Employment and exchange rates: the role of openness and technology*

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Abstract

The declining share of jobs in manufacturing, namely in low technology sectors, has been a main feature of the labour markets of industrialized countries, in the last decades. In this paper we investigate the role of trade openness and technology level on the impact of real exchange rate movements in manufacturing employment. We find that, whereas employment in high-technology sectors seems to be relatively immune to changes in real exchange rates, these appear to have sizable and significant effects on highly open low-technology sectors.

Keywords: exchange rates, international trade, job flows, EMU

JEL-codes: F15, F16, F41

1 Introduction

In recent decades, employment in manufacturing has been declining in developed countries – between 1988 and 2006 it decreased by approximately 40% and 20% in the UK and in the US, respectively. In 2006, manufacturing employment represented approximately 10% of the workforce in those countries. Skill-biased technological change – see, for example, Bound and Johnson (1992) or Machin and Van Reenen (1998) – and globalization – see, for example, Wood (1994, 1998) – have been the leading explanations for

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the observed decline in manufacturing employment and, in particular, for the decrease in the demand for unskilled relative to skilled workers. Analyses of the impact on manufacturing of reduction in trade barriers in recent years suggest that competition from emerging countries exports, namely of China and India, have had a negative impact on manufacturing employment – see, for example, Bernard et al (2006).[1]

Another strand of the literature has been focusing on the impact of movements in real exchange rates on manufacturing labour markets. Economic theory suggests that changes in real exchange rates may have an impact on the reallocation of resources between sectors of the economy as they reflect changes in relative prices of domestic and foreign goods.[2] The reallocation effects of exchange rate movements should be stronger the higher the openness degree of the economy or of the industry. The relevance of openness to the effect of exchange rates on economic activity has been explored by several authors – see, for example, Klein et al (2003) or Gourinchas (1998). The conclusion of these studies is that trading sectors and, in particular, sectors more exposed to international competition are more affected by exchange rate movements.

Branson and Love (1988), using data for the 70s and 80s for the US, were among the first to conclude that real exchange rate movements had a strong impact on manufacturing sectors employment. Namely, they found that the appreciation of the dollar in the first half of the 80s had a strong negative effect on employment. A similar result was found by Revenga (1992), for the period 1977-1987, who concluded that real exchange rates movements had sizable effects on employment and a smaller, but significant, effect on US manufacturing wages. Burgess and Knetter (1998) evaluate the impact of real exchange rate movements on employment at the industry level for the G-7 countries and show that real appreciations are associated with declines in manufacturing employment in most cases. In particular, these authors conclude that employment growth in the US, UK, Canada and Italy is more sensitive to exchange rates than Germany, Japan and France. In the same vein, Gourinchas (1999) and Klein et al (2003) found that real exchange rates have a significant impact on job reallocation.

Recent advances in international trade theory, following Melitz (2003), have been focusing on the relation between international trade, or trade liberalisation, and productivity. Namely, these authors have concluded that firms' reaction to international competition differs sharply across different levels of productivity. A recent work by Berman et al (2009) looks at the implications of the new literature on trade and their implications for the adjustment of export firms to exchange rate movements and conclude that

[1] Auer and Fischer (2008), in a related paper, conclude that trade with low-income countries have had a significant impact on U.S. industry productivity and prices.

[2] Feenstra (1989), for example, shows that exchange rate movements and changes in tariffs produce similar effects on firms' international competition.

heterogeneity in productivity across firms implies different responses to exchange rate movements. According to their conclusions high productivity firms use their markups to adjust for exchange rate shocks; on the other hand, low productivity firms adjust to exchange rate movements by changing quantities. Given that high productivity firms (and sectors) are also more exposed to international competition it is not clear-cut which sectors are expected to be more affected by exchange rate movements.

In this paper, we use sector-level data for Portugal to shed light on the role of openness and technology in the impact of exchange rate movements on employment growth. The evolution of the Portuguese economy in recent decades has made it an important case study for countries contemplating accession to the European Union and the euro area (see section 3). We focus our analysis of the Portuguese case on the effect of real exchange rate movements on 20 manufacturing sectors, for the period 1988-2006. In that period, manufacturing employment decreased by 16% accompanying the international trends described above. Low and medium-low technology sectors (according to the OECD technology classification), in 2006, still represented over 80% of manufacturing employment, and accounted for more than 50% of total exports. The degree of openness has increased for all technology sectors and is higher for higher levels of technology. In the same period, the real effective exchange rate appreciated by more than 20%. The timing of those changes suggests that the Portuguese experience may improve the understanding of the role of differences in trade openness and technology level across sectors in the effects of exchange rate movements on economic activity.

In the 80s, Portuguese exports based their competitiveness on nominal exchange rate devaluations: between 1980 and 1987 the nominal exchange rate was devalued by over 60%. The decision to join the European Exchange Rate Mechanism placed severe restrictions on nominal exchange rate movements and resulted in a strong real exchange rate appreciation. The impact of this change in exchange rate behaviour, namely, the end of competitive nominal devaluations, should have had differentiated effects across sectors. Bugamelli, Schivardi and Zizza (2008) use cross-country (and cross-sector analysis and firm-level analysis for Italy) to test whether the euro has had differentiated effects across countries and sectors. According to those authors countries specialized in low-skill sectors, that is, southern European economies, like Italy, Greece and Portugal, should have been the most affected by the euro. Overall, their results suggest that the impact of changes in exchange rate behaviour had a significant impact on intra-sectoral restructuring, enhancing productivity growth. In our analysis, we focus on the effects on employment growth and job flows. We evaluate the role of the technology level and of the degree of exposure to international competition in employment adjustment following changes in the exchange rate. Foreshadowing our conclusions, our estimates suggest that exchange rates movements have a larger impact on very open and low technology industries. On the other hand, our estimates seem to indicate that open economies specialised in high technology sectors are more isolated from disturbances in exchange rates. These results suggest that the evaluation of the benefits from joining an economic and monetary union should take into consideration the degree of openness to trade and the technological composition of manufacturing sectors.

The remainder of the paper is organized as follows. Section 2 discusses the relation between openness and technology level and its implications for the impact of exchange rate movements on employment. The exchange rate elasticity of employment is deduced as a function of productivity. Section 3 describes the data for trade, employment and exchange rates used in the estimation of the empirical models. Section 4 estimates a set of models in first-differences to evaluate the role of openness and technology in the determination of the impact of real exchange rates on employment. Section 5 concludes.

2 Employment and exchange rates

There have been several approaches to modelling the impact of exchange rate movements on firms' decisions concerning quantities and prices. Real exchange rate movements reflect changes in relative prices of domestic and foreign goods. These changes affect firms' international competitiveness and may result in a reallocation of resources, namely, of workers. For example, a real exchange rate appreciation, by decreasing foreign prices denominated in domestic currency, implies a decrease in the competitiveness of domestic firms which may affect profit margins, investment decisions, and hiring and firing decisions – see, for example, Campa and Goldberg (2001). However, these effects are expected to be more acute for exporting and import-competing firms. Sectors more exposed to international competition, that is, sectors with higher trade openness, should be more affected by changes in exchange rates. These channels are emphasized by Klein et al. (2003), who estimate a model for job flows where the impact of exchange rate movements depend positively on the degree of openness.

Recent advances in international trade theory, namely the work by Melitz (2003), have led Berman et al (2009) to suggest an alternative mechanism. Berman et al (2009) highlight the role of productivity, i.e., they show that high and low performance (measured in terms of productivity or value added per worker) firms react very differently to exchange rate depreciations, that is, heterogeneity in productivity across firms results in differentiated responses to exchange rate depreciations. According to their theoretical and empirical results, high performance firms raise their markup instead of exported quantities when there is an exchange rate depreciation, whereas low performance firms follow the opposite strategy.

We follow the modelling of Berman et al. (2009), which is a variant of the model proposed by Melitz (2003), to derive the exchange rate elasticity of employment as a function of productivity. We show that both productivity and competition affect the reaction of employment to exchange rate movements, which we assume to be exogenous.[3] The representative consumer is assumed to have the usual Dixit-Stiglitz utility function, with elasticity of substitution between two differentiated goods given by σ:

$$U\left(C_i\right)\left[\int_X x\left(\varphi\right)^{1-1/\sigma}d\varphi\right]^{\frac{1}{1-1/\sigma}} \tag{1}$$

where $x\left(\varphi\right)$ is consumption of variety φ. φ will also represent productivity in the production function of variety φ, i.e., $1/\varphi$ stands for the units of labour necessary for producing the good. This utility function implies the following demand for good φ in country i:

$$x_i(\varphi) = Y_i P_i^{\sigma-1}[p_i^c(\varphi)]^{-\sigma} \tag{2}$$

where Y_i is the income of country i and P_i is the price index in country i. Berman et al (2009) main innovation is the introduction of distribution costs. These distribution costs affect the price charged in destination countries, which is assumed to be given by:

$$p_i^c(\varphi) = \frac{p_i(\varphi)}{\varepsilon_i} + \eta_i w_i \tag{3}$$

In the formula above, $p_i^c(\varphi)$ is the consumer price, in foreign currency, of a variety φ exported to country i, $p_i(\varphi)$ is the producer price of the good exported to i expressed in domestic currency, ε_i is the nominal exchange rate between the home country and country i expressed as the price of foreign currency in terms of home's currency, w_i is the wage in country i, and η_i is the distribution cost in units of labour in country i per unit consumed in that country.

