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


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**NIPE WP 22/ 2010**

NÚCLEO DE INVESTIGAÇÃO EM POLÍTICAS ECONÓMICAS
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# Manufacturing employment and exchange rates in the Portuguese economy: the role of openness, technology and labour market rigidity

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2nd August 2010

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**Abstract**

Integration into the world economy, specialization in low-technology sectors and labour market rigidity have been singled out as structural features of the Portuguese economy that are crucial for the understanding of its performance. 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 the dynamics of employment in Portugal. Our estimates indicate that employment in low-technology sectors with a high degree of trade openness and facing less rigidity in the labour market is more sensitive to movements in exchange rates. Therefore, our results provide additional evidence on the relevance of those structural features for explaining the evolution of the Portuguese economy in the last decades. In this paper the degree of labour market rigidity is measured at the sector level by means of a novel index. According to this index, high-technology sectors face less labour market rigidity. These sectors are also more exposed to international competition. However, the bulk of employment destruction has occurred in low-technology sectors. This suggests that productivity/technology may be the key variable to reduce the economy's exposure to external shocks.

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

JEL-codes: J23, F16, F41

**Resumo**

A crescente integração da economia portuguesa na economia mundial, a sua especialização em sectores de baixa tecnologia e a rigidez do mercado de trabalho têm sido destacadas como características estruturais iniludíveis em qualquer exercício de análise do desempenho da economia portuguesa. Neste artigo analisamos empiricamente o papel da abertura, da tecnologia e da rigidez do mercado de trabalho na determinação do efeito da taxa de câmbio sobre a dinâmica do emprego em Portugal. As nossas estimativas indicam que o emprego em sectores de baixa tecnologia, com um elevado grau de abertura ao comércio internacional e com um menor grau de rigidez no mercado de trabalho é mais sensível aos movimentos das taxas de câmbio. Os nossos resultados fornecem assim mais evidência empírica sobre a relevância daquelas características estruturais na explicação da evolução da economia portuguesa nas últimas décadas. Neste artigo propomos ainda um novo índice para medir o grau de rigidez do mercado de trabalho. De acordo com aquele índice, os sectores de alta tecnologia apresentam uma menor rigidez do mercado de trabalho. Estes sectores estão também mais expostos à concorrência internacional. No entanto, o grosso da destruição de emprego teve lugar nos sectores de baixa tecnologia. Estes resultados sugerem que a produtividade/tecnologia é a variável chave para mitigar os efeitos negativos da exposição da economia portuguesa aos choques externos.

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# 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 structural features of the Portuguese economy in explaining the dynamics of 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.

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 (2010) 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 linked 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.* (2010) 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 rigidity. Our estimates, using employment data for 20 manufacturing sectors from the *"Quadros de Pessoal"* database, for the period 1988-2006, are consistent with the predictions derived from the models of Alexandre *et al.* (2009b) and Alexandre *et al.* (2010), namely they suggest that employment in low-technology sectors with a high degree of openness to trade and less labour market rigidities are more sensitive to exchange rate changes.

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

# 2 Employment, exchange rates, trade and technology

In the last two decades, Portuguese international trade patterns changed significantly, both in terms of export destinations and of import origins.[5] The behaviour of aggregate and sector-specific exchange rate indexes in the period will be described in section 2.1. The behaviour of the exchange rate will be contrasted with that of manufacturing employment. In section 2.2, 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 employment and international trade per technology level, defined according to the OECD

[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).

[5] This section follows closely Alexandre et al. (2009b).

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.[6] We focus on 20 manufacturing sectors, as they are more exposed to foreign trade – the list of sectors is presented in Table 18 in the Appendix. The 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.

## 2.1 Employment and exchange rates

The Portuguese manufacturing labour force followed the declining trend described in the Introduction for industrialized countries.[7] 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. Table 21 in the Appendix shows the evolution of employment in the 20 manufacturing sectors, grouped by OECD level of technology, according to *"Quadros de Pessoal"*. The main facts in Table 21 are captured by Figure 1, which 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 almost 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 (Table 21 in the Appendix presents the sectors' rank in terms of employment).

As mentioned above, one explanation given in the literature for these trends in manufac-

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

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

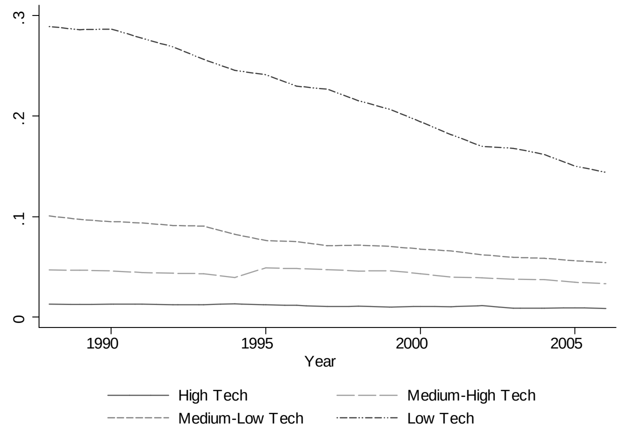


Figure 1: Share of employment by technology level

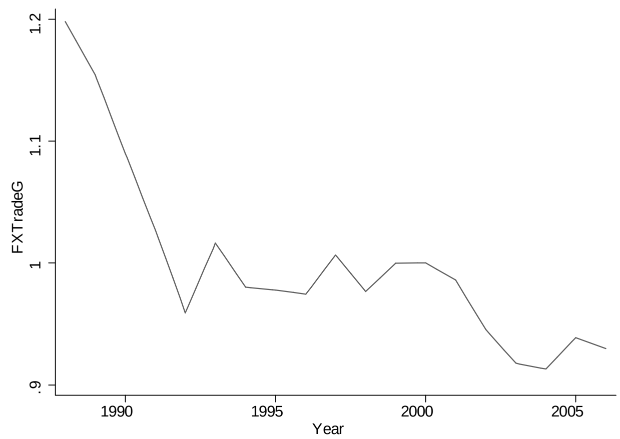


Figure 2: Real effective exchange rate

turing employment is the effect of movements in exchange rates – see, for example, Campa and Goldberg (2001) and Gourinchas (1999). In fact, the period under study (1988-2006) was characterized by an appreciation of the real effective exchange rate by more than 20% – see Figure 2. This coincidence suggests that the links between employment and exchange rates in the Portuguese economy should be investigated.

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%. 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,

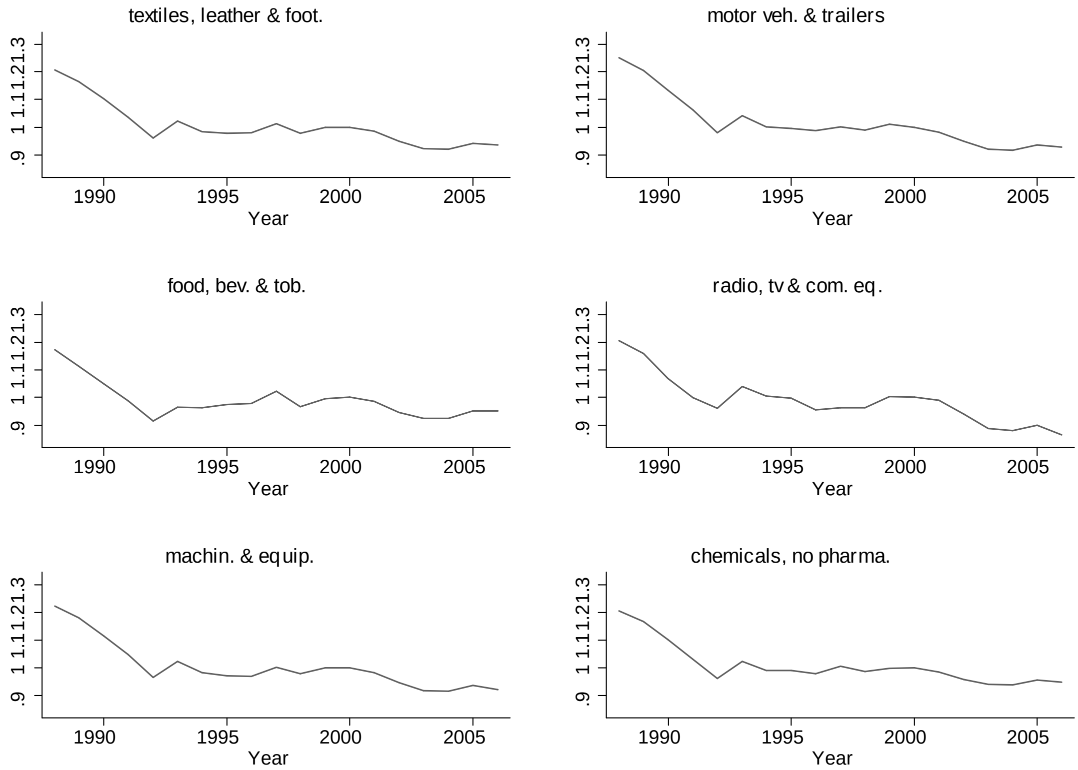


Figure 3: Sector-specific exchange rates

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. 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). In fact, several authors have shown that sector-specific exchange rates are better explanatory variables of labour markets dynamics - see, for example, Campa and Goldberg (2001) for the US and Gourinchas (1999) for France. Alexandre *et al.* (2009a) have reached the same conclusion for the Portuguese economy, although the sector-specific and the aggregate exchange rate indexes display very similar patterns - cf. Figure 3, where sector-specific exchange rates for the six most important exporting sectors are presented. The next section provides additional information on the characteristics of high- and low-technology sectors in Portugal, especially concerning participation in international trade.

