECD, Paris.

OECD (2008). STAN Bilateral Trade Database. OECD, Paris.

OECD (2009). Employment Protection Indicators. OECD, Paris.

Portela, M. (2001). Measuring skill: a multi-dimensional index. Economics Letters, 72(1), 27-32.

Portugal. Ministry of Social Security and Employment (MSSE) (1988-2006). Quadros de Pessoal. Data in magnetic media.

Revenga, A.L. (1992). The impact of import competition on employment and wages in U.S. manufacturing. Quarterly Journal of Economics. 107 (1), 255-284.

Ravn, Morten O. and H. Uhlig (2002). On adjusting the Hodrick-Prescott filter for the frequency of observations. Review of Economic and Statistics, 84, 2, 371-376.

Varejão, J. (2003). Job and worker flows in high adjustment cost settings. Portuguese Economic Journal, 2, 37-51.

Appendix

Table 7: List of Sectors

Sector	ISIC Rev. 3
Low and medium-low technology sectors	
food products, beverages and tobacco	15 - 16
textiles, textile products, leather and footwear	17 - 19
wood and products of wood and cork	20
pulp, paper, paper products, printing and publishing	21 - 22
rubber and plastics products	25
other non-metallic mineral products	26

Continued on next page...

... table 7 continued

Sector	ISIC Rev. 3
iron and steel	271 + 2731
non-ferrous metals	272 + 2732
fabricated metal products, except machinery and equipment	28
building and repairing of ships and boats	351
manufacturing nec	36 - 37
High and medium-high technology sectors	
chemicals excluding pharmaceuticals	24, excl. 2423
pharmaceuticals	2423
machinery and equipment, nec	29
office, accounting and computing machinery	30
electrical machinery and apparatus, nec	31
radio, television and communication equipment	32
medical, precision and optical instruments, watches and clocks	33
motor vehicles, trailers and semi-trailers	34
railroad equipment and transport equipment nec	352 + 359

Table 8: Values of the flex index

Sector	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1	0.94	0.99	0.90	0.82	0.77	0.75	0.80	0.77	0.72	0.74	0.75	0.83	0.86	1.10	1.38	1.24	1.33	1.30	1.58
2	0.78	0.80	0.85	0.91	1.15	1.05	1.14	1.08	1.10	1.19	1.32	0.88	0.92	1.26	1.54	1.51	1.61	1.51	1.52
3	0.83	0.65	0.69	0.72	0.72	0.85	0.91	0.78	0.80	0.80	0.89	0.84	0.96	1.13	1.31	1.43	1.47	1.45	1.51
4	0.82	0.77	0.73	0.69	0.82	0.90	0.83	0.80	0.73	0.78	0.71	0.78	0.98	1.46	1.80	2.15	2.21	2.00	1.91
5	0.72	0.73	0.74	0.76	0.70	0.75	0.70	0.82	0.81	0.85	0.94	1.25	1.29	1.34	1.39	1.47	1.42	1.50	1.47
6	0.76	0.73	0.68	0.63	0.74	0.78	0.74	0.72	0.83	1.14	1.19	1.09	0.96	1.15	1.33	1.26	1.43	1.51	1.47
7	0.87	0.80	0.83	0.86	0.88	0.76	0.75	0.84	0.84	0.90	1.03	0.92	0.80	1.02	1.30	1.22	1.29	1.30	1.54
8	0.99	0.93	0.94	0.95	1.01	1.06	1.12	1.04	1.03	0.95	0.80	0.81	1.47	1.49	1.52	1.42	1.46	1.57	1.53
9	0.74	0.71	0.70	0.69	0.72	0.73	1.25	1.00	0.75	1.16	0.76	0.65	0.83	1.02	1.26	1.66	1.76	1.69	1.82
High-Tech	0.85	0.82	0.81	0.82	0.86	0.88	0.95	0.89	0.88	0.92	0.95	0.93	1.06	1.24	1.41	1.45	1.49	1.48	1.54
10	0.77	0.71	0.81	0.91	0.85	0.82	0.85	0.82	0.75	0.79	0.79	0.73	0.93	1.12	1.32	1.28	1.39	1.49	1.58
11	0.49	0.47	0.46	0.44	0.43	0.45	0.49	0.46	0.49	0.51	0.61	0.57	0.74	0.96	1.13	1.07	1.04	1.00	1.43
12	0.48	0.49	0.51	0.52	0.51	0.50	0.52	0.51	0.53	0.50	0.62	0.57	0.68	0.82	0.97	1.09	1.14	1.17	1.20
13	0.61	0.60	0.61	0.61	0.68	0.69	0.75	0.73	0.74	0.75	0.81	0.79	0.89	1.07	1.27	1.39	1.39	1.60	1.62
14	0.86	0.98	0.91	0.85	0.88	0.81	0.72	0.67	0.72	0.71	0.80	0.74	1.01	1.12	1.23	1.43	1.46	2.01	2.05
15	0.75	0.76	0.80	0.83	0.86	0.84	0.82	0.79	0.79	0.80	0.86	0.87	1.06	1.21	1.37	1.48	1.60	1.61	1.69
16	0.70	0.72	0.75	0.77	0.72	0.74	0.91	0.84	0.78	0.81	0.80	0.80	0.83	1.11	1.38	1.35	1.38	1.35	1.42
17	0.63	0.62	0.66	0.70	0.62	0.64	0.70	0.64	0.64	0.65	0.77	0.68	0.77	0.96	1.19	1.43	1.26	1.65	1.39
18	0.62	0.62	0.58	0.54	0.55	0.61	0.62	0.55	0.58	0.62	0.72	0.68	0.75	0.93	1.13	1.17	1.28	1.36	1.39
19	1.27	0.99	1.20	1.31	1.34	1.28	0.99	0.91	0.82	0.83	1.06	1.10	1.39	1.49	1.58	1.95	2.14	2.04	2.22
20	0.60	0.58	0.56	0.54	0.52	0.52	0.51	0.48	0.48	0.49	0.64	0.63	0.73	0.92	1.12	1.22	1.27	1.31	1.35
Low-Tech	0.61	0.59	0.59	0.60	0.59	0.60	0.62	0.59	0.59	0.61	0.69	0.66	0.82	1.01	1.19	1.21	1.25	1.31	1.49
Aggregate	0.64	0.62	0.62	0.63	0.63	0.64	0.66	0.63	0.64	0.66	0.74	0.71	0.86	1.05	1.23	1.25	1.29	1.34	1.50

Sectors: 1 - chemicals, ex. pharm.; 2 - electrical mach.; 3 - machinery & equip.; 4 - medical & opt. inst.; 5 - motor vehicles; 6 - office, account. & comp.; 7 - pharmaceuticals; 8 - radio, tv & com.; 9 - railroad equip. & trans.; 10 - food, bev. & tobacco; 11 - text., leather & foot.; 12 - wood & cork; 13 - pulp, paper, print.; 14 - rubber and plast. prod.; 15 - other non-met. min. prod.; 16 - iron and steel; 17 - non-ferrous metals; 18 - fab. metal prod., ex. mach.; 19 - build & rep. of ships; 20 - manufacturing nec.