The production cost of good φ is assumed to be:

$$c_i(\varphi) = \frac{w x_i(\varphi)}{\varphi} + F_i(\varphi) \tag{4}$$

where w is the wage in the home country and $F_i(\varphi)$ is the fixed cost of exporting to country i, assumed to depend also on productivity.

Applying Shephard's lemma, the demand for labour is:

[3] Our model is not a general equilibrium model of the type presented in Corsetti and Dedola (2007) where exchange rates movements result from monetary and productivity shocks.

$$L_i(\varphi) = \frac{\partial c_i(\varphi)}{\partial w} = \frac{x_i(\varphi)}{\varphi} \tag{5}$$

From this we can deduce the elasticity of labour demand with respect to the exchange rate:

$$\frac{\partial L_i(\varphi)}{\partial q_i}\frac{q_i}{L_i(\varphi)} = \sigma\frac{1}{1+\eta_i q_i \varphi} \tag{6}$$

where the real exchange rate is $q_i = \varepsilon_i w_i / w$. Similarly to what Berman et al. (2009) conclude in the case of output, a higher productivity decreases the sensitivity of labour demand to the exchange rate. Since high-technology sectors are more productive than low-technology sectors, we expect high-technology sectors to be less sensitive to exchange rate movements. However, this result hinges on the inclusion of distribution costs. In the absence of these costs, the elasticity of labour demand with respect to the exchange rate would be σ (the elasticity of substitution between varieties). In fact, this is the result Klein et al (2003), who do not model distribution costs, reach.

However, Klein et al (2003) assume that σ is an increasing function of openness. This may be justified on the ground that a higher degree of openness means that consumers may substitute more easily by goods produced elsewhere. In Klein et al (2003) model, therefore, the impact of the exchange rate on employment depends on the degree of openness. These alternative views suggest that we estimate a model in which both the degree of openness and the technology level mediate the impact of exchange rate movements on labour markets developments.

Using data for the Portuguese economy, for the period 1988-2006, we evaluate the relevance of trade openness and technology level on the impact of the exchange rate on labour markets. In the next section we present sectoral data on openness, technology, productivity and exchange rates. These data show that high-technology sectors are also the most open and productive, two characteristics that, according to the models discussed above, push the impact of exchange rate movements in different directions. Therefore, our empirical study will investigate Klein et al. (2003) view that openness is the main indicator of exchange rate movements' impact on employment, and Berman et al. (2009) alternative hypothesis that productivity is the key variable. In our analysis we use the OECD technology classification to distinguish between high- and low-productivity sectors.

3 Employment, trade, technology and exchange rates: the Portuguese experience

Portugal has seen a dramatic change in its economy in the course of the last three decades. Since the early 1980s the Portuguese economy has fought a two-digit inflation in the early 1980s, has asked for two IMF-led rescue operations due to external imbalances, has gained accession to the EEC and to the euro area. The Portuguese performance during the first years of the European Union was widely seen as evidence of the positive impact that integration may have on a small open economy. However, the performance in recent years has been dismal and has been singled out as an example of what aspiring European Union/euro area members should not do. Therefore, it seems of wide interest to understand the evolution of the Portuguese economy.

As a first step to that end, this section describes the recent trends in Portuguese external trade and manufacturing employment and technology. We begin by noting that in the last two decades, Portuguese international trade patterns changed significantly, both in terms of export destinations and of import origins. These changes convey relevant information on structural changes in the economy and have implications for the behaviour of exchange rate indexes. The behaviour of aggregate and sector specific exchange rate indexes in the period will be described in section 3.1. The behaviour of the exchange rate will be contrasted with that of manufacturing employment. In section 3.2, we will describe briefly the main trends in Portuguese international trade, between 1988 and 2006. In both sections, the discussion will highlight the evolution of the technology level of exports and imports.

Data on Portuguese international trade comes from OECD STAN bilateral trade database.[4] We focus on 20 manufacturing sectors, as they are more exposed to foreign trade. The sectors were selected to match the International Standard Industrial Classification of all economic activities, Revision 3 (ISIC Rev. 3) – for the list of sectors see, for example, Table 9 in the Appendix. Data on employment comes from the "Quadros de Pessoal" dataset provided by the Portuguese Ministry of Labour and Social Solidarity. 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 43% of total employment. In 2006, it included 344,024 firms and 3,099,513 workers, covering 55% of total employment.

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

3.1 Employment and exchange rates

The Portuguese manufacturing labour force followed the declining trend described above for industrialized countries: in 2006, manufacturing sectors accounted for 13.3% of Portuguese labour force, down from 19.3% in 1988. Over this period, total employment in these sectors declined 16%, representing almost 150 000 jobs.[5] This reduction of manufacturing sectors' share in the labour force partly reflects the deindustrialization trend, mentioned above, that has affected advanced countries since the 1980s. However, it is also important to analyse sectoral trends. Table 9 in the Appendix shows the evolution of employment in the 20 manufacturing sectors and by OECD level of technology. The main facts in Table 9 are captured by Figure 1 that shows the evolution of employment shares by OECD level of technology. 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. In this period, these sectors lost over 150 000 jobs, i.e., these sectors 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. 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. Table 9 in the Appendix presents the sectors' rank in terms of employment.

One possible explanation in the literature for the trends described above is movements in exchange rates – see, for example, Campa and Goldberg (2001) and Gourinchas (1999). In section 4 we investigate whether this hypothesis holds for the Portuguese economy. In fact, the period under study (1988-2006) was characterized by an appreciation of the real effective exchange rate over 20% – see Figure 2.

The bulk of this 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%. The real aggregate exchange rate presented in Figure 2 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 (2009) provide a detailed description of

[5] However, the decrease in employment in manufacturing was accompanied by a 21% increase in the labour force.

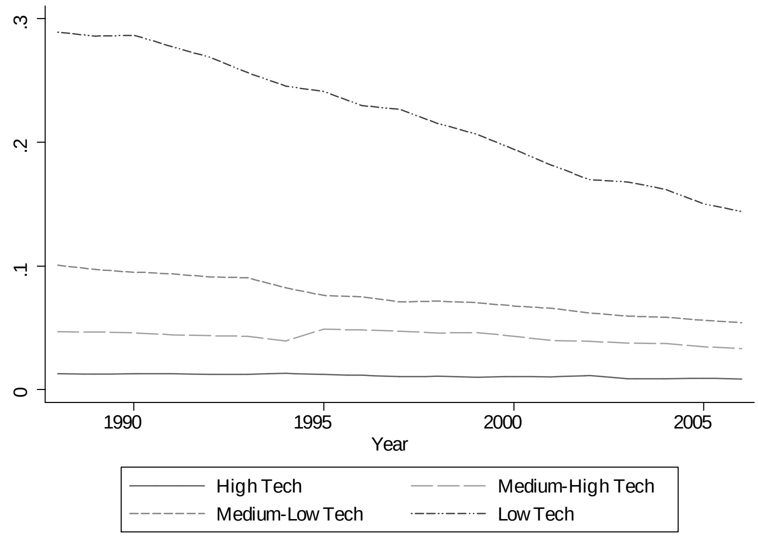

Figure 1: Share of employment by technology level

Figure 2: Real effective exchange rate

the computations for a set of alternative effective exchange rates indexes for the Portuguese economy in the period 1988-2006. The results in that paper suggest that the choice of bilateral weights does not make much difference. The set of countries included in exchange rate indexes originates more variation but produces similar trends. A more important issue is whether to use aggregate or sector-specific exchange rates.

When the importance of trading partners varies across sectors, sector-specific exchange rates may be more informative than aggregate exchange rate indexes as indicators of industries' competitiveness – see, for example, Goldberg (2004). Figure 3 presents sector-specific exchange rates for the six most important exporting sectors. Although they display very similar patterns between them and with the aggregate exchange rate, several authors have shown that sector-specific exchange rates are better explanatory variables of labour markets dynamics – see, for example, see, for example, Campa and Goldberg (2001) for the US and Gourinchas (1999) for France. Alexandre et al (2009) have reached the same conclusion for the Portuguese economy. Section 4 explores this matter further, taking the different behaviour of high- and low-technology sectors into account. Before that, the next section provides additional information on the characteristics of high- and low-technology sectors, especially concerning participation in international trade.