## 2.2 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. 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 20 in the Appendix). The share of high technology sectors in exports remained low by world standards, but similar to Greece and Spain (Amador *et al.* 2007: Table 3, pp. 16).

Table 1: Trade shares, openness and penetration rates 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 |

*Continued on next page...*

*... table 1 continued*

| | 1988 | 2006 | Δ*p.p.* |
|---|---|---|---|
| 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 |
| | | | |
| *Export share* | | | |
| High-technology 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-technology 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)* | | | Δ% |
| High-technology 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. Δ*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.[8] 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.[9]

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

[9] 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.

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 assess the role of the exchange rate in this evolution, while taking also into consideration the part played by labour market rigidities, to which we turn next.

# 3 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 emphasizing the importance of the interaction between shocks and labour market institutions to understand the dynamics of employment and unemployment. For example, Blanchard and Portugal (2001) focus on the differences in labour markets institutions to compare the unemployment rates in Portugal and in the US and conclude that employment protection institutions affect job reallocation and the unemployment duration. Almeida *et al.* (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 economy.

In this section we propose an index to evaluate the labour market rigidity at the sector level, which will be used in our empirical estimates. This index is presented in section 3.2. Before that, in section 3.1, 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.

## 3.1 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

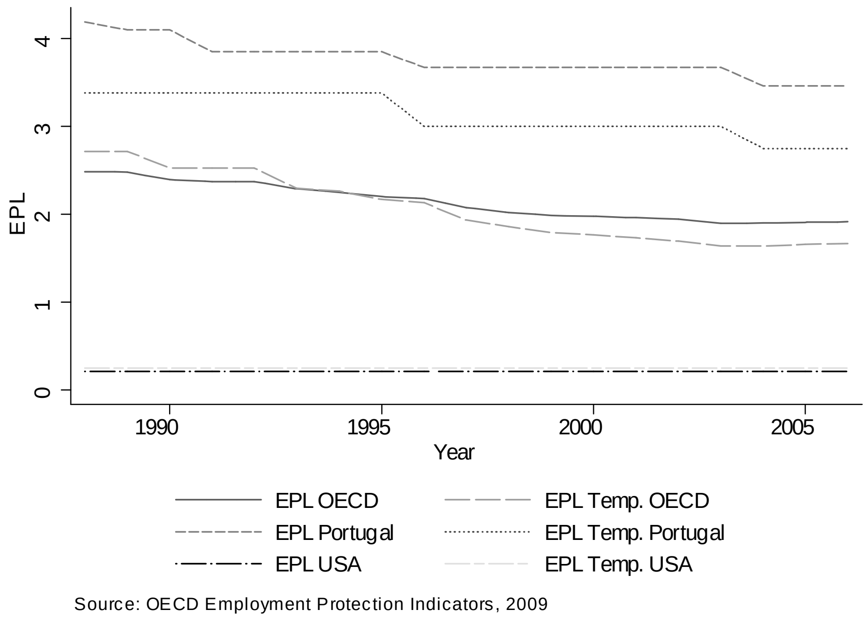


Figure 4: Employment Protection Legislation index

(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 4, 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 Fig. 4, the reduction from 4.19, in 1988, to 3.46, in 2006, was achieved through the increase in fixed-term contracts. This new contractual arrangement increased flexibility and became a very important contractual form in the Portuguese labour market, leading to its increasing segmentation.[10] The introduction of this type of contract coincided with much higher job and worker flows (Centeno *et al.*, 2009).

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

While 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, and compared to the EPL index.

### 3.2 An index of sectoral labour market rigidity

Our index of labour market rigidity at the sector level is a composite measure of 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 full-time working contract. We standardise each measure by subtracting the mean and dividing by the standard deviation over its entire distribution. Again, the data comes from *"Quadros de Pessoal"*.[11]

We argue that all three shares are expected to bear relation to labour market flexibility. The greater the share of contracts not regulated by a collective agreement the lower is the bargaining power accrued to unions, which implies a higher vulnerability of workers towards dismissals. This way, firms should find it easier to implement labour quantity adjustments. We also expect flexibility to increase with the share of workers without a full-time contract, as the dismissal costs associated with this type of workers are lower. Finally, 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. In fact, 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 strategy is particularly relevant for manufacturing within Europe.

The composite index that we propose – equation (1) – incorporates these three measures of labour market flexibility. In our formulation the dimensions of flexibility are interacted

[11] 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.

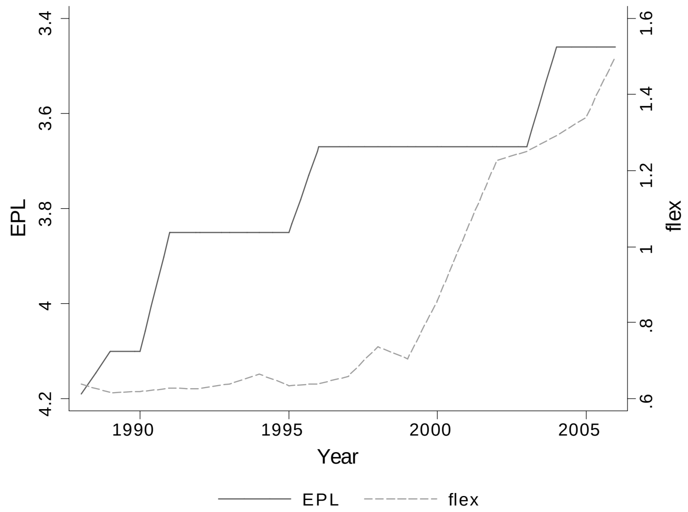


Figure 5: EPL vs. flex

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.[12] 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 order to test for the validity of our measure we compare it to OECD's $EPL$ index. 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 $flex_{jt}$ and $EPL_t$ is about $-0.73$. Figure 5 shows the evolution of $EPL$ and a weighted average of our sectoral index, using as weights the share of employment in each sector. At the sector level, the correlation is bounded between $-0.83$, in "Office, accounting and computing machinery", and $-0.49$, in "Chemicals excluding pharmaceuticals". Additionally, we run a set of regressions with $f_{1,jt}$, $f_{2,jt}$, $f_{3,jt}$ and $flex_{jt}$ as dependent variables and $EPL_t$ as a regressor. The results are reported in Table 2. From column (1) we conclude that, as expected, for all measures of flexibility there is a negative association with $EPL$. All estimates are highly significant. The $R^2$ varies between 0.0840 for $f_3$ and 0.3671 for $flex$. Adding a set of sector dummies and their interaction with $EPL$, column (2), our estimates indicate that 58% of the variation in $flex$ is explained within the model. The coefficient on $EPL$ is $-0.93$ and statistically significant at the 1% level. A reduction in the $EPL$ at the country level is matched by an increase in flexibility at the sector level, as measured by $flex$. Since the match is not exact, there is sectoral variability which can be used in the regressions in the next section.

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

In columns (3), (4) and (5) we report regressions performed for sectors "Textile, textile products, leather", "Pulp, paper, paper products" and "Fabricated metal products", respectively. We confirm that $EPL$ explains our flexibility measures, particularly our composite index, $flex$. For example, for "Fabricated Metal Products" 48% of the variation in $flex$ is explained by $EPL$, with the estimated coefficient being $-1.1115$. The estimations for the remaining sectors included in our analysis are reported in the appendix, Table 25. These results confirm those shown in Table 2.

Table 2: Flex vs. EPL

| | Overall | | Within sector | | |
|---|---|---|---|---|---|
| Variable | (1) | (2) | (3) | (4) | (5) |
| | -1.8466*** | -1.1264* | -1.1724** | -2.6474*** | -0.9614*** |
| $f_{1,jt}$ | (0.2321) | (0.6532) | (0.5514) | (0.5348) | (0.2818) |
| | [0.1434] | [0.6949] | [0.2101] | [0.5905] | [0.4065] |
| | -2.1958*** | -1.1036 | -1.1724** | -1.0827* | -2.0284** |
| $f_{2,jt}$ | (0.2295) | (0.8648) | (0.5514) | (0.5536) | (0.7533) |
| | [0.1950] | [0.4858] | [0.2101] | [0.1837] | [0.2990] |
| | -1.4298*** | -1.8267*** | -1.1724** | -2.3676*** | -1.7706*** |
| $f_{3,jt}$ | (0.2829) | (0.3021) | (0.5514) | (0.2667) | (0.2786) |
| | [0.0840] | [0.9363] | [0.2101] | [0.8225] | [0.7038] |
| | -1.0811*** | -0.9336*** | -1.1724** | -1.3091*** | -1.1115*** |
| $flex_{jt}$ | (0.0730) | (0.2812) | (0.5514) | (0.2480) | (0.2793) |
| | [0.3671] | [0.5776] | [0.2101] | [0.6211] | [0.4822] |

Notes: The coefficients reported are the estimates of $\beta_1$ in the OLS regression $y_{jt} = \beta_0 + \beta_1 EPLt_t + \epsilon_{jt}$, where $y_{jt}$=$\{f_{1,jt}$,$f_{2,jt}$,$f_{3,jt}$,$flex_{jt}\}$. Regression (2) includes sector dummies and sector specific slopes for $EPL$. Regression (3) is for 'Textile, Textile Products, Leather', regression (4) is for 'Pulp, Paper, Paper Products' and regression (5) is for 'Fabricated Metal Products'. Significance levels: $*$ : 10% $**$ : 5% $***$ : 1%. Standard errors in parenthesis. $R^2$ in brackets.

