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Sectoral Employment Effects of Trade and Productivity in Europe.

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DISCUSSION PAPER

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Abstract

This paper assesses the impact of trade and technology in the European case. A framework is developed which incorporates employment effects of (i) export expansion (ii) import competition and (iii) labour saving productivity improvements. In this context, evidence is found for the hypothesis that international trade induces adjustments in technology.

JEL classification :F 16 : Trade and Labour Market Interactions

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1 Introduction

In recent years, a growing number of articles investigate the impact of international trade on labour markets. Most of the papers focus on the US experience and view international trade specialisation as one possible explanation for job losses. Although dissenting opinions exist (Wood, 1994), the consensus view is that international trade only plays a minor role and that the primary driving force of US labour market trends is technological change (Berman, Bound and Griliches, 1994, Krugman and Lawrence, 1996).

This paper studies the impact of international trade on sectoral employment in a European context. There are three valid reasons for doing so. First, European countries are much more open than the United States. In 1996, the export/GDP ratio is 30 % for the EU-15 whereas it is 11 % for the US[1]. Especially the Netherlands and Belgium which experience respectively an export/GDP ratio of 53 % and 68 % are typical examples of small open economies with a high degree of openness. Krugman (1995) among others argues that the evolution of exports and imports cannot explain US labour market developments because the US economy is just not open enough for trade to matter a lot. Turning this argument around, we expect significant employment effects from European trade.

The second motivation refers to the rigid labour markets in Europe. For the EU-15, the unemployment rate currently stands at 10 % (OECD, 1999). Minimum wages, strong unions and other institutional features prevent wages from going down in order to bring down unemployment. Moreover, the reallocation between sectors in the European economies is slow and quite limited due to insufficient labour mobility and generous unemployment benefits (see Decressin and Fatas, 1995, for a comparison of the US and the European experience). This justifies a detailed look at trade-related employment changes at the sectoral level and would imply that the assumption of full labour mobility in conventional trade models serves at best as a long-run approximation. In the European case, it is also important to consider hiring and firing costs which make changes in employment more difficult.

A third and final reason concerns the dichotomy between technical change and international trade that underlies the debate on US labour market de-

[1] These figures are calculated with data from the National Accounts of the OECD Statistical Compendium 1998/2.

velopments. International trade and technological progress are seen as mutually exclusive explanations of employment changes. In Europe however, business leaders and company surveys usually emphasise the link between international trade and the introduction of new technologies and production methods (see Abraham and Konings, 1999). Export expansion gives rise to productivity gains and in the case of import competition companies may end up restructuring. Theoretically speaking, this means that trade variables influence productivity and therefore indirectly affect employment. Hence, a distinction should be made between direct and technology-induced indirect effects of trade on employment. An innovation of this paper is to develop a framework that allows us to empirically distinguish between those direct and indirect effects.

The remainder of the paper is structured as follows. In the next paragraph, we analyse the relation between trade, technology and labour markets based on the existing theoretical and empirical literature. In section 2, we derive a European model for employment adjustments that serves as the basis for the empirical work. The third section presents the estimation results. The paper ends with a summary of the main insights.

2 Review of the literature

The Heckscher-Ohlin-Samuelson (HOS) theory is the most common framework to address the employment effects of trade. This theory is based on assumptions of perfect intersectoral mobility of all production factors and full employment[2]. International trade leads - through a world-wide equalisation of product prices - to a specialisation according to relative abundance of production factors.

In a stylised version of the model that is typically applied to industrialised countries like Europe, two types of labour (skilled and unskilled) are employed in a skill-intensive export sector and an import-competing sector with relatively more unskilled labour. From a sectoral perspective, an expansion of trade leads to an increase in demand for goods of the export sector which creates new jobs in this sector. We define the positive relation between

[2] Recent work by Davis (1998) drops the hypothesis of full employment by considering minimum wages.

an expansion of export demand and total sectoral employment as the *export demand effect.*

On the other hand, the import-competing sector experiences increased competition from countries with a relative abundance of cheap unskilled labour. Due to this import competition, jobs are lost. The negative impact of import competition on total sectoral employment is called the *import competition effect* in this paper.