3.2 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 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). 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% (see Table 8 in the Appendix). The share of high technology sectors in

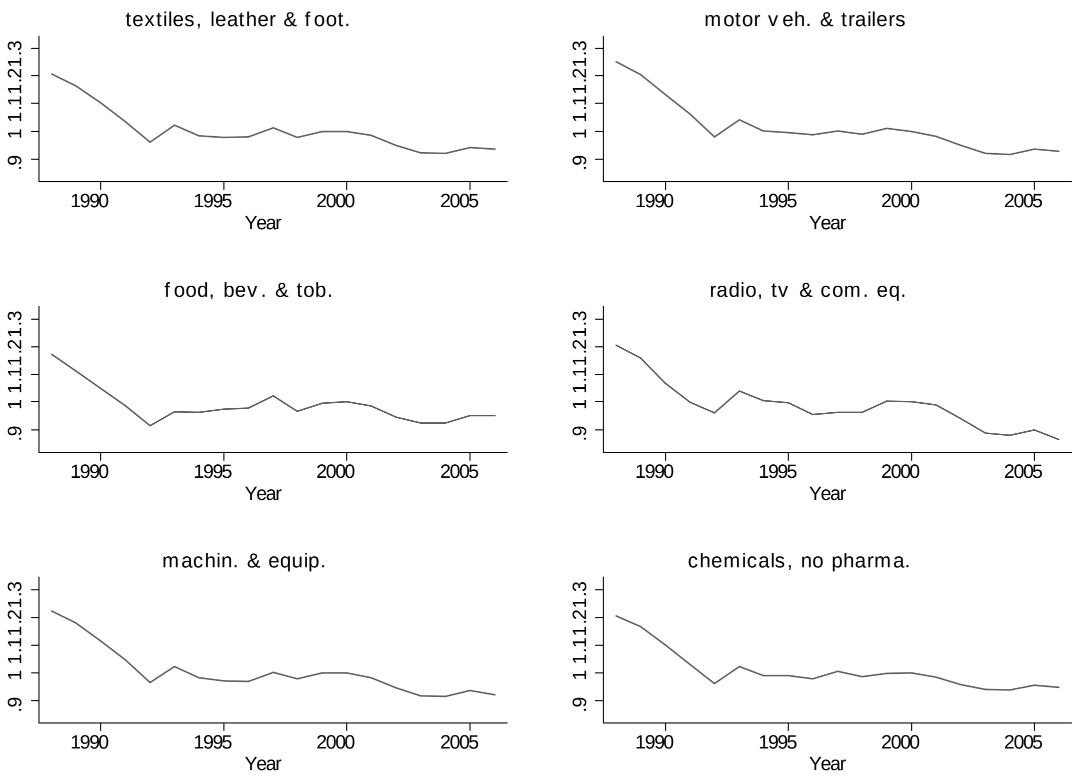

Figure 3: Sector-specific exchange rates

exports remained low by world standards, but similar to Greece and Spain (Amador et al 2007: Table 3, pp. 16).

The results presented in Table 1 show that the degree of openness increases with the level of technology.[6] Our openness measure is: $(X + M)/(GO + X + M)$, where X stands for exports, M stands for imports and GO stands for gross output. This may be decomposed as the sum of export share ($X/(GO + X + M)$) and import penetration rate ($M/(GO + X + M)$). From that decomposition we conclude that imports dominate the openness measure for higher technology sectors. However, the import penetration ratio has been diminishing in these higher technology sectors and increasing in lower technology sectors. Concerning the export share it should be noticed the decrease in low technology sectors and the increase in all other sectors.

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. The next section attempts to assess the role of the exchange rate in this evolution, making use of the framework presented in section 2.

Table 1: Trade shares, openness and penetration rates

	1988	2006	$\Delta p.p.$
Share in total exports (%)			
High-technologies 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-technologies 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-technologies 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

Continued on next page...

[6] Using data from the STAN bilateral trade database we concluded that this result holds for other industrialised countries such as France, Germany, Italy, Spain, UK and US.

... table 1 continued

	1988	2006	$\Delta p.p.$
Export share			
High-technologies manufactures	16,9	23,4	6,5
Medium-high technology manufactures	13,6	27,0	13,4
Medium-low technology manufactures	11,9	21,2	9,3
Low technology manufactures	24,2	22,4	-1,8
Import penetration rate			
High-technologies manufactures	52,3	51,0	-1,3
Medium-high technology manufactures	48,9	41,3	-7,6
Medium-low technology manufactures	21,7	25,4	3,7
Low technology manufactures	12,9	22,0	9,1
Productivity: annual sales per worker (10^3 euros)			$\Delta\%$
High-technologies manufactures	41,2	70,8	71,8
Medium-high technology manufactures	59,2	76,8	29,7
Medium-low technology manufactures	37,2	51,4	38,2
Low technology manufactures	40,5	49,6	22,5

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

4 Estimation and results

In order to disentangle the relevance of trade openness and productivity to the effects of exchange rate movements on employment, implied by equation (6), we implemented a three steps strategy. First, we estimate benchmark regressions, like those estimated in Campa and Goldberg (2001) and Klein et al (2003), among others, where we include only the exchange rate and its interaction with openness. In a second step we allow the technology level to affect the impact on employment of both the exchange rate and trade openness. Finally, we introduce additional flexibility by estimating the model separately for each technology level. Throughout the analysis we divide our sample in high technology sectors (high and medium-high technology level, according to OECD classification) and low technology sectors (low and medium-low technology level, according to OECD classification).

The base line specification for the econometric analysis is as follows:

$$
\begin{aligned}
\Delta y_{jt} &= \beta_0 + \beta_1 \Delta ExRate_{j,t-1} + \beta_2 \Delta ExRate_{j,t-1} \times Open_{j,t-1} \\
&\quad + \beta_{1L} \Delta ExRate_{j,t-1} \times Low_j + \beta_{2L} \Delta ExRate_{j,t-1} \times Open_{j,t-1} \times Low_j \\
&\quad + \beta_3 \Delta ShareImp_{j,t-1} + \beta_4 Open_{j,t-1} + \lambda_t + \theta_j + \varepsilon_{jt}, \qquad (7)
\end{aligned}
$$

where Δ denotes first-difference, j refers to sectors and t indexes years. The dependent variables y_{jt} may be either employment (measured as total workers or total hours), job creation, job destruction or gross reallocation (these three variables are defined at the sector level). $ExRate_{j,t-1}$ is the lagged real effective exchange rate for sector j, where bilateral exchange rates weights are given by total trade (exports plus imports) shares. This exchange rate is smoothed by the Hodrick-Prescott filter, which filters out the transitory component of the exchange rate. 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. An increase of the index is a depreciation of the currency.

As discussed above, the effects of exchange rates on employment should differ according to the degree of trade openness. Therefore, we include in equation (7) an interaction term for the exchange rate and trade openness, $Open_{j,t-1}$. Similarly, following the discussion of equation (6), we include the interaction of the exchange rate with a dummy variable indicating low technology sectors, Low_j. For additional flexibility of the model's functional form, we also extend this interaction to sectors' trade openness.

Recent studies have concluded that competition from emerging countries has had a significant impact on manufacturing sectors in industrialized countries – see, for example, Auer and Fischer (2008). The 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. Therefore, to account for competitors from emerging countries, we include in our regressions the variable $ShareImp_{j,t-1}$, which is the share of these countries in sector j OECD countries' imports.[7] [8]

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, and a set of sectoral dummies θ_j. Since we specify a model in first-differences, these dummies account for sector-specific trends. Finally, ε_{jt} is a white noise error term. All variables

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

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

are in real terms. The model is estimated by OLS, with robust standard errors allowing for within sectoral correlation.[9]

4.1 Results: exchange rates and employment

Tables 2 and 3 summarize the results for the model specified in equation (7), using employment and hours as dependent variables. The first two columns of Table 2 show the results for the effect of real exchange rates using the benchmark regression, ALL. Columns (3) and (4), under FULL, extend this specification by including the level of technology. The next two sets of regressions, columns (5) and (6), and columns (7) and (8), respectively, implement the estimation of the model for the high-technology sectors, HighTech, and low-technology sectors, LowTech. Even-numbered columns include sectoral dummies.

In the top panel of Table 2 we show the estimated coefficients and their standard errors. In order to assess the roles of openness and technology in the sensitivity of employment to exchange rate movements we compute exchange rate elasticities of employment for different degrees of trade openness. In our analysis we consider a low, a median and a high degree of openness. We measure these as three percentiles of the degree of openness: 10, 50 and 90.

Looking at the benchmark regressions (ALL), which do not control for the technology level, we observe that the interaction term for the exchange 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.[10]

Computing the elasticities at different openness percentiles, its magnitude does increase going from 0.4 to 2.1 (column 2). However, these estimated elasticities are not statistically different from zero. This suggests that, in our sample, using the benchmark model, exchange rate movements do not impact on employment.