Finally, running a regression of $flex$ on a dummy for high-technology sectors and a set of year dummies we can evaluate how flexibility varies across technology and over time. We estimate the following model:

$$\log(flex_{jt}) = \beta_0 + \beta_1 High_{jt} + \gamma_t + \varepsilon_t \tag{2}$$

OLS estimation yields $\hat{\beta}_1 = 0.1613$, with a standard error of 0.0193, i.e., low-technology industries are about 16% more rigid than high-technology sectors. Furthermore, rigidity has been relatively stable until the end of the 1990s, and decreased after that. In 2007, our estimates indicate that overall the Portuguese labour for manufacturing was 44% more flexible, compared to 1988 (the estimate for the coefficient for the year 2007 dummy is 0.4435, with a standard error of 0.0607). This regression shows an $R^2$ of 0.6989.

These results suggest that our index may be useful for characterising labour market flexibility at the sector level. We will use it as a measure of labour market flexibility in empirical analysis of employment and job flows presented in the next section.

# 4 Econometric analysis

We focus our analysis on the effect of exchange rate movements on employment in 20 manufacturing sectors, in the period 1988-2006. The previous sections provided evidence on five major facts concerning the evolution of the Portuguese economy during this period: 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 related, as the model developed in Alexandre *et al.* (2010) 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.* (2010), 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:

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

where $\Delta$ denotes first-difference, $j$ refers to sectors and $t$ indexes years. The dependent variable $y_{jt}$ may be either log-employment (measured as total workers or total hours), job creation, job destruction or gross reallocation (these three variables are defined at the sector level – see section 4.2). $ExRate_{j,t-1}$ 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.[13] 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.[14] 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 2010), the effects of exchange rates on employment should differ according to the degree of trade openness. Therefore, we include in equation (3) an interaction term for the exchange rate and our measure of trade openness, $Open_{j,t-1}$ (see section 2.2). 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 classification (again, recall section 2.2). For additional flexibility of the model's functional form, we also extend this interaction to the sectors' trade openness.

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 3.2. 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,[15] we include in our regressions the variable $ShareImp_{j,t-1}$, which is the share of these countries in sector $j$ OECD countries' imports.[16] 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, $\lambda_t$, in order to control for any common aggregate time varying shocks that are potentially correlated with exchange rates, and a set of sectoral dummies $\theta_j$. Since we specify a model in first-differences, these dummies represent sector-specific trends. Finally, $\varepsilon_{jt}$ is a white noise error term. All variables are in real terms. The model is estimated by OLS, with robust standard errors allowing for

[13] 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.

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

[15] 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.

[16] 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.

within-sector correlation.[17]

## 4.1 Employment and exchange rates

Tables 3 and 8 summarize the results for the model specified in equation (3), using workers employed and hours worked as the dependent variable, respectively. Our estimation strategy is the following. We start by estimating equation (3) 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 (3) separately for low- ($LowTech$) and high-technology sectors ($HighTech$) – 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 3 (where the dependent variable is total workers), the results concerning the control variable $ShareImp_{j,t-1}$ show 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.

[17] 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, $flex_{j,t-1}$.

Table 3: Employment (total workers), OLS regressions in first-differences

| 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 3) introduces the dummy variable *Low* in the model via additional interactions with the exchange rate and the degree of openness (besides 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) –, we reinforce the conclusion reached with $FULL$ regressions, 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 will now compute the elasticity of employment with respect to the exchange rate implied by the different specifications of our empirical model. The elasticity will be evaluated at different degrees of trade openness and labour market flexibility, using the results presented in Table 3. 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 4, 5 and 6.

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 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 3.

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 50 | | | | | |
| ExRate Elasticity | 10 | .951 | 1.623 | | | | | | |
| | 50 | 1.165 | 1.763 | | | | | | |
| | 90 | 1.799 | 2.175 | | | | | | |
| HighTech Elasticity | 10 | | | .665 | -.122 | -4.400 | -4.070 | | |
| | 50 | | | .658 | -.243 | -4.756 | -4.688 | | |
| | 90 | | | .634 | -.602 | -5.808 | -6.518 | | |
| LowTech Elasticity | 10 | | | 4.243** | 3.907* | | | 4.527** | 4.249* |
| | 50 | | | 4.631** | 4.283* | | | 4.890** | 4.621* |
| | 90 | | | 5.781*** | 5.393** | | | 5.965*** | 5.722** |
| F-test: equal elasticities | 10 | | | 5.563** | 3.630* | | | | |
| | 50 | | | 5.383** | 3.459* | | | | |
| | 90 | | | 4.903** | 3.095* | | | | |

Notes: see notes to Table 3.

Table 6: 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 3.

The results shown in Tables 4 to 6, 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 almost the same as 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.[18]

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 7, 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 4 to 6, 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 4, 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-

[18] 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 7: 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 counter part. This difference may be explained by the fact that Portugal is a very open economy, specialized in low-technology sectors.

As a further robustness check, equation (3) was estimated using hours worked as the dependent variable instead of total workers. Table 8 shows the results and follows the layout of Table 3. The figures presented in Table 8 reinforce the results found for total workers (Table 3). We observe once more that for low-technology sectors the impact of exchange rate movements on employment intensity is magnified by the degree of labour market flexibility. This result is shown in columns (3) and (4) for the interaction $\Delta ExRate_{j,t-1} \times flex_{j,t-1} \times Low_j$, and it appears in Table 10 under $FULL$ and $LowTech$ elasticities. We also confirm, columns (3) and (4) of Table 10, that elasticities are higher for low-technology sectors and statistically different according to the technology level (bottom section of Table 10). Compared to employment, elasticities for hours are higher. Exploring additional variation in the degree of openness, in Tables 9 and 11 we analyse exchange rate hours elasticities for openness evaluated at percentiles $10^{th}$ and $90^{th}$. We confirm the previous results according to which the elasticity of hours with respect to the exchange rate increases both with openness and flexibility, and applies to low-technology industries. For example, considering low-technology industries, for percentiles $10^{th}$ of openness and labour market flexibility (Table 9), a 1% depreciation is associated with a 3.6% increase in hours hired; however, for percentile $90^{th}$ of openness and labour market flexibility (Table 11) the elasticity is 7.5%. An exception occurs for high-technology industries operating in a closed environment and facing a rigid labour market. With an increase in openness or flexibility, exchange rates do not impact any more on high-technology sectors employment adjustments. This result is independent of the empirical specification we use once we control for technology.

Table 8: Hours worked, OLS regressions in first-differences

| Model | ALL | | FULL | | HighTech | | LowTech | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $\Delta ExRate_{t-1}$ | 3.196 | 1.920 | 7.639$^{***}$ | 1.233 | 2.296 | -1.700 | -.554 | -.406 |
| | (1.980) | (1.684) | (2.828) | (3.043) | (4.245) | (5.909) | (1.457) | (1.328) |
| $\Delta ExRate_{t-1} \times Low$ | | | -8.758$^{***}$ | -2.406 | | | | |
| | | | (3.121) | (3.535) | | | | |
| $\Delta ExRate_{t-1} \times Open$ | -.266 | .034 | -4.225 | 2.699 | 3.566 | 1.377 | 7.370$^{**}$ | 7.133$^{**}$ |
| | (1.586) | (1.797) | (2.686) | (3.586) | (3.727) | (4.337) | (3.574) | (3.186) |
| $\Delta ExRate_{t-1} \times Open \times Low$ | | | 15.820$^{***}$ | 4.186 | | | | |
| | | | (5.585) | (6.309) | | | | |
| $Open_{t-1}$ | .041 | -.151 | .034 | -.093 | .235$^{***}$ | -.243 | -.078$^{*}$ | .145 |
| | (.043) | (.125) | (.044) | (.159) | (.083) | (.205) | (.045) | (.241) |
| $\Delta ExRate_{t-1} \times Flex$ | -1.383 | -.192 | -2.908$^{*}$ | -1.771 | -3.186 | .173 | 1.394 | 1.508 |
| | (1.220) | (.960) | (1.669) | (1.626) | (2.360) | (4.707) | (.892) | (1.039) |
| $\Delta ExRate_{t-1} \times Flex \times Low$ | | | 3.615$^{*}$ | 3.355$^{*}$ | | | | |
| | | | (2.029) | (1.827) | | | | |
| $Flex_{t-1}$ | -.009 | -.035 | -.011 | -.038 | -.036 | -.050 | -.010 | -.044 |
| | (.028) | (.058) | (.023) | (.053) | (.046) | (.078) | (.029) | (.081) |
| $\Delta ShareImp_{t-1}$ | -.183 | -.900$^{***}$ | -.545 | -1.069$^{**}$ | -.748 | -1.710$^{**}$ | -1.018$^{***}$ | -1.016$^{**}$ |
| | (.483) | (.315) | (.473) | (.470) | (.839) | (.721) | (.305) | (.448) |
| Sectoral dummies | no | yes | no | yes | no | yes | no | yes |
| Observations | 280 | 280 | 280 | 280 | 126 | 126 | 154 | 154 |
| $Adj.R^2$ | .055 | .082 | .086 | .087 | .087 | .079 | .25 | .243 |
| LogLikelihood | 254.776 | 269.428 | 261.145 | 272.056 | 101.304 | 105.695 | 196.231 | 201.578 |
| RMSE | .101 | .1 | .099 | .099 | .118 | .119 | .073 | .073 |

Notes: Significance levels: $*$ : 10% $**$ : 5% $***$ : 1%. The dependent variable is the difference in the log hours. 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.