The import competition and export demand effects arise naturally in a theoretical framework that analyses the role of unions in the transmission of trade shocks (Brander and Spencer (1988), Driffil and van der Ploeg (1995), Gaston and Treffler (1995), Huizinga (1993), Mezzetti and Dinopoulus (1991), Naylor (1998) and Vandenbussche and Konings (1998)). While the theoretical set-up of the model varies, these papers are cast in terms of interfirm rivalry in one industry. Import competition takes the form of a decline in output or market share of the domestic firm with respect to its foreign competitor(s). In a straightforward way, this leads to the domestic reduction in the sectoral employment level captured by the import competition effect. The export demand effect follows from the fact that trade integration offers domestic firms the opportunity to penetrate in the foreign market, raising exports and sectoral employment in the home country.

Among the extensive empirical work in this area, we focus on studies which concentrate on trade-related total employment changes at the sectoral level. Revenga (1992) for the US and Neven and Wyplosz (1999) for German, French, Italian and UK manufacturing use a product price methodology and focus on the import competition effect. Revenga finds a statistically significant but small impact of import prices on sectoral employment. Neven and Wyplosz find no clear pattern for the HOS effect of import competition on employment but they do observe a drastic restructuring in unskilled labour intensive industries. The work by Freeman and Revenga (1999) and by Larre (1995) draw a direct link between trade flows and employment in OECD countries. This has the advantage of not having to use international price data which are often of lower quality than the reported trade volumes (see Slaughter and Swagel, p. 17-18). Like most of the empirical research, those studies find only small labour market adjustments to international trade.

A growing literature looks at the relation between international trade and productivity. As one of the first, Wood (1994) asserted that international competition leads firms in the advanced economies to raise productivity by focusing on labour-saving innovations. This implies that there is an indirect negative employment effect which we call in this paper *the productivity effect of international trade on employment*.

Looking at this reasoning more carefully, the trade-related productivity effect on employment requires: (i) exports or/and import competition affect technology (measured by productivity) and (ii) this increase in productivity affects employment. Note that, in principle, the first condition can go in both directions. On the one hand, domestic companies may not be able to cope with foreign competition. In this case, internal restructuring in the form of lay-offs does not keep up with the decline in sales so that domestic firms are confronted with falling productivity. On the other hand, trade may induce firms to successfully introduce productivity-enhancing technologies. This situation is more plausible with large hiring and firing costs which are present in the European economies see Bertola (1990), Grubb and Wells (1993), Bentolila and Bertola (1990), Garibaldi (1998) and Booth (1997). Such hiring and firing costs unambigously decrease employment variation in response to various economic shocks. For the US, Bernard and Jensen (1998 and 1999) find no evidence for a positive impact of exports on productivity. Causality goes in the other direction : more productive firms become better exporters. The results of Lawrence (1999) who uses both price and quantity measures indicate that import competition has a positive impact on US total factor productivity. This effect was mainly present in skill-intensive sectors and industries competing with developing countries. With studies for Europe lacking, we further explore the link between international trade and productivity. But we go a step further by explicitly computing the employment effects of trade-related productivity changes.

3 A European model for employment adjustments

3.1 The set-up of the model

In the following pages we propose a European model for employment adjustments which explicitly relates changes in labour and total factor productivity to exports and imports in addition to capturing the export demand and import competition effects on sectoral employment. This model serves as a background for the empirical analysis which is the primary focus of this paper. We consider one representative sector for which a model of monopolistic competition is constructed. Product differentiation is consistent with the observation that the EU-countries' trade with each other and the rest of the world is mainly of the intra-industry type. In our derivations, the subscript i refers to a specific country. Assume that there are m countries. In each country, there are n_i identical firms in the representative industry. Therefore, firms within the same country charge the same price.