Nevertheless, the benchmark model ignores Berman et al (2009) view that productivity influences the exchange rate elasticity of employment. It is to this alternative that we now turn. Specification FULL (columns 3 and 4 in Table 2) introduces the dummy variable Low in the model via to additional interactions: (i) $\beta_{1L}\Delta ExRate_{j,t-1} \times Low_j \beta_{2L}$; (ii) $\Delta ExRate_{j,t-1} \times Open_{j,t-1} \times Low_j$. These interactions aim at evaluating the importance of trade openness and technology level on the impact of exchange rate movements on employment. Our results, shown in columns (3) and (4), FULL, indicate that for a high degree of openness, percentile 90, employment in high-technology sectors does not

[9] Since we use time dummies to account for aggregate shocks, our identification strategy relies mainly on the inclusion of the sector real effective exchange rates. Other sources of heterogeneity are variations in overall level of trade exposure $Open_{j,t-1}$.

[10] Klein et al (2003) measure industry openness using a five-year moving average of the ratio of total trade to total market sales.

seem to be sensitive to exchange rate movements (the estimated elasticity is 1.5, but not statistically different from zero). However, for low-technology sectors a 1% depreciation of the exchange rate is associated with a 4.8% increase in employment. Moreover, the F-statistic of 5.4 indicates that exchange rate elasticities is different for low- and high-technology sectors. Even though the sign and the magnitude of the elasticities are as expected when the specification includes sectoral dummies – column (4) –, its statistical significance does not hold.

This result seems to support the implications of equation (6), that is, that the level of technology plays a role on the effect of exchange rate movements on labour market adjustments, and motivates further estimations. Namely, we separate the sample between low- and high-technology sectors for the estimation of equation (7). What stands out in columns (5) and (6), HighTech – high-technology sectors –, is the negative exchange rate elasticity of employment 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.[11]

Proceeding to columns (7) and (8), LowTech – low-technology industries –, we find that a depreciation affects positively employment growth, and that this effect is higher the higher the degree of openness. As we focus our attention on low-technology sectors with a higher degree of exposure to external innovations, the impact of the exchange rate movements on employment growth becomes clear-cut in terms of economic and statistical significance. Sectors with a high openness degree, that is, in percentile 90, present an exchange rate elasticity of employment of 4.9: a 1% depreciation induces a 4.9% increase low-technology sectors' employment. This estimated elasticity is larger than those reported in the literature for other countries, namely for the US (Revenga, 1992, Campa and Goldberg, 2001) and France (Gourinchas, 1998). The fact that Portugal is a smaller and more open economy may help explain the larger impact of exchange rates on employment in Portugal.

The specification of our regressions controls for the impact of emerging countries competition on domestic employment. The coefficients estimated for the share of emerging countries in sector j OECD countries' imports show that this competition has had a negative and statistically significant impact on employment growth. The statistical sig-

[11] 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).

nificance of this effect is independent of the technology level. However, the impact of the competition of emerging countries' imports seems to be higher for high-technology sectors (HighTech regressions in Table 2). For example, from the analysis of column (8) we conclude that for low-technology sectors a 1 percentage point increase in the share of emerging countries decreases employment by 1.4%.

As a further test, we estimated equation (7) using hours as the dependent variable instead of employment. Table 3 shows the results and follows the layout of Table 2.[12] The figures presented in Table 3 reinforces the results found in the estimates for employment growth (Table 2). The estimates for the FULL specification (which uses the dummy variable *Low* to distinguish high- and low-technology sectors) continue to point to a different impact of exchange rate movements on hours worked according to technology level. For high-technology sectors (see HighTech columns) the exchange rate elasticity of hours is not statistically significant. On the contrary, and most noticeable, hours worked in low-technology sectors are sensitive to exchange rate movements and this sensitivity increases with the degree of openness. In particular, a 1% exchange rate depreciation is associated with a 6.2% increase in the number of hours worked.

Again, the empirical results suggest that both the degree of openness and the technology level mediate the impact of exchange rate movements on employment growth. In particular, we find robust evidence that exchange rate movements affect employment growth in low-technology sectors more than in high-technology sectors and that this effect increases with the degree of openness.

[12] Data for hours is not available for 1990 and 2001.

Table 2: Employment: OLS regressions in first-differences

Model	ALL		FULL		HighTech		LowTech	
$\Delta LogExRate_{t-1}$	-.655	-.486	.010	-3.135	-8.310***	-7.632**	-.217	-.045
	(1.376)	(1.505)	(1.910)	(2.605)	(2.903)	(3.127)	(.916)	(.997)
$\Delta LogExRate_{t-1} * Low$			-2.202	1.652				
			(1.544)	(2.117)				
$\Delta LogExRate_{t-1} * Open$	2.666**	3.665**	2.089	6.929**	8.519***	8.380***	8.210***	7.066**
	(1.195)	(1.545)	(2.290)	(2.789)	(2.789)	(2.935)	(2.508)	(2.899)
$\Delta LogExRate_{t-1} * Open * Low$			7.827**	.454				
			(3.580)	(4.351)				
$\Delta ShareImp_{t-1}$	-1.398***	-1.811***	-1.527***	-1.843***	-2.445**	-2.701*	-1.157**	-1.425***
	(.403)	(.567)	(.455)	(.594)	(1.036)	(1.552)	(.485)	(.525)
$Open_{t-1}$	.101***	.211	.104***	.269*	.336***	.309*	.046*	.162
	(.037)	(.149)	(.036)	(.140)	(.065)	(.169)	(.025)	(.209)
Sectoral dummies	no	yes	no	yes	no	yes	no	yes
	Exchange Rate Employment Elasticities							
	Percentile 10							
ExRate Elasticity	.004	.419						
HighTech Elasticity			.526	-1.423	-6.205**	-5.562*		
LowTech Elasticity			.258	.341			1.812	1.700
F-test: equal elasticities			.089	1.850				
	Percentile 50							
ExRate Elasticity	.622	1.268						
HighTech Elasticity			1.010	.183	-4.231*	-3.620		

Continued on next page...

... table 2 continued

Model	ALL		FULL		HighTech		LowTech	
LowTech Elasticity			2.555	2.052			3.714*	3.338
F-test: equal elasticities			3.145*	3.017*				
				Percentile 90				
ExRate Elasticity	1.215	2.084						
HighTech Elasticity			1.475	1.725	-2.334	-1.754		
LowTech Elasticity			4.763**	3.695			5.542**	4.911*
F-test: equal elasticities			5.388**	1.511				
Observations	360	360	360	360	162	162	198	198
R^2	.124	.177	.14	.186	.22	.23	.252	.32
RMSE	.103	.103	.103	.103	.125	.128	.074	.073

Notes: Significance levels: $*$: 10% $**$: 5% $***$: 1%. The dependent variable in each model is the difference in the log of the variable identified in each section of the Table. All regressions are estimated by OLS, and include time dummies. RMSE is root mean squared error. The exchange rate is the average import/export exchange rate.

Table 3: Hours: OLS regressions in first-differences

Model	ALL		FULL		HighTech		LowTech	
$\Delta LogExRate_{t-1}$	1.589	1.816	3.531	.038	-1.748	-.267	1.156	1.487*
	(.975)	(1.115)	(2.375)	(3.000)	(3.076)	(3.135)	(.995)	(.890)
$\Delta LogExRate_{t-1} * Low$			-4.823*	-.030				
			(2.730)	(3.317)				
$\Delta LogExRate_{t-1} * Open$	-.297	-.132	-2.999	1.700	4.532	.377	6.855*	6.735*
	(1.563)	(1.916)	(3.791)	(4.062)	(4.437)	(4.843)	(3.797)	(3.531)
$\Delta LogExRate_{t-1} * Open * Low$			14.669**	4.735				
			(5.963)	(7.241)				
$\Delta ShareImp_{t-1}$	-.237	-.852***	-.401	-.879**	-.591	-1.505**	-.888***	-.846**
	(.489)	(.319)	(.426)	(.392)	(.823)	(.692)	(.263)	(.353)
$Open_{t-1}$	.043	-.132	.045	-.128	.240***	-.206	-.076**	.162
	(.043)	(.128)	(.041)	(.167)	(.082)	(.200)	(.037)	(.235)
Sectoral dummies	no	yes	no	yes	no	yes	no	yes
	Exchange Rate Hours Elasticities							
	Percentile 10							
ExRate Elasticity	1.516	1.783						
HighTech Elasticity			2.790*	.458	-.628	-.174		
LowTech Elasticity			1.592**	1.598			2.850*	3.151*
F-test: equal elasticities			.732	.499				
	Percentile 50							
ExRate Elasticity	1.447	1.753						
HighTech Elasticity			2.095**	.852	.422	-.087		

Continued on next page...

... table 3 continued

Model	ALL		FULL		HighTech		LowTech	
LowTech Elasticity			4.296***	3.089			4.439*	4.712*
F-test: equal elasticities			6.372**	9.189***				
				Percentile 90				
ExRate Elasticity	1.381	1.723						
HighTech Elasticity			1.427*	1.231	1.431	-.003		
LowTech Elasticity			6.894***	4.522			5.965*	6.212*
F-test: equal elasticities			9.331***	2.798				
Observations	280	280	280	280	126	126	154	154
R^2	.117	.205	.15	.214	.222	.274	.335	.377
RMSE	.101	.099	.099	.099	.117	.118	.072	.073

Notes: Significance levels: $*$: 10% $**$: 5% $***$: 1%. The dependent variable in each model is the difference in the log of the variable identified in each section of the Table. All regressions are estimated by OLS, and include time dummies. RMSE is root mean squared error. The exchange rate is the average import/export exchange rate.