Table 9: Elasticity of hours worked 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 | 1.222 | 1.667 | | | | | | |
| | 50 | 1.009 | 1.637 | | | | | | |
| | 90 | .376 | 1.549 | | | | | | |
| HighTech Elasticity | 10 | | | 2.377* | -.372 | -.983 | -1.045 | | |
| | 50 | | | 1.927 | -.646 | -1.475 | -1.018 | | |
| | 90 | | | .597 | -1.455 | -2.932 | -.939 | | |
| LowTech Elasticity | 10 | | | 3.369*** | 3.086* | | | 3.592* | 3.822* |
| | 50 | | | 3.479** | 3.331* | | | 3.807* | 4.055* |
| | 90 | | | 3.802** | 4.055* | | | 4.445** | 4.745* |
| F-test: equal elasticities | 10 | | | .471 | 6.023** | | | | |
| | 50 | | | .836 | 6.090** | | | | |
| | 90 | | | 1.613 | 5.687** | | | | |

Notes: see notes to Table 8.

Table 10: Elasticity of hours worked with respect to the exchange rate

| Model | | ALL | | FULL | | HighTech | | LowTech | |
|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| | Flexibility, percentile | Openness, percentile 50 | | | | | | | |
| ExRate Elasticity | 10 | 1.162 | 1.675 | | | | | | |
| | 50 | .949 | 1.645 | | | | | | |
| | 90 | .316 | 1.557 | | | | | | |
| HighTech Elasticity | 10 | | | 1.424* | .237 | -.179 | -.735 | | |
| | 50 | | | .975 | -.037 | -.671 | -.708 | | |
| | 90 | | | -.355 | -.847 | -2.128 | -.629 | | |
| LowTech Elasticity | 10 | | | 5.984*** | 4.638* | | | 5.253* | 5.431* |
| | 50 | | | 6.093*** | 4.883* | | | 5.469* | 5.664* |
| | 90 | | | 6.417** | 5.607* | | | 6.107** | 6.353** |
| F-test: equal elasticities | 10 | | | 7.195** | 6.820** | | | | |
| | 50 | | | 6.791** | 6.429** | | | | |
| | 90 | | | 5.825** | 5.603** | | | | |

Notes: see notes to Table 8.

Table 11: Elasticity of hours worked 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 | 1.112 | 1.681 | | | | | | |
| | 50 | .898 | 1.651 | | | | | | |
| | 90 | .266 | 1.563 | | | | | | |
| HighTech Elasticity | 10 | | | .629 | .744 | .492 | -.476 | | |
| | 50 | | | .180 | .471 | -.0005 | -.449 | | |
| | 90 | | | -1.150 | -.339 | -1.457 | -.370 | | |
| LowTech Elasticity | 10 | | | 8.165*** | 5.933* | | | 6.640* | 6.772* |
| | 50 | | | 8.274*** | 6.178* | | | 6.855* | 7.006* |
| | 90 | | | 8.598*** | 6.902* | | | 7.493* | 7.695** |
| F-test: equal elasticities | 10 | | | 9.490*** | 4.047* | | | | |
| | 50 | | | 8.708*** | 3.343* | | | | |
| | 90 | | | 8.223*** | 4.271* | | | | |

Notes: see notes to Table 8.

Again, using hours as the dependent variable, 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 report 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. Additionally, the estimated elasticities are larger than those estimated for more advanced economies. Overall, our set of results shows strong evidence pointing to higher elasticities for hours, compared to total workers, which confirms previous results discussed in the literature. For example, Bertola (1992, p.407) states that "dynamic restrictions on employment should induce firms to exploit other margins of adjustment, and job security should imply higher volatility of hours worked per employee or a more pronounced tendency to contract out parts of the production process."

## 4.2 Exchange rates and job flows

In this section, we evaluate the impact of exchange rate movements on job creation, job destruction and job reallocation. As shown by Davis, Haltiwanger and Schuh (1996), measures of job creation and destruction provide additional information on the dynamics of labour markets. In our case, the analysis of job flows may contribute to a better understanding of the role of openness, flexibility and technology level on the effect of exchange rate movements on employment growth. The analysis of job flows is particularly relevant in the context of an economy facing labour adjustment costs, possibly as a result of labour market rigidity.

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

$$C_{jt} = \frac{\sum\limits_{i \in j^{+}} \Delta E_{it}}{\frac{1}{2}\left(E_{j,t-1} + E_{j,t}\right)} \tag{4}$$

and

$$D_{jt} = \frac{\sum\limits_{i \in j^{-}} \mid \Delta E_{it} \mid}{\frac{1}{2}\left(E_{j,t-1} + E_{j,t}\right)} \tag{5}$$

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 $j$'s 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 22 in the Appendix presents averages of annual 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 22 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 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.[19]

Following the discussion in the beginning of this section, we estimate equation (3) using as dependent variables $C_{jt}$, $D_{jt}$, and $R_{jt}$ as defined above.

Starting by job creation, Tables 12, 13 and Table 26 in the Appendix, our main conclusion is that labour market flexibility mediates the effect of exchange rate innovations on this flow. However, this only occurs for tow-technology industries. Not controlling for technology, columns (1) and (2) in Table 12, does not allow us to identify the effect of rigidities on employment creation through the exchange rate. However, the degree of flexibility impacts positively in job creation, which is a standard result in the literature. Under column (2) the estimated coefficient for $flex$ is 0.065, with a standard error of 0.017. This implies that a standard-deviation increase in the degree of flexibility (0.36) is expected to increase employment creation by 2.3% $(= 0.065 * 0.36)$.[20]

Moving to regressions of type $FULL$, we observe that the degree of rigidity does not operate on job creation through the exchange rate for high-technology sectors. The same is not true for low-technology industries. In face of a depreciation, industries in low-technology create more employment when operating in a more flexible employment environment. Focusing our attention on column (4) – i.e., including a set of interactions between exchange rate and openness and flexibility, as well as sector dummies–, we estimate the coefficient of $\Delta ExRate_{j,t-1} \times flex_{j,t-1} \times Low_j$ to be about 2, with a standard error of 0.8. The corresponding exchange rate job creation elasticity is 2.3 for the $90^{th}$ percentile of flexibility and $50^{th}$ percentile of openness (Table 13): a 1% depreciation leads to 2.3% job creation, *ceteris paribus*. For this level of technology it seems that a rigid labour market insulates the job creation process from external shocks.

We conclude also that low-technology sectors' elasticities are not only positive but also

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

[20] The mean value of $flex$ is about 1, varying between 0.43 and 2.22. The percentiles 10, 25, 50, 75 and 90 are, respectively, 0.61, 0.73, 0.88, 1.26 and 1.48. Between 1988 and 2006, average flex has changed from 0.76 to 1.58; i.e., on average, a one standard-deviation increase in flexibility took about 8 years $\left(= (1.58 - 0.76)^{-1} 0.36 * 18\right)$ to be in place.

statistically different from the ones computed for higher levels of technology. However, once we run the estimations by level of technology we get the same unexpected result that we obtained for total workers: for high-technology sectors the elasticity is negative (Table 13, columns (5) and (6)). One possible explanation, as we have mentioned above, hints at input costs determinants. Our conclusions on job creation are not reversed either by the degree of openness or flexibility (see Table 26).

Proceeding to job destruction – Tables 14, 15 and 27–, our results reveal a negative elasticity with respect to the exchange rate for low-technology sectors, and no effect for high-technology sectors. The elasticities in Table 15 indicate a clear result for low-technology sectors: an appreciation induces job losses. This effect is magnified under more open or more flexible regimes: comparing elasticities computed at different degrees of openness, Table 27, we observe an exchange rate job destruction elasticity of $-2.6$ for the $10^{th}$ percentile of openness and $-2.9$ for its $90^{th}$ percentile (both are computed at the $90^{th}$ percentile of flexibility).