The worldwide real consumption (X) of the products of a representative industry is expressed in a Dixit-Stiglitz framework. In the following expression, X_i refers to the sectoral production of country i. Because of the assumption of n_i identical firms in the sector of this country i, X_i equals $n_i.x_i$ where x_i denotes the production of an individual firm. σ (with $\sigma \succ 1$) is the elasticity of substitution.

$$X = \left(\sum_{i=1}^{m} X_i^{(\sigma-1)/\sigma}\right)^{\sigma/(\sigma-1)} = \left(\sum_{i=1}^{m} (n_i.x_i)^{(\sigma-1)/\sigma}\right)^{\sigma/(\sigma-1)} \tag{1}$$

Standard utility maximisation (see Dixit and Stiglitz, 1977) yields the following demand function for the output of country i :

$$X_i = n_i.x_i = \left(\frac{p_i}{P}\right)^{-\sigma}.\frac{E}{P} \tag{2}$$

with p_i as the price which prevails for all firms in country i, $P = \left(\sum\limits_{i=1}^{m} p_i^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$ as the price index of manufacturing consumption and $E = p_i.X_i$ as the worldwide expenditures on the products of the representative sector. The inverse demand function is then equal to:

$$p_i = \frac{E}{X}\left(\frac{X_i}{X}\right)^{-1/\sigma} = \frac{E}{X}\left(\frac{n_i.x_i}{X}\right)^{-1/\sigma} \tag{3}$$

Next, we turn to the supply side of the model. Total costs of an individual firm in country i are the sum of fixed costs (F_i) and variable costs C_i. The variable costs are determined by the cost of labour (w_i) and capital (r_i). For the variable cost function, a Constant Returns to Scale Cobb-Douglas function is used (see Varian 1984, p.29). Therefore, the total costs C_i^{tot} are :

$$C_i^{tot} = F_i + C_i = F_i + K_i.A_i^{-1}.w_i^{\gamma_i}.r_i^{1-\gamma_i}x_i \qquad (4)$$

where $K_i = \gamma_i^{-\gamma_i}.\left(1-\gamma_i\right)^{(\gamma_i - 1)}$

In this expression, A_i refers to technological progress and K_i refers to a constant. When using expression (4), declining average costs and economies of scale are introduced. The profits of an individual firm are given by : $\pi_i = p_i.X_i - C_i^{tot}$. From expression (3) and assuming that firms are sufficiently small so that they are not able to influence aggregate production when their individual production rises, the perceived elasticity of demand equals σ. When c_i denotes marginal costs, the first order condition reduces to :

$$p_i.\left(1 - \frac{1}{\sigma}\right) = c_i \qquad (5)$$

with $c_i = K_i.A_i^{-1}.w_i^{\gamma_i}.r_i^{1-\gamma_i}$.

Combining expressions (3) and (5) gives the equilibrium sectoral demand/output of a representative sector in country i :

$$X_i = \left(\frac{\sigma}{\sigma - 1}\right)^{-\sigma}.c_i^{-\sigma}.E^{\sigma}.X^{1-\sigma} \qquad (6)$$

For deriving the conditional labour demand (l_i) of an individual firm, we apply Shepard's lemma to (4) :

$$l_i = K_i.A_i^{-1}.\gamma_i.w_i^{\gamma_i - 1}.r_i^{1-\gamma_i}.x_i \qquad (7)$$

Because firms within a sector are identical, total sectoral employment equals $L_i = n_i.l_i$:

$$L_i = K_i.A_i^{-1}.\gamma_i.w_i^{\gamma_i - 1}.r_i^{1-\gamma_i}.X_i \qquad (8)$$

Substituting (6) into (8) and using the expression for c_i, labour demand of a representative sector reduces to :

$$\begin{aligned} \ln\left(L_i\right) &= G_i + \sigma.\ln\left(E\right) - \left(\sigma - 1\right).\ln\left(X\right) \\ &\quad - \left(\gamma_i.\left(\sigma - 1\right) + 1\right).\ln\left(w_i\right) - \left(1 - \gamma_i\right).\left(\sigma - 1\right).\ln\left(r_i\right) \\ &\quad + \left(\sigma - 1\right).\ln\left(A_i\right) \end{aligned} \qquad (9)$$

with $G_i = (1 - \sigma).\ln\left(K_i\right) + \ln\left(\gamma_i\right) - \sigma.\ln\left(\sigma\right) + \sigma.\ln\left(\sigma - 1\right)$

3.2 The export demand effect

In equation (9), the variable E captures the effect of an expansion in world-wide expenditures on sectoral employment. According to the theoretical model where σ is larger than 1, we expect