4.2 Results: exchange rates and job flows

In this section, we evaluate the impact of exchange rate movements on job creation, job destruction and job reallocation. The analysis of job flows may contribute to a better understanding of the role of openness and technology level on the effect of exchange rate movements on employment growth. Indeed, gross creation and destruction flows are usually one order of magnitude higher that net ones: the same net variation in jobs might be in principle generated by different combination of creation and destruction with diverse welfare implications. As summarized by Klein, Schuh and Triest (2003b), labor adjustment costs arise with hiring and firing costs, particularly training, in case of job creation, and loss of firm-specific human capital, in case of job destruction. Therefore, measures of job creation and destruction provide additional information on the dynamics of labour markets. (Davis, Haltiwanger and Schuh, 1996).

The rate of job creation in sector j, in year t, C_{jt}, and the rate of job destruction, D_{jt}, are defined as

$$C_{jt} = \frac{\sum_{i \in j^+} \Delta E_{it}}{\frac{1}{2}\left(E_{j,t-1} + E_{j,t}\right)} \tag{8}$$

and

$$D_{jt} = \frac{\sum_{i \in j^-} \mid \Delta E_{it} \mid}{\frac{1}{2}\left(E_{j,t-1} + E_{j,t}\right)} \tag{9}$$

where j^+ is the set of firms of sector j for which $\Delta E_{it} > 0$, j^- is the set of firms of sector j for which $\Delta E_{it} < 0$ and $E_{j,t}$ is sector j employment level at year t. Job reallocation is given by the sum of job creation and job destruction rates: $R_{jt} = C_{jt} + D_{jt}$.

Table 10 in the Appendix presents annual averages rates of job creation, destruction and reallocation for 20 manufacturing sectors, for OECD technology level sectors and for total sectors in "Quadros de Pessoal". The numbers in Table 10 in the Appendix show that annual job reallocation for the period 1988-2006 was around 21% for manufacturing sectors and 31% for the whole economy. These job flows values are very large but nevertheless comparable to international evidence on labour market dynamics – see, for example, Haltiwanger, Scarpeta and Schweiger (2006). Job flows in high and medium-high technological level sectors are slightly higher than in low and medium-low technology level sectors. Annual average job reallocation rates in high and medium-high technology level sectors were 25.7% and 23.1%, respectively, against 20.4% and 20.2% in low and medium-low technology level sectors. These differences result from both higher job creation and higher job destruction rates.[13]

In this section we estimate equation (7) using as dependent variables C_{jt}, D_{jt}, and R_{jt} as defined above. Tables 4, 5 and 6 present the results for the creation rate, the destruction rate and the reallocation rate, respectively. As for the creation rate, it should be noticed the negative exchange rate elasticity of job creation for high technology sectors. This result may be related to the negative elasticity of employment found in previous set of regressions (see HighTech columns in Table 2), which may be related to the impact of exchange rate movements on the price of imported inputs.

As for the destruction rate (Table 5), the noticeable result is the negative effect that a depreciation has on employment destruction for very open (percentile 90) low-technology sectors: a 1% depreciation decreases employment destruction by 3.8%. This result reinforces the findings in previous estimates: exchange rate movements appear to have a higher impact on highly open low-technology sectors and this effect seems to occur through employment destruction. Job destruction in high-technology sectors seems to be immune to exchange rate movements. The inclusion of sectoral dummies makes the exchange rate elasticity for job destruction statistically insignificant, but does not change the sign, nor the economic significance, of the estimated elasticities.

The asymmetry of responsiveness of job creation and job destruction to exchange rates variation is consistent with the idea that costs associated with firm size reductions might be smaller than the ones related with firm growth. This asymmetry may have welfare implications as decreases in job creation and increases in job destruction may carry very different costs for firms and workers. For example, in low-technology sectors, older and less skilled workers are more likely to be dismissed in the process of job destruction. This is an issue that deserves further research.

Finally, Table 6 shows the results for the reallocation rate. The main result is the possibility that a depreciation may produce a 'chill' effect in the labour market, i.e., a reduction in job creation and destruction, and thus in job reallocation (see, e.g., Gourinchas, 1999). Namely, this may occur in the case of high-technology sectors with lower degrees of openness.

[13] Centeno, Machado and Novo (2007) present a description of job creation and destruction for Portugal.

Table 4: Job Creation: OLS regressions in first-differences

Model	ALL		FULL		HighTech		LowTech	
$\Delta LogExRate_{t-1}$	-1.300	-1.204	-.188	-3.677	-9.778***	-8.703**	.384	.598
	(1.383)	(1.591)	(2.121)	(2.729)	(3.031)	(3.435)	(.625)	(.555)
$\Delta LogExRate_{t-1} * Low$			-1.640	2.653				
			(1.386)	(1.824)				
$\Delta LogExRate_{t-1} * Open$	1.435	2.122	.008	5.378*	9.364***	8.470***	.540	.534
	(2.046)	(1.699)	(3.182)	(3.135)	(2.944)	(2.558)	(1.802)	(1.673)
$\Delta LogExRate_{t-1} * Open * Low$			3.569	-4.220				
			(2.803)	(3.731)				
$\Delta ShareImp_{t-1}$	.015	-.540*	-.041	-.512	-.672	-1.713***	.089	-.091
	(.334)	(.328)	(.330)	(.338)	(.718)	(.446)	(.212)	(.238)
$Open_{t-1}$	.052	.134	.053	.194**	.373***	.335***	-.048*	-.004
	(.059)	(.098)	(.059)	(.099)	(.074)	(.083)	(.026)	(.054)
Sectoral dummies	no	yes	no	yes	no	yes	no	yes
	Exchange Rate Job Creation Elasticities							
	Percentile 10							
ExRate Elasticity	-.946	-.680						
HighTech Elasticity			-.186	-2.348	-7.464**	-6.610*		
LowTech Elasticity			-.944	-.737			.517	.729
F-test: equal elasticities			.951	2.736				
	Percentile 50							
ExRate Elasticity	-.613	-.189						
HighTech Elasticity			-.184	-1.101	-5.295**	-4.647		

Continued on next page...

... table 4 continued

Model	ALL		FULL		HighTech		LowTech	
LowTech Elasticity			-.115	-.469			.642	.853
F-test: equal elasticities			.020	1.540				
				Percentile 90				
ExRate Elasticity	-.293	.284						
HighTech Elasticity			-.183	.096	-3.210**	-2.762		
LowTech Elasticity			.681	-.211			.763	.972
F-test: equal elasticities			1.085	.094				
Observations	360	360	360	360	162	162	198	198
R^2	.114	.291	.123	.307	.357	.436	.307	.4
RMSE	.05	.046	.049	.045	.058	.056	.029	.027

Notes: Significance levels: $*$: 10% $**$: 5% $***$: 1%. The dependent variable in each model is the difference in the log of the variable identified in each section of the Table. All regressions are estimated by OLS, and include time dummies. RMSE is root mean squared error. The exchange rate is the average import/export exchange rate.

Table 5: Job destruction: OLS regressions in first-differences

Model	ALL		FULL		HighTech		LowTech	
$\Delta LogExRate_{t-1}$	-.302	-.317	1.288	1.572	1.907	2.676	-1.486	-1.687
	(1.374)	(1.279)	(1.944)	(1.859)	(2.801)	(2.783)	(2.179)	(1.764)
$\Delta LogExRate_{t-1} * Low$			-1.499	-2.164*				
			(1.613)	(1.234)				
$\Delta LogExRate_{t-1} * Open$	-1.431	-1.923**	-3.662*	-4.437***	-2.140	-3.635	-3.270***	-1.395
	(.876)	(.911)	(1.986)	(1.627)	(2.647)	(2.289)	(1.261)	(.967)
$\Delta LogExRate_{t-1} * Open * Low$			1.168	3.798*				
			(3.211)	(2.170)				
$\Delta ShareImp_{t-1}$	.696**	.404	.681***	.375	1.018	-.082	.198	.531*
	(.281)	(.323)	(.230)	(.305)	(.669)	(.487)	(.144)	(.311)
$Open_{t-1}$	-.026	-.135	-.026	-.181**	.036	-.065	-.046	-.345***
	(.032)	(.083)	(.033)	(.078)	(.045)	(.095)	(.050)	(.063)
Sectoral dummies	no	yes	no	yes	no	yes	no	yes
	Exchange Rate Job Destruction Employment Elasticities							
	Percentile 10							
ExRate Elasticity	-.655	-.792						
HighTech Elasticity			.383	.475	1.378	1.778		
LowTech Elasticity			-.827	-.750			-2.294	-2.031
F-test: equal elasticities			1.924	2.435				
	Percentile 50							
ExRate Elasticity	-.987	-1.238						
HighTech Elasticity			-.466	-.553	.882	.936		

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... table 5 continued

Model	ALL		FULL		HighTech		LowTech	
LowTech Elasticity			-1.405	-.899			-3.052	-2.355
F-test: equal elasticities			4.980**	.411				
				Percentile 90				
ExRate Elasticity	-1.305	-1.666						
HighTech Elasticity			-1.281	-1.541	.406	.126		
LowTech Elasticity			-1.960	-1.041			-3.780*	-2.665
F-test: equal elasticities			.700	.550				
Observations	360	360	360	360	162	162	198	198
R^2	.172	.308	.186	.314	.236	.349	.248	.372
RMSE	.061	.058	.061	.057	.055	.052	.064	.06

Notes: Significance levels: $*$: 10% $**$: 5% $***$: 1%. The dependent variable in each model is the difference in the log of the variable identified in each section of the Table. All regressions are estimated by OLS, and include time dummies. RMSE is root mean squared error. The exchange rate is the average import/export exchange rate.