Finally, focusing our attention on job reallocation we conclude that exchange rate movements have a negative impact on overall movements in the labour market for high-technology sectors. For high-technology sectors, although our estimations suggest that labour market rigidities are not relevant for the effect of exchange rate movements on job reallocation – Table 16 –, looking to the elasticities we observe that their magnitude increases with the degree of labour market flexibility (Tables 17 and 28). For example, for the $50^{th}$ percentile of openness and $10^{th}$ percentile of flexibility the exchange rate elasticity of job reallocation is about $-3.1$, while for the $90^{th}$ percentile of flexibility it becomes $-4.1$ (Table 17, column 6).

Summing up, our results suggest that a higher labour market flexibility makes job flows more responsive to exchange rate movements.

Table 12: Job Creation, OLS regressions in first-differences

| Model | ALL | | FULL | | HighTech | | LowTech | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $\Delta LogExRate_{t-1}$ | -2.714 | -2.773 | -.487 | -4.505 | -9.147* | -8.266 | -1.394*** | -1.416*** |
| | (1.690) | (2.094) | (2.094) | (2.881) | (4.814) | (5.684) | (.359) | (.528) |
| $\Delta LogExRate_{t-1} * Low$ | | | -2.707** | 1.226 | | | | |
| | | | (1.129) | (1.644) | | | | |
| $\Delta LogExRate_{t-1} * Open$ | 1.309 | 1.773 | -.323 | 5.393* | 8.662*** | 8.188*** | .678 | .657 |
| | (1.986) | (1.587) | (2.951) | (2.909) | (2.980) | (2.461) | (1.804) | (1.659) |
| $\Delta LogExRate_{t-1} * Open * Low$ | | | 3.658 | -3.962 | | | | |
| | | | (2.751) | (3.463) | | | | |
| $Open_{t-1}$ | .049 | .138 | .045 | .221** | .369*** | .369*** | -.050** | -.006 |
| | (.059) | (.093) | (.059) | (.097) | (.075) | (.096) | (.025) | (.032) |
| $\Delta LogExRate_{t-1} * Flex$ | 1.374 | 1.515 | .418 | .428 | .366 | .250 | 1.470*** | 1.736*** |
| | (.849) | (1.094) | (.980) | (.926) | (2.077) | (2.089) | (.341) | (.329) |
| $\Delta LogExRate_{t-1} * Flex * Low$ | | | 1.241** | 2.004** | | | | |
| | | | (.601) | (.810) | | | | |
| $Flex_{t-1}$ | .030* | .065*** | .028 | .059*** | .072*** | .062*** | -.0007 | .012 |
| | (.018) | (.017) | (.018) | (.016) | (.023) | (.020) | (.017) | (.011) |
| $\Delta ShareImp_{t-1}$ | -.018 | -.552* | -.109 | -.590* | -.678 | -1.587*** | -.193 | -.206 |
| | (.362) | (.310) | (.333) | (.321) | (.685) | (.464) | (.233) | (.229) |
| Sectoral dummies | no | yes | no | yes | no | yes | no | yes |
| Observations | 360 | 360 | 360 | 360 | 162 | 162 | 198 | 198 |
| $Adj.R^2$ | .065 | .224 | .07 | .247 | .282 | .321 | .254 | .327 |
| LogLikelihood | 584.086 | 628.074 | 586.802 | 635.412 | 246.803 | 256.18 | 440.501 | 456.542 |
| RMSE | .049 | .045 | .049 | .044 | .057 | .056 | .028 | .027 |

Notes: Significance levels: $*$ : 10% $**$ : 5% $***$ : 1%. The dependent variable is the difference in job creation. 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.

Table 13: Elasticity of job creation with respect to the exchange rate

| Model | | ALL | | FULL | | HighTech | | LowTech | |
|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| | Flexibility, percentile | | | Openness, percentile 50 | | | | | |
| ExRate Elasticity | 10 | -.141 | .239 | | | | | | |
| | 50 | .072 | .474 | | | | | | |
| | 90 | .700 | 1.167 | | | | | | |
| HighTech Elasticity | 10 | | | -.086 | -1.066 | -4.065** | -3.593 | | |
| | 50 | | | -.021 | -1.000 | -4.008** | -3.554 | | |
| | 90 | | | .170 | -.804 | -3.841* | -3.440** | | |
| LowTech Elasticity | 10 | | | .841 | .808 | | | .977 | 1.307 |
| | 50 | | | 1.098 | 1.184 | | | 1.204 | 1.576* |
| | 90 | | | 1.856** | 2.296** | | | 1.877** | 2.369*** |
| F-test: equal elasticities | 10 | | | 2.081 | 6.423** | | | | |
| | 50 | | | 2.545 | 6.917** | | | | |
| | 90 | | | 3.442* | 7.420** | | | | |

Notes: see notes to Table 12.

Table 14: Job Destruction, OLS regressions in first-differences

| Model | ALL | | FULL | | HighTech | | LowTech | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $\Delta LogExRate_{t-1}$ | .889 | -.198 | 1.025 | -.061 | 4.720 | 4.997 | -.116 | -.773 |
| | (1.506) | (1.503) | (2.991) | (2.653) | (3.289) | (3.778) | (2.593) | (1.904) |
| $\Delta LogExRate_{t-1} * Low$ | | | .728 | .068 | | | | |
| | | | (1.935) | (1.482) | | | | |
| $\Delta LogExRate_{t-1} * Open$ | -1.452 | -1.875** | -3.581* | -4.595*** | -2.851 | -3.830 | -3.363** | -1.459 |
| | (.945) | (.939) | (1.943) | (1.589) | (2.673) | (2.517) | (1.435) | (.963) |
| $\Delta LogExRate_{t-1} * Open * Low$ | | | .859 | 3.714* | | | | |
| | | | (3.049) | (2.030) | | | | |
| $Open_{t-1}$ | -.030 | -.137 | -.021 | -.217** | .032 | -.034 | -.039 | -.352*** |
| | (.034) | (.089) | (.028) | (.091) | (.046) | (.100) | (.047) | (.067) |
| $\Delta LogExRate_{t-1} * Flex$ | -.904 | -.130 | .603 | 1.786 | -2.042* | -1.844 | -1.015 | -.807 |
| | (.592) | (.500) | (2.006) | (1.733) | (1.064) | (1.315) | (.874) | (.635) |
| $\Delta LogExRate_{t-1} * Flex * Low$ | | | -2.785 | -2.953 | | | | |
| | | | (1.940) | (1.815) | | | | |
| $Flex_{t-1}$ | .010 | -.011 | .018 | .0003 | .005 | -.007 | .028 | -.031 |
| | (.027) | (.029) | (.029) | (.030) | (.019) | (.036) | (.045) | (.036) |
| $\Delta ShareImp_{t-1}$ | .767** | .399 | .874*** | .444 | .963 | -.071 | .603* | .559* |
| | (.303) | (.322) | (.290) | (.326) | (.657) | (.508) | (.355) | (.296) |
| Sectoral dummies | no | yes | no | yes | no | yes | no | yes |
| Observations | 360 | 360 | 360 | 360 | 162 | 162 | 198 | 198 |
| $Adj.R^2$ | .123 | .216 | .152 | .228 | .125 | .199 | .16 | .249 |
| LogLikelihood | 508.194 | 539.018 | 515.851 | 543.478 | 253.229 | 265.226 | 275.786 | 292.68 |
| RMSE | .061 | .058 | .06 | .057 | .055 | .053 | .064 | .061 |

Notes: Significance levels: $*$ : 10% $**$ : 5% $***$ : 1%. The dependent variable is the difference in job destruction. 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.

Table 15: Elasticity of job destruction with respect to the exchange rate

| Model | | ALL | | FULL | | HighTech | | LowTech | |
|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| | Flexibility, percentile | | | Openness, percentile 50 | | | | | |
| ExRate Elasticity | 10 | -1.118 | -1.368 | | | | | | |
| | 50 | -1.257 | -1.388 | | | | | | |
| | 90 | -1.671 | -1.448 | | | | | | |
| HighTech Elasticity | 10 | | | -.044 | -.047 | .417 | .447 | | |
| | 50 | | | .049 | .229 | .101 | .162 | | |
| | 90 | | | .325 | 1.045 | -.833 | -.682 | | |
| LowTech Elasticity | 10 | | | -2.674** | -2.058* | | | -3.284** | -2.649 |
| | 50 | | | -3.011** | -2.238* | | | -3.441** | -2.774 |
| | 90 | | | -4.009*** | -2.772** | | | -3.906*** | -3.143* |
| F-test: equal elasticities | 10 | | | 5.668** | 3.388* | | | | |
| | 50 | | | 4.907** | 3.366* | | | | |
| | 90 | | | 3.758* | 3.203* | | | | |

Notes: see notes to Table 14.