Table 6: Job Reallocation: OLS regressions in first-differences

Model	ALL		FULL		HighTech		LowTech	
$\Delta LogExRate_{t-1}$	-1.602	-1.521	1.100	-2.105	-7.871***	-6.026**	-1.103	-1.089
	(1.304)	(1.325)	(2.046)	(2.109)	(2.329)	(2.514)	(1.870)	(1.617)
$\Delta LogExRate_{t-1} * Low$			-3.138	.489				
			(1.992)	(1.679)				
$\Delta LogExRate_{t-1} * Open$	.005	.198	-3.654	.941	7.224***	4.834**	-2.730	-.862
	(1.640)	(1.269)	(2.763)	(2.593)	(2.332)	(2.051)	(2.369)	(2.090)
$\Delta LogExRate_{t-1} * Open * Low$			4.737	-.422				
			(3.784)	(3.897)				
$\Delta ShareImp_{t-1}$	.712	-.137	.640	-.137	.346	-1.795***	.286*	.440***
	(.520)	(.547)	(.484)	(.546)	(1.298)	(.690)	(.169)	(.144)
$Open_{t-1}$	.026	-.00006	.027	.013	.410***	.270*	-.094	-.349***
	(.084)	(.166)	(.084)	(.163)	(.093)	(.138)	(.063)	(.063)
Sectoral dummies	no	yes	no	yes	no	yes	no	yes
	Exchange Rate Job Reallocation Elasticities							
	Percentile 10							
ExRate Elasticity	-1.601	-1.472						
HighTech Elasticity			.197	-1.872	-6.086**	-4.832*		
LowTech Elasticity			-1.771	-1.488			-1.777	-1.302
F-test: equal elasticities			3.066*	.189				
	Percentile 50							
ExRate Elasticity	-1.600	-1.426						
HighTech Elasticity			-.650	-1.654	-4.412**	-3.712		

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... table 6 continued

Model	ALL		FULL		HighTech		LowTech	
LowTech Elasticity			-1.520	-1.367			-2.410	-1.502
F-test: equal elasticities			2.403	.147				
				Percentile 90				
ExRate Elasticity	-1.599	-1.382						
HighTech Elasticity			-1.463	-1.445	-2.804*	-2.635		
LowTech Elasticity			-1.279	-1.252			-3.018	-1.693
F-test: equal elasticities			.040	.020				
Observations	360	360	360	360	162	162	198	198
R^2	.151	.34	.166	.34	.318	.47	.266	.379
RMSE	.083	.076	.083	.076	.086	.078	.072	.068

Notes: Significance levels: $*$: 10% $**$: 5% $***$: 1%. The dependent variable in each model is the difference in the log of the variable identified in each section of the Table. All regressions are estimated by OLS, and include time dummies. RMSE is root mean squared error. The exchange rate is the average import/export exchange rate.

5 Conclusion

Recent papers on international trade and exchange rates differ in their assessment of the impact of exchange rates on employment. The view that the impact of the exchange rate depends essentially on the openness degree (Klein et al, 2003) has been challenged. Berman et al (2009) contend, instead, that productivity is the important factor in the determination of the impact of exchange rate movements. This issue may be relevant for the evaluation of the potential costs and benefits of joining a currency area, such as the euro zone. In this respect, Portugal offers an interesting case study and this paper makes use of Portuguese data to investigate the matter.

In order to capture the effect of exchange rate changes in employment, hours and job flows, we estimated a model that includes both a measure of openness and a measure of productivity, interacted with the exchange rate. Our estimates suggest that low-technology sectors very exposed to international competition suffer the most from exchange rate changes. The estimated elasticities are larger than those estimated for more advanced economies. A country specialized in low-technology products should therefore be prepared for the consequences of a structural change in the composition of its manufacturing sector as a result of joining an economic and monetary union.

References

Alexandre, F., P. Bação, J. Cerejeira and M. Portela (2009). Aggregate and sector-specific exchange rates for the Portuguese economy. NIPE WP #/2009, University of Minho.

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.

Atkeson, A. and A. Burstein (2008). Pricing-to-market, trade costs and international relative prices. American Economic Review, 98(5), 1998-2031.

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.

Berman, N., P. Martin and T. Mayer (2009). How do different exporters react to exchange rate changes? Theory and empirics. mimeo.

Bernard, A., J.B. Jensen and P.K. Schott (2006). Survival of the best fit: exposure to low-wage countries and the (uneven) growth of U.S. manufacturing plants. Journal of

International Economics, 86(1), 219-237.

Bound, J. and G. Johnson (1992). Changes in the Structure of Wages in the 1980's: An Evaluation of Alternative Explanations. American Economic Review, 82(3), 371-392.

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.

Bugamelli, M., F. Schivardi and R. Zizza (2008). The euro and firm restructuring. NBER WP 14454, National Bureau of Economic Research, Cambridge.

Burgess, S. and M.K. Knetter (1998). An international comparison of employment adjustment to exchange rate fluctuations. Review of International Economics, 6 (1), 151-163.

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., C. Machado and A. Novo (2007). Job creation and destruction in Portugal. Economic Bulletin, Winter, Banco de Portugal.

Davis, S., J.C. Haltiwanger and S. Schuh (1996). Job creation and destruction. MIT Press, Cambridge, Massachusetts.

Karolina E., 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.

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.

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

Goldberg, L., J. Tracy and S. Aaronson (1999). Exchange rates and employment instability: evidence from matched CPS data. American Economic Review Papers and Proceedings, 89 (2). 204-210.

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

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.

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.

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.

Klein, M.K., S. Schuh and R. Triest (2003b). Job creation, job destruction and international competition. Kalamazoo, Mich.: Upjohn Institute for Employment Research.

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

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

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.

John Sutton (1998). Technology and Market Structure: Theory and History. Cambridge, MA: MIT Press.

Wood, A. (1998). Globalisation and the Rise in Labour Market Inequalities. Economic Journal. 108, 1453-82.

Wood, A. (1994). North-South Trade, Employment and Inequality: Changing Fortunes in a Skill-Driven World. Oxford: Clarendon Press.

6 Appendix

Table 7: Exports by Sector and Technology Level: Total exports, sector share and rank

Sector	$Ex88$	$S88$	$R88$	$Ex92$	$S92$	$R92$	$Ex98$	$S98$	$R98$	$Ex06$	$S06$	$R06$
pharmaceuticals	88133	0.008	14	108742	0.006	17	212794	0.009	16	453816	0.012	17
office, accounting and computing machinery	66290	0.006	16	70669	0.004	19	90092	0.004	21	748174	0.020	15
radio, television and communication equipment	371430	0.035	8	731454	0.042	9	1122160	0.048	6	3039757	0.080	4
medical, precision and opt. inst., watches, clocks	64578	0.006	18	131533	0.008	15	255436	0.011	15	374783	0.010	18
aircraft and spacecraft	38257	0.004	20	80136	0.005	18	114750	0.005	17	99656	0.003	20
high-technology manufactures	628689	0.060	4	1122535	0.064	4	1795231	0.077	4	4716186	0.124	4
chemicals excluding pharmaceuticals	617246	0.059	6	712332	0.041	10	919230	0.039	9	2462823	0.065	6
machinery and equipment, nec	361495	0.035	9	794584	0.046	8	1082506	0.046	8	2572785	0.068	5
electrical machinery and apparatus, nec	297018	0.028	10	904136	0.052	6	1718700	0.074	3	1678416	0.044	9
motor vehicles, trailers and semi-trailers	721393	0.069	5	1287228	0.074	2	3748591	0.161	2	5482275	0.144	2
railroad equipment and transport equipment nec	12225	0.001	21	45148	0.003	21	98335	0.004	20	188601	0.005	19
medium-high technology manufactures	2009377	0.192	2	3743428	0.215	2	7567361	0.324	2	12384899	0.326	2
rubber and plastics products	134250	0.013	13	248476	0.014	13	537207	0.023	12	1689521	0.045	8
other non-metallic mineral products	431736	0.041	7	827197	0.048	7	897042	0.038	10	1711633	0.045	7
iron and steel	66259	0.006	17	122352	0.007	16	267493	0.011	14	1084494	0.029	14
non-ferrous metals	75396	0.007	15	46270	0.003	20	112274	0.005	18	633388	0.017	16
fabricated metal products, except mach and equip	239127	0.023	11	448028	0.026	11	667437	0.029	11	1615982	0.043	10
building and repairing of ships and boats	44271	0.004	19	155182	0.009	14	107541	0.005	19	87711	0.002	21
medium-low technology manufactures	991038	0.095	3	1847504	0.106	3	2588993	0.111	3	6822730	0.180	3
food products, beverages and tobacco	812261	0.078	3	1243405	0.071	3	1551434	0.067	4	3076193	0.081	3
textiles, textile products, leather and footwear	4245899	0.406	1	7158235	0.411	1	7020658	0.301	1	6657559	0.175	1
wood and products of wood and cork	731368	0.070	4	971966	0.056	4	1160826	0.050	5	1582630	0.042	11

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... table 7 continued

Sector	$Ex88$	$S88$	$R88$	$Ex92$	$S92$	$R92$	$Ex98$	$S98$	$R98$	$Ex06$	$S06$	$R06$
pulp, paper, paper products, printing and pub	853416	0.082	2	943577	0.054	5	1117660	0.048	7	1565557	0.041	12
manufacturing nec	194072	0.019	12	381427	0.022	12	520204	0.022	13	1135634	0.030	13
low technology manufactures	6837016	0.653	1	10698609	0.614	1	11370781	0.488	1	14017573	0.369	1
Total exports	10466119			17412076			23322366			37941388		

Note: in the column title 'Ex' stands for exports, 'S' for share and 'R' for rank; numbers stand for years. Export values are in current values.

Table 8: Imports by Sector and Technology Level: Total imports, sector share and rank

Sector	$Im88$	$S88$	$R88$	$Im92$	$S92$	$R92$	$Im98$	$S98$	$R98$	$Im06$	$S06$	$R06$
pharmaceuticals	288493	0.020	15	507293	0.019	16	878421	0.027	13	2396052	0.046	8
office, accounting and computing machinery	488890	0.033	8	808640	0.031	10	978054	0.030	11	1533581	0.030	13
radio, television and communication equipment	758549	0.051	6	1305493	0.050	6	1869403	0.057	6	4262404	0.082	6
medical, precision and opt. inst., watches, clocks	352934	0.024	13	674747	0.026	13	859125	0.026	14	1375875	0.027	15
aircraft and spacecraft	55028	0.004	19	186112	0.007	20	386316	0.012	18	703127	0.014	18
high-technology manufactures	1943895	0.132	3	3482284	0.134	3	4971319	0.153	3	10271038	0.198	3
chemicals excluding pharmaceuticals	1671470	0.113	3	2466377	0.095	4	2913956	0.090	5	5196197	0.100	3
machinery and equipment, nec	2312008	0.157	2	3282950	0.126	3	3375984	0.104	3	4469612	0.086	5
electrical machinery and apparatus, nec	463250	0.031	9	1051248	0.040	7	1399139	0.043	7	1865671	0.036	10
motor vehicles, trailers and semi-trailers	2706021	0.184	1	4731232	0.182	1	5808397	0.179	1	7176663	0.139	1
railroad equipment and transport equipment nec	53892	0.004	20	212665	0.008	18	207679	0.006	20	224804	0.004	20
medium-high technology manufactures	7206641	0.489	1	11744472	0.451	1	13705154	0.421	1	18932946	0.366	1
rubber and plastics products	378555	0.026	12	790867	0.030	11	1199014	0.037	9	1653024	0.032	12
other non-metallic mineral products	243315	0.017	17	413911	0.016	17	574714	0.018	17	995673	0.019	17
iron and steel	587824	0.040	7	844633	0.032	9	1268128	0.039	8	2685929	0.052	7
non-ferrous metals	388547	0.026	10	567399	0.022	15	666063	0.020	16	1895516	0.037	9
fabricated metal products, except mach and equip	298798	0.020	14	658682	0.025	14	907584	0.028	12	1495433	0.029	14
building and repairing of ships and boats	35974	0.002	21	75863	0.003	21	70001	0.002	21	52798	0.001	21
medium-low technology manufactures	1933012	0.131	4	3351355	0.129	4	4685504	0.144	4	8778372	0.170	4
food products, beverages and tobacco	1415829	0.096	5	2466096	0.095	5	3204431	0.099	4	5478461	0.106	2
textiles, textile products, leather and footwear	1546021	0.105	4	3288974	0.126	2	3721338	0.114	2	4588713	0.089	4
wood and products of wood and cork	62355	0.004	18	193596	0.007	19	334859	0.010	19	592207	0.011	19

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... table 8 continued

Sector	$Im88$	$S88$	$R88$	$Im92$	$S92$	$R92$	$Im98$	$S98$	$R98$	$Im06$	$S06$	$R06$
pulp, paper, paper products, printing and pub	385853	0.026	11	856927	0.033	8	1107934	0.034	10	1775249	0.034	11
manufacturing nec	251414	0.017	16	678015	0.026	12	796924	0.025	15	1355517	0.026	16
low technology manufactures	3661473	0.248	2	7483608	0.287	2	9165485	0.282	2	13790147	0.266	2
Total imports	14745021			26061718			32527462			51772504		

Note: in the column title 'Im' stands for imports, 'S' for share and 'R' for rank; numbers stand for years. Import values are in current values.

Table 9: Employment by Sector: number of workers, sector share and rank

Sector	$W88$	$S88$	$R88$	$W92$	$S92$	$R92$	$W98$	$S98$	$R98$	$W06$	$S06$	$R06$
pharmaceuticals	7172	0.008	16	5877	0.006	16	6198	0.007	14	5904	0.008	16
office, accounting and computing machinery	1243	0.001	20	785	0.001	20	577	0.001	21	1198	0.002	21
radio, television and communication equipment	13305	0.015	15	17103	0.018	13	13400	0.016	13	12373	0.017	13
medical, precision and opt. inst., watches, clocks	4336	0.005	19	4471	0.005	18	5242	0.006	16	6136	0.008	14
aircraft and spacecraft	89	0.000	21	113	0.000	21	1802	0.002	20	1938	0.003	20
high-technology manufactures	26145	0.029	4	28349	0.030	4	27219	0.032	4	27549	0.037	4
chemicals excluding pharmaceuticals	29879	0.033	8	24383	0.026	10	18045	0.021	12	15664	0.021	12
machinery and equipment, nec	24573	0.028	9	26884	0.029	8	38730	0.046	8	38849	0.052	8
electrical machinery and apparatus, nec	16130	0.018	12	25440	0.027	9	28341	0.034	9	16529	0.022	11
motor vehicles, trailers and semi-trailers	18063	0.020	11	19064	0.020	12	23182	0.027	10	29481	0.040	9
railroad equipment and transport equipment nec	5091	0.006	18	3604	0.004	19	4848	0.006	18	2962	0.004	19
medium-high technology manufactures	93736	0.105	3	99375	0.106	3	113146	0.134	3	103485	0.139	3
rubber and plastics products	22185	0.025	10	23326	0.025	11	20879	0.025	11	24378	0.033	10
other non-metallic mineral products	64109	0.072	4	70513	0.075	4	66121	0.078	4	54450	0.073	4
iron and steel	15821	0.018	13	11484	0.012	15	5676	0.007	15	6027	0.008	15
non-ferrous metals	5466	0.006	17	5585	0.006	17	4097	0.005	19	5287	0.007	17
fabricated metal products, except mach and equip	72717	0.082	3	79917	0.085	3	72146	0.085	3	73767	0.099	3
building and repairing of ships and boats	14753	0.017	14	11898	0.013	14	4904	0.006	17	4203	0.006	18
medium-low technology manufactures	195051	0.219	2	202723	0.216	2	173823	0.206	2	168112	0.225	2
food products, beverages and tobacco	103711	0.116	2	103564	0.110	2	92352	0.109	2	102122	0.137	2
textiles, textile products, leather and footwear	332766	0.373	1	358016	0.381	1	298727	0.354	1	212525	0.285	1
wood and products of wood and cork	49305	0.055	5	47548	0.051	7	44859	0.053	7	39679	0.053	7

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... table 9 continued

Sector	$W88$	$S88$	$R88$	$W92$	$S92$	$R92$	$W98$	$S98$	$R98$	$W06$	$S06$	$R06$
pulp, paper, paper products, printing and pub	45127	0.051	7	49674	0.053	6	45729	0.054	6	42297	0.057	6
manufacturing nec	46261	0.052	6	51189	0.054	5	48997	0.058	5	49783	0.067	5
low technology manufactures	577170	0.647	1	609991	0.649	1	530664	0.628	1	446406	0.599	1
Total employment in the 21 sectors	892102			940438			844852			745552		
Labour force	4615250			4568500			5108850			5587275		
Share 21 sectors in labour force		0.193			0.206			0.165			0.133	

Note: in the column title 'W' stands for workers, 'S' for share and 'R' for rank; numbers stand for years.