Table 16: Job Reallocation, OLS regressions in first-differences

| Model | ALL | | FULL | | HighTech | | LowTech | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $\Delta LogExRate_{t-1}$ | -1.825 | -2.970 | .538 | -4.567 | -4.427 | -3.268 | -1.510 | -2.189 |
| | (1.809) | (2.285) | (3.589) | (3.847) | (5.113) | (3.960) | (2.742) | (2.191) |
| $\Delta LogExRate_{t-1} * Low$ | | | -1.978 | 1.294 | | | | |
| | | | (2.420) | (2.110) | | | | |
| $\Delta LogExRate_{t-1} * Open$ | -.143 | -.102 | -3.904 | .798 | 5.811$^{***}$ | 4.358$^{**}$ | -2.685 | -.803 |
| | (1.542) | (1.138) | (2.607) | (2.489) | (2.173) | (1.908) | (2.321) | (2.072) |
| $\Delta LogExRate_{t-1} * Open * Low$ | | | 4.517 | -.248 | | | | |
| | | | (3.885) | (3.680) | | | | |
| $Open_{t-1}$ | .019 | .0005 | .024 | .004 | .401$^{***}$ | .335$^{***}$ | -.089 | -.358$^{***}$ |
| | (.082) | (.164) | (.080) | (.174) | (.093) | (.127) | (.056) | (.063) |
| $\Delta LogExRate_{t-1} * Flex$ | .469 | 1.385 | 1.020 | 2.214 | -1.676 | -1.594 | .455 | .929 |
| | (.786) | (1.078) | (2.598) | (2.395) | (2.749) | (2.000) | (.970) | (.573) |
| $\Delta LogExRate_{t-1} * Flex * Low$ | | | -1.544 | -.949 | | | | |
| | | | (2.050) | (1.994) | | | | |
| $Flex_{t-1}$ | .040 | .054$^{*}$ | .046 | .059$^{*}$ | .077$^{***}$ | .055 | .027 | -.019 |
| | (.040) | (.032) | (.042) | (.031) | (.025) | (.040) | (.058) | (.035) |
| $\Delta ShareImp_{t-1}$ | .749 | -.154 | .766 | -.146 | .285 | -1.658$^{**}$ | .410$^{**}$ | .352$^{***}$ |
| | (.537) | (.495) | (.520) | (.540) | (1.263) | (.705) | (.186) | (.126) |
| Sectoral dummies | no | yes | no | yes | no | yes | no | yes |
| Observations | 360 | 360 | 360 | 360 | 162 | 162 | 198 | 198 |
| $Adj.R^2$ | .099 | .259 | .114 | .253 | .24 | .359 | .172 | .258 |
| LogLikelihood | 395.999 | 441.502 | 400.511 | 441.907 | 182.317 | 200.98 | 252.719 | 269.48 |
| RMSE | .083 | .076 | .083 | .076 | .085 | .078 | .072 | .068 |

Notes: Significance levels: $*$ : 10% $**$ : 5% $***$ : 1%. The dependent variable is the difference in job reallocation. 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.

Table 17: Elasticity of job reallocation with respect to the exchange rate

| Model | | ALL | | FULL | | HighTech | | LowTech | |
|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| | Flexibility, percentile | Openness, percentile 50 | | | | | | | |
| ExRate Elasticity | 10 | -1.259 | -1.128 | | | | | | |
| | 50 | -1.186 | -.914 | | | | | | |
| | 90 | -.971 | -.281 | | | | | | |
| HighTech Elasticity | 10 | | | -.130 | -1.113 | -3.648*** | -3.146* | | |
| | 50 | | | .028 | -.771 | -3.907*** | -3.392** | | |
| | 90 | | | .494 | .242 | -4.674** | -4.121** | | |
| LowTech Elasticity | 10 | | | -1.833 | -1.250 | | | -2.307 | -1.342 |
| | 50 | | | -1.914 | -1.054 | | | -2.237 | -1.199 |
| | 90 | | | -2.153* | -.476 | | | -2.029 | -.774 |
| F-test: equal elasticities | 10 | | | 1.641 | .011 | | | | |
| | 50 | | | 1.438 | .033 | | | | |
| | 90 | | | 1.108 | .092 | | | | |

Notes: see notes to Table 16.

# 5 Conclusions and policy implications

Our results show that the degree of openness to trade, technology and labour market rigidity are essential to understanding 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. Estimations using job flows suggest that the impact of exchange rates on these sectors occurs through employment destruction. Additionally, the estimated elasticities are larger than those estimated for more advanced economies. The fact that Portugal is a very open economy and specialized in low-technology products may explain these results.

In this paper the degree of labour market rigidity is measured at the sector level by means of a novel index. According to this index, high-technology sectors face less labour market rigidity on average. These sectors are also the more exposed to international competition. However, the bulk of employment destruction has occurred in low-technology sectors. This suggests that productivity/technology may be the key variable to reduce the economy's exposure to external shocks. In other words, for the Portuguese economy to restore its competitiveness and to mitigate the negative impact of increasing competition from the emerging countries, resources should be reallocated to higher technology sectors.

However, higher labour adjustment costs appear to reduce the elasticity of employment with respect to the exchange rate. This may have contradictory macroeconomic implications. On the one hand, it may smooth unemployment variations and, consequently, prevent some social costs associated with sharp increases in unemployment, and even social unrest. Nevertheless, it may also hinder an efficient reallocation of resources towards higher technology sectors. In addition, given that the restructuring of firms is essential to improve productivity, labour market rigidities might be part of the explanation for the productivity slowdown observed in the period of our analysis in the Portuguese economy.

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# Appendix

Table 18: List of Sectors

| Sector | ISIC Rev. 3 |
|---|---|
| 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 |
| chemicals excluding pharmaceuticals | 24, excl. 2423 |
| pharmaceuticals | 2423 |
| rubber and plastics products | 25 |
| other non-metallic mineral products | 26 |
| iron and steel | 271 + 2731 |
| non-ferrous metals | 272 + 2732 |
| fabricated metal products, except machinery and equipment | 28 |
| 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 |
| building and repairing of ships and boats | 351 |
| railroad equipment and transport equipment nec | 352 + 359 |
| manufacturing nec | 36 - 37 |

Table 19: Exports by Sector and Technology Level: Total exports (US $10^3$ dollars), sector share and rank

| | 1988 | | | 2006 | | |
|---|---|---|---|---|---|---|
| Sector | *Ex* | *S* | *R* | *Ex* | *S* | *R* |
| pharmaceuticals | 88133 | 0.008 | 14 | 453816 | 0.012 | 17 |

*Continued on next page...*

*… table 19 continued*

| | 1988 | | | 2006 | | |
|---|---|---|---|---|---|---|
| Sector | *Ex* | *S* | *R* | *Ex* | *S* | *R* |
| office, accounting and computing machinery | 66290 | 0.006 | 16 | 748174 | 0.020 | 15 |
| radio, television and communication equipment | 371430 | 0.035 | 8 | 3039757 | 0.080 | 4 |
| medical, precision and opt. inst., watches, clocks | 64578 | 0.006 | 18 | 374783 | 0.010 | 18 |
| aircraft and spacecraft | 38257 | 0.004 | 20 | 99656 | 0.003 | 20 |
| high-technology manufactures | 628689 | 0.060 | 4 | 4716186 | 0.124 | 4 |
| chemicals excluding pharmaceuticals | 617246 | 0.059 | 6 | 2462823 | 0.065 | 6 |
| machinery and equipment, nec | 361495 | 0.035 | 9 | 2572785 | 0.068 | 5 |
| electrical machinery and apparatus, nec | 297018 | 0.028 | 10 | 1678416 | 0.044 | 9 |
| motor vehicles, trailers and semi-trailers | 721393 | 0.069 | 5 | 5482275 | 0.144 | 2 |
| railroad equipment and transport equipment nec | 12225 | 0.001 | 21 | 188601 | 0.005 | 19 |
| medium-high technology manufactures | 2009377 | 0.192 | 2 | 12384899 | 0.326 | 2 |
| rubber and plastics products | 134250 | 0.013 | 13 | 1689521 | 0.045 | 8 |
| other non-metallic mineral products | 431736 | 0.041 | 7 | 1711633 | 0.045 | 7 |
| iron and steel | 66259 | 0.006 | 17 | 1084494 | 0.029 | 14 |
| non-ferrous metals | 75396 | 0.007 | 15 | 633388 | 0.017 | 16 |
| fabricated metal products, except mach and equip | 239127 | 0.023 | 11 | 1615982 | 0.043 | 10 |
| building and repairing of ships and boats | 44271 | 0.004 | 19 | 87711 | 0.002 | 21 |
| medium-low technology manufactures | 991038 | 0.095 | 3 | 6822730 | 0.180 | 3 |
| food products, beverages and tobacco | 812261 | 0.078 | 3 | 3076193 | 0.081 | 3 |
| textiles, textile products, leather and footwear | 4245899 | 0.406 | 1 | 6657559 | 0.175 | 1 |
| wood and products of wood and cork | 731368 | 0.070 | 4 | 1582630 | 0.042 | 11 |
| pulp, paper, paper products, printing and pub | 853416 | 0.082 | 2 | 1565557 | 0.041 | 12 |
| manufacturing nec | 194072 | 0.019 | 12 | 1135634 | 0.030 | 13 |
| low technology manufactures | 6837016 | 0.653 | 1 | 14017573 | 0.369 | 1 |
| Total exports | 10466119 | | | 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 20: Imports by Sector and Technology Level: Total imports (US $10^3$ dollars), sector share and rank

| | 1988 | | | 2006 | | |
|---|---|---|---|---|---|---|
| Sector | *Im* | *S* | *R* | *Im* | *S* | *R* |
| pharmaceuticals | 288493 | 0.020 | 15 | 2396052 | 0.046 | 8 |
| office, accounting and computing machinery | 488890 | 0.033 | 8 | 1533581 | 0.030 | 13 |

*Continued on next page…*

*... table 20 continued*

| | 1988 | | | 2006 | | |
|---|---|---|---|---|---|---|
| Sector | *Im* | *S* | *R* | *Im* | *S* | *R* |
| radio, television and communication equipment | 758549 | 0.051 | 6 | 4262404 | 0.082 | 6 |
| medical, precision and opt. inst., watches, clocks | 352934 | 0.024 | 13 | 1375875 | 0.027 | 15 |
| aircraft and spacecraft | 55028 | 0.004 | 19 | 703127 | 0.014 | 18 |
| high-technology manufactures | 1943895 | 0.132 | 3 | 10271038 | 0.198 | 3 |
| chemicals excluding pharmaceuticals | 1671470 | 0.113 | 3 | 5196197 | 0.100 | 3 |
| machinery and equipment, nec | 2312008 | 0.157 | 2 | 4469612 | 0.086 | 5 |
| electrical machinery and apparatus, nec | 463250 | 0.031 | 9 | 1865671 | 0.036 | 10 |
| motor vehicles, trailers and semi-trailers | 2706021 | 0.184 | 1 | 7176663 | 0.139 | 1 |
| railroad equipment and transport equipment nec | 53892 | 0.004 | 20 | 224804 | 0.004 | 20 |
| medium-high technology manufactures | 7206641 | 0.489 | 1 | 18932946 | 0.366 | 1 |
| rubber and plastics products | 378555 | 0.026 | 12 | 1653024 | 0.032 | 12 |
| other non-metallic mineral products | 243315 | 995673 | 0.019 | 17 | | |
| iron and steel | 587824 | 0.040 | 7 | 2685929 | 0.052 | 7 |
| non-ferrous metals | 388547 | 0.026 | 10 | 1895516 | 0.037 | 9 |
| fabricated metal products, except mach and equip | 298798 | 0.020 | 14 | 1495433 | 0.029 | 14 |
| building and repairing of ships and boats | 35974 | 0.002 | 21 | 52798 | 0.001 | 21 |
| medium-low technology manufactures | 1933012 | 0.131 | 4 | 8778372 | 0.170 | 4 |
| food products, beverages and tobacco | 1415829 | 0.096 | 5 | 5478461 | 0.106 | 2 |
| textiles, textile products, leather and footwear | 1546021 | 4588713 | 0.089 | 4 | | |
| wood and products of wood and cork | 62355 | 0.004 | 18 | 92207 | 0.011 | 19 |
| pulp, paper, paper products, printing and pub | 385853 | 0.026 | 11 | 1775249 | 0.034 | 11 |
| manufacturing nec | 251414 | 0.017 | 16 | 1355517 | 0.026 | 16 |
| low technology manufactures | 3661473 | 0.248 | 2 | 13790147 | 0.266 | 2 |
| Total imports | 14745021 | | | 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 21: Employment by Sector: number of workers, sector share and rank

| | 1988 | | | 2006 | | |
|---|---|---|---|---|---|---|
| Sector | *W* | *S* | *R* | *W* | *S* | *R* |
| pharmaceuticals | 7172 | 0.008 | 16 | 5904 | 0.008 | 16 |
| office, accounting and computing machinery | 1243 | 0.001 | 20 | 1198 | 0.002 | 21 |
| radio, television and communication equipment | 13305 | 0.015 | 15 | 12373 | 0.017 | 13 |

*Continued on next page...*

*... table 21 continued*

| | 1988 | | | 2006 | | |
|---|---|---|---|---|---|---|
| Sector | *W* | *S* | *R* | *W* | *S* | *R* |
| medical, precision and opt. inst., watches, clocks | 4336 | 0.005 | 19 | 6136 | 0.008 | 14 |
| aircraft and spacecraft | 89 | 0.000 | 21 | 1938 | 0.003 | 20 |
| high-technology manufactures | 26145 | 0.029 | 4 | 27549 | 0.037 | 4 |
| chemicals excluding pharmaceuticals | 29879 | 0.033 | 8 | 15664 | 0.021 | 12 |
| machinery and equipment, nec | 24573 | 0.028 | 9 | 38849 | 0.052 | 8 |
| electrical machinery and apparatus, nec | 16130 | 0.018 | 12 | 16529 | 0.022 | 11 |
| motor vehicles, trailers and semi-trailers | 18063 | 0.020 | 11 | 29481 | 0.040 | 9 |
| railroad equipment and transport equipment nec | 5091 | 0.006 | 18 | 2962 | 0.004 | 19 |
| medium-high technology manufactures | 93736 | 0.105 | 3 | 103485 | 0.139 | 3 |
| rubber and plastics products | 22185 | 0.025 | 10 | 24378 | 0.033 | 10 |
| other non-metallic mineral products | 64109 | 0.072 | 4 | 54450 | 0.073 | 4 |
| iron and steel | 15821 | 0.018 | 13 | 6027 | 0.008 | 15 |
| non-ferrous metals | 5466 | 0.006 | 17 | 5287 | 0.007 | 17 |
| fabricated metal products, except mach and equip | 72717 | 0.082 | 3 | 73767 | 0.099 | 3 |
| building and repairing of ships and boats | 14753 | 0.017 | 14 | 4203 | 0.006 | 18 |
| medium-low technology manufactures | 195051 | 0.219 | 2 | 168112 | 0.225 | 2 |
| food products, beverages and tobacco | 103711 | 0.116 | 2 | 102122 | 0.137 | 2 |
| textiles, textile products, leather and footwear | 332766 | 0.373 | 1 | 212525 | 0.285 | 1 |
| wood and products of wood and cork | 49305 | 0.055 | 5 | 39679 | 0.053 | 7 |
| pulp, paper, paper products, printing and pub | 45127 | 0.051 | 7 | 42297 | 0.057 | 6 |
| manufacturing nec | 46261 | 0.052 | 6 | 49783 | 0.067 | 5 |
| low technology manufactures | 577170 | 0.647 | 1 | 446406 | 0.599 | 1 |
| Total employment in manufacturing sectors | 892102 | | | 745552 | | |
| Employment (from STAN database) | 4469233 | | | 5126086 | | |
| Share of manufacturing sectors in labour force | | 0.244 | | | 0.181 | |

Note: in the column title 'W' stands for workers, 'S' for share and 'R' for rank. Except where noted, the data is from 'Quadros de Pessoal' dataset.

Table 22: Job Creation and Job Destruction by Sector (annual average, 1988-2006)

| 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 |

*Continued on next page...*

*... table 22 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 |
| Quadros Pessoal: 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 their standard-deviations.

Table 23: 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 OECD technology level classification.

Table 24: 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. Trade openness was computed according to the formula $(X+M)/(GO+X+M)$, as described in Section 3.2.

Table 25: Flex vs. EPL: estimates by sector

| Sector | $f_1$ | $f_2$ | $f_1$ | $flex$ |
|---|---|---|---|---|
| | -1.1264*** | -1.1036* | -1.8267*** | -0.9336*** |
| Food products, beverages and tobacco | ( 0.3276) | ( 0.6234) | ( 0.2667) | ( 0.2345) |
| | [0.4101] | [0.1556] | [0.7339] | [0.4825] |
| | -1.0000*** | -1.7963** | -3.5606*** | -0.9551*** |
| Wood and products of wood and cork | ( 0.2025) | ( 0.7027) | ( 0.3882) | ( 0.2075) |
| | [0.5892] | [0.2777] | [0.8319] | [0.5548] |
| | -1.2881*** | -0.7904 | -0.1649* | -0.6190** |
| Chemicals excluding pharmaceuticals | ( 0.4055) | ( 0.6703) | ( 0.0932) | ( 0.2636) |
| | [0.3725] | [0.0756] | [0.1554] | [0.2449] |
| | -1.3653*** | -0.9935 | -0.6746*** | -0.7703*** |
| Pharmaceuticals | ( 0.2576) | ( 0.6560) | ( 0.1601) | ( 0.1887) |
| | [0.6230] | [0.1189] | [0.5108] | [0.4949] |
| | -2.1670*** | -1.3790 | -0.9337*** | -1.1677*** |
| Rubber and plastics products | ( 0.7201) | ( 0.9387) | ( 0.1660) | ( 0.3872) |
| | [0.3476] | [0.1127] | [0.6505] | [0.3486] |
| | -1.3418*** | -2.1729*** | -1.2828*** | -1.1867*** |
| Other non-metallic mineral products | ( 0.2765) | ( 0.7112) | ( 0.1436) | ( 0.2600) |
| | [0.5807] | [0.3545] | [0.8244] | [0.5506] |
| | -0.2620*** | -2.9063*** | -0.9944*** | -0.9299*** |
| Iron and steel | ( 0.0457) | ( 0.8894) | ( 0.1125) | ( 0.2210) |
| | [0.6590] | [0.3858] | [0.8213] | [0.5102] |
| | -0.9168*** | -2.0163** | -1.9789*** | -1.0342*** |
| Fabricated metal products, except mach. | ( 0.1972) | ( 0.8329) | ( 0.2815) | ( 0.2422) |
| | [0.5597] | [0.2563] | [0.7440] | [0.5175] |
| | -0.3474 | -2.2589** | -1.7856*** | -1.0506*** |
| Machinery and equipment, nec | ( 0.2318) | ( 0.7815) | ( 0.2419) | ( 0.2278) |
| | [0.1167] | [0.3295] | [0.7622] | [0.5558] |
| | - 10.0836*** | -0.4163 | -0.3109 | -1.1802*** |
| Office, accounting and computing mach. | ( 1.6065) | ( 0.3984) | ( 0.2406) | ( 0.1890) |
| | [0.6986] | [0.0603] | [0.0895] | [0.6964] |
| | -0.5807*** | -2.8249*** | -1.1299*** | -1.0320*** |
| Electrical machinery and apparatus, nec | ( 0.1255) | ( 0.7353) | ( 0.1774) | ( 0.1923) |
| | [0.5575] | [0.4647] | [0.7048] | [0.6287] |
| | 0.3479* | -3.8523*** | -0.2909** | -0.7869*** |
| Radio, television and communication eq. | ( 0.1686) | ( 1.2547) | ( 0.1163) | ( 0.2489) |
| | [0.2004] | [0.3567] | [0.2691] | [0.3703] |