Table 10: Job Creaction and Job Destruction by Sector

Sector	C	sdC	D	sdD	R	sdR
pharmaceuticals	0.076	0.062	0.093	0.042	0.169	0.075
office, accounting and computing machinery	0.145	0.076	0.135	0.067	0.280	0.117
radio, television and communication equipment	0.154	0.082	0.146	0.075	0.300	0.138
medical, precision and opt. inst., watches, clocks	0.107	0.052	0.108	0.050	0.215	0.096
aircraft and spacecraft	1.977	4.363	0.821	1.691	2.798	4.419
high-technology manufactures	0.131	0.033	0.127	0.031	0.257	0.060
chemicals excluding pharmaceuticals	0.058	0.031	0.077	0.047	0.135	0.075
machinery and equipment, nec	0.135	0.031	0.139	0.040	0.275	0.059
electrical machinery and apparatus, nec	0.173	0.096	0.176	0.101	0.349	0.120
motor vehicles, trailers and semi-trailers	0.140	0.115	0.116	0.058	0.256	0.142
railroad equipment and transport equipment nec	0.051	0.092	0.073	0.043	0.124	0.125
medium-high technology manufactures	0.114	0.015	0.118	0.015	0.231	0.025
rubber and plastics products	0.094	0.034	0.090	0.036	0.185	0.058
other non-metallic mineral products	0.096	0.035	0.104	0.031	0.200	0.054
iron and steel	0.036	0.029	0.066	0.073	0.102	0.096
non-ferrous metals	0.093	0.051	0.089	0.045	0.182	0.076
fabricated metal products, except mach and equip	0.130	0.036	0.117	0.035	0.247	0.061
building and repairing of ships and boats	0.045	0.038	0.082	0.068	0.127	0.074
medium-low technology manufactures	0.100	0.018	0.102	0.016	0.202	0.032
food products, beverages and tobacco	0.102	0.025	0.104	0.028	0.206	0.050
textiles, textile products, leather and footwear	0.089	0.039	0.108	0.032	0.197	0.058
wood and products of wood and cork	0.102	0.038	0.111	0.029	0.213	0.061
pulp, paper, paper products, printing and pub	0.098	0.035	0.101	0.037	0.199	0.061

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… table 10 continued

Sector	C	sdC	D	sdD	R	sdR
manufacturing nec	0.123	0.038	0.122	0.037	0.246	0.062
low technology manufactures	0.096	0.024	0.108	0.028	0.204	0.049
Total in the 21 sectors	0.100	0.014	0.108	0.016	0.208	0.029
QP: Total Sectors	0.169	0.069	0.140	0.053	0.309	0.121

Note: Authors' computations based on Portugal (1988-2006). C, D and R are rates of job creation, destruction, and reallocation, respectively, while sdC, sdD, and sdR, are theirs standard-deviations.

Table 11: Job Creaction and Job Destruction by Year and Technological Sector

	High		Med-High		Med-Low		Low	
Year	C	D	C	D	C	D	C	D
1989	0.204	0.120	0.172	0.074	0.163	0.092	0.186	0.086
1990	0.118	0.071	0.092	0.096	0.117	0.097	0.131	0.095
1991	0.151	0.145	0.131	0.127	0.105	0.107	0.111	0.107
1992	0.094	0.129	0.090	0.098	0.098	0.106	0.096	0.122
1993	0.092	0.130	0.111	0.138	0.082	0.116	0.076	0.138
1994	0.231	0.163	0.110	0.147	0.113	0.190	0.128	0.166
1995	0.065	0.076	0.132	0.089	0.092	0.097	0.090	0.111
1996	0.127	0.066	0.097	0.103	0.098	0.094	0.088	0.108
1997	0.063	0.077	0.103	0.063	0.112	0.087	0.107	0.098
1998	0.118	0.184	0.105	0.068	0.117	0.094	0.097	0.097
1999	0.120	0.095	0.124	0.093	0.108	0.086	0.093	0.100
2000	0.102	0.086	0.139	0.107	0.116	0.099	0.095	0.111
2001	0.132	0.153	0.093	0.132	0.132	0.109	0.120	0.135
2002	0.136	0.151	0.078	0.112	0.098	0.110	0.096	0.140
2003	0.049	0.095	0.053	0.102	0.080	0.128	0.082	0.131
2004	0.071	0.075	0.058	0.095	0.082	0.109	0.074	0.120
2005	0.088	0.075	0.057	0.094	0.081	0.105	0.074	0.124
2006	0.090	0.138	0.060	0.091	0.081	0.102	0.076	0.124

Note: Authors' computations based on Portugal (1988-2006). C and D are rates of job creation and destruction. High, Med-High, Med-Low and Low refer to the aggregate levels of technology.

Table 12: Trade Opennes by Sector and Year

Sector	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
food, bev. & tobacco	0.21	0.20	0.21	0.22	0.22	0.22	0.24	0.26	0.26	0.27	0.28	0.30	0.31	0.31	0.31	0.31	0.31	0.32	0.34
text., leather & foot.	0.36	0.37	0.40	0.40	0.41	0.40	0.41	0.42	0.42	0.43	0.43	0.44	0.45	0.46	0.46	0.45	0.45	0.46	0.46
wood & cork	0.32	0.32	0.32	0.30	0.30	0.29	0.31	0.30	0.32	0.33	0.32	0.33	0.35	0.35	0.35	0.34	0.34	0.34	0.35
pulp, paper, print.	0.28	0.29	0.29	0.29	0.30	0.31	0.31	0.33	0.32	0.33	0.33	0.34	0.36	0.36	0.36	0.37	0.35	0.34	0.35
chemicals, ex. pharm.	0.42	0.42	0.45	0.47	0.48	0.49	0.53	0.54	0.55	0.56	0.57	0.60	0.60	0.60	0.62	0.61	0.61	0.63	0.63
pharmaceuticals	0.42	0.38	0.39	0.37	0.39	0.41	0.43	0.47	0.48	0.46	0.53	0.56	0.59	0.63	0.63	0.65	0.66	0.65	0.67
rubber and plast. prod.	0.27	0.29	0.33	0.36	0.39	0.40	0.43	0.46	0.47	0.49	0.49	0.50	0.51	0.50	0.52	0.52	0.51	0.49	0.50
other non-met. min. prod.	0.18	0.18	0.19	0.19	0.19	0.19	0.20	0.21	0.21	0.21	0.21	0.22	0.22	0.22	0.23	0.24	0.24	0.27	0.27
iron and steel	0.48	0.47	0.47	0.54	0.54	0.49	0.59	0.57	0.58	0.58	0.61	0.64	0.62	0.63	0.65	0.62	0.63	0.62	n.a.
non-ferrous metals	0.51	0.52	0.52	0.56	0.58	0.57	0.57	0.64	0.64	0.67	0.67	0.69	0.75	0.74	0.73	0.73	0.71	0.74	n.a.
fab. metal prod., ex. mach.	0.19	0.19	0.21	0.22	0.23	0.21	0.23	0.26	0.28	0.28	0.29	0.30	0.31	0.31	0.32	0.31	0.32	0.33	0.34
machinery & equip.	0.62	0.63	0.64	0.63	0.64	0.62	0.60	0.60	0.62	0.63	0.62	0.63	0.64	0.64	0.61	0.61	0.61	0.62	0.62
office, account. & comp.	0.96	0.96	0.93	0.91	0.94	0.91	0.86	0.88	0.88	0.86	0.87	0.86	0.90	0.93	0.91	0.92	0.92	0.92	0.92
electrical mach.	0.40	0.44	0.50	0.53	0.54	0.55	0.56	0.54	0.56	0.56	0.55	0.56	0.58	0.55	0.57	0.57	0.56	0.56	0.56
radio, tv & com.	0.56	0.57	0.58	0.58	0.59	0.56	0.56	0.60	0.58	0.61	0.64	0.65	0.65	0.65	0.64	0.64	0.62	0.62	0.64
medical & opt. inst.	0.73	0.72	0.76	0.71	0.71	0.68	0.66	0.65	0.65	0.67	0.68	0.71	0.75	0.72	0.70	0.68	0.68	0.70	0.69
motor vehicles	0.71	0.69	0.67	0.67	0.70	0.69	0.70	0.64	0.63	0.63	0.66	0.68	0.69	0.68	0.67	0.67	0.68	0.68	0.67
build & rep. of ships	0.26	0.44	0.40	0.18	0.38	0.35	0.36	0.29	0.28	0.34	0.25	0.21	0.25	0.23	0.24	0.26	0.37	0.30	0.25
railroad equip. & trans.	0.17	0.18	0.60	0.66	0.70	0.74	0.51	0.51	0.44	0.45	0.50	0.55	0.39	0.40	0.37	0.38	0.38	0.39	0.41
manufacturing nec	0.30	0.32	0.33	0.34	0.31	0.29	0.28	0.28	0.29	0.31	0.31	0.33	0.33	0.33	0.34	0.36	0.37	0.38	0.39

Note: Authors' computations.