*Continued on next page...*

*... table 25 continued*

| Sector | $f_1$ | $f_2$ | $f_1$ | $flex$ |
|---|---|---|---|---|
| | -6.8605*** | -2.0855** | -0.9361*** | -1.7506*** |
| Medical, precision and optical inst. | ( 1.8037) | ( 0.7429) | ( 0.2377) | ( 0.4881) |
| | [0.4598] | [0.3167] | [0.4770] | [0.4308] |
| | -0.0361 | -4.5627*** | -1.1125*** | -1.2044*** |
| Motor vehicles, trailers and semi-trail | ( 0.1010) | ( 1.0043) | ( 0.1293) | ( 0.2341) |
| | [0.0075] | [0.5484] | [0.8132] | [0.6089] |
| | -2.2861** | -2.2215* | -0.0442 | -1.1976** |
| Building and repairing of ships and boats | ( 0.7964) | ( 1.2298) | ( 0.2209) | ( 0.4178) |
| | [0.3265] | [0.1610] | [0.0023] | [0.3258] |
| | -1.8172*** | -3.0874** | -0.3534 | -1.3383*** |
| Railroad equipment and transport eq. | ( 0.4315) | ( 1.0998) | ( 0.2089) | ( 0.3480) |
| | [0.5105] | [0.3167] | [0.1442] | [0.4653] |
| | -1.0190*** | -2.0526** | -5.2185*** | -1.0337*** |
| Manufacturing nec | ( 0.2942) | ( 0.9593) | ( 0.8397) | ( 0.2752) |
| | [0.4137] | [0.2122] | [0.6944] | [0.4535] |

Notes: Significance levels: $*$ : 10% $**$ : 5% $***$ : 1%. Standard errors in parenthesis. $R^2$ in brackets. In all regressions $EPL$ is the explanatory variable and flex is the dependent variable. The regressions are performed at the sector level.

Table 26: Elasticity of job creation 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 | -.436 | -.160 | | | | | | |
| | 50 | -.224 | .074 | | | | | | |
| | 90 | .405 | .767 | | | | | | |
| HighTech Elasticity | 10 | | | -.013 | -2.282 | -6.018** | -5.439* | | |
| | 50 | | | .051 | -2.216 | -5.961** | -5.400* | | |
| | 90 | | | .242 | -2.020 | -5.794** | -5.286** | | |
| LowTech Elasticity | 10 | | | .089 | .485 | | | .824* | 1.159** |
| | 50 | | | .346 | .861 | | | 1.051** | 1.427*** |
| | 90 | | | 1.104 | 1.974** | | | 1.724*** | 2.221*** |
| F-test: equal elasticities | 10 | | | .017 | 6.463** | | | | |
| | 50 | | | .115 | 6.794** | | | | |
| | 90 | | | .610 | 7.265** | | | | |
| | Flexibility, percentile | Openness, percentile 90 | | | | | | | |
| ExRate Elasticity | 10 | .105 | .573 | | | | | | |
| | 50 | .318 | .807 | | | | | | |
| | 90 | .946 | 1.500 | | | | | | |
| HighTech Elasticity | 10 | | | -.147 | -.051 | -2.435* | -2.052 | | |
| | 50 | | | -.082 | .015 | -2.379* | -2.014 | | |
| | 90 | | | .109 | .211 | -2.211 | -1.900 | | |
| LowTech Elasticity | 10 | | | 1.469 | 1.077 | | | 1.105 | 1.431 |
| | 50 | | | 1.725 | 1.453 | | | 1.332 | 1.699 |
| | 90 | | | 2.484** | 2.566** | | | 2.004* | 2.493** |
| F-test: equal elasticities | 10 | | | 3.178* | 1.344 | | | | |
| | 50 | | | 5.837* | 2.577 | | | | |
| | 90 | | | 5.179** | 3.752* | | | | |

Notes: see notes to Table 12.

Table 27: Elasticity of job destruction 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 | -.790 | -.945 | | | | | | |
| | 50 | -.930 | -.965 | | | | | | |
| | 90 | -1.344 | -1.025 | | | | | | |
| HighTech Elasticity | 10 | | | .763 | .989 | 1.059 | 1.310 | | |
| | 50 | | | .857 | 1.265 | .744 | 1.025 | | |
| | 90 | | | 1.132 | 2.082 | -.190 | .182 | | |
| LowTech Elasticity | 10 | | | -2.060* | -1.859 | | | -2.526* | -2.320 |
| | 50 | | | -2.397** | -2.039 | | | -2.683* | -2.445 |
| | 90 | | | -3.395*** | -2.573** | | | -3.147** | -2.814 |
| F-test: equal elasticities | 10 | | | 4.342* | 4.319* | | | | |
| | 50 | | | 4.028* | 4.164* | | | | |
| | 90 | | | 3.401* | 3.770* | | | | |
| | Flexibility, percentile | | | | Openness, percentile 90 | | | | |
| ExRate Elasticity | 10 | -1.391 | -1.721 | | | | | | |
| | 50 | -1.531 | -1.741 | | | | | | |
| | 90 | -1.944* | -1.800 | | | | | | |
| HighTech Elasticity | 10 | | | -.718 | -.912 | -.120 | -.274 | | |
| | 50 | | | -.625 | -.636 | -.435 | -.559 | | |
| | 90 | | | -.349 | .181 | -1.369 | -1.402 | | |
| LowTech Elasticity | 10 | | | -3.186** | -2.223* | | | -3.917*** | -2.924 |
| | 50 | | | -3.524** | -2.404* | | | -4.074*** | -3.049* |
| | 90 | | | -4.522*** | -2.938** | | | -4.538*** | -3.418* |
| F-test: equal elasticities | 10 | | | 4.262* | 1.826 | | | | |
| | 50 | | | 8.683*** | 1.511 | | | | |
| | 90 | | | 3.580* | 2.513 | | | | |

Notes: see notes to Table 14.

Table 28: Elasticity of job reallocation 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 | -1.226 | -1.105 | | | | | | |
| | 50 | -1.154 | -.891 | | | | | | |
| | 90 | -.939 | -.258 | | | | | | |
| HighTech Elasticity | 10 | | | .750 | -1.293 | -4.958*** | -4.128** | | |
| | 50 | | | .908 | -.951 | -5.217*** | -4.375** | | |
| | 90 | | | 1.375 | .062 | -5.984*** | -5.104** | | |
| LowTech Elasticity | 10 | | | -1.971* | -1.374 | | | -1.702 | -1.161 |
| | 50 | | | -2.052* | -1.178 | | | -1.632 | -1.018 |
| | 90 | | | -2.291** | -.600 | | | -1.424 | -.593 |
| F-test: equal elasticities | 10 | | | 3.172* | .003 | | | | |
| | 50 | | | 2.712 | .019 | | | | |
| | 90 | | | 1.905 | .071 | | | | |
| | Flexibility, percentile | Openness, percentile 90 | | | | | | | |
| ExRate Elasticity | 10 | -1.285 | -1.148 | | | | | | |
| | 50 | -1.213 | -.934 | | | | | | |
| | 90 | -.998 | -.300 | | | | | | |
| HighTech Elasticity | 10 | | | -.865 | -.963 | -2.555** | -2.326 | | |
| | 50 | | | -.707 | -.621 | -2.814*** | -2.573* | | |
| | 90 | | | -.240 | .392 | -3.580** | -3.302* | | |
| LowTech Elasticity | 10 | | | -1.717 | -1.146 | | | -2.812 | -1.493 |
| | 50 | | | -1.798 | -.951 | | | -2.742 | -1.350 |
| | 90 | | | -2.038 | -.372 | | | -2.534 | -.925 |
| F-test: equal elasticities | 10 | | | .295 | .013 | | | | |
| | 50 | | | .265 | .187 | | | | |
| | 90 | | | .469 | .095 | | | | |

Notes: see notes to Table 16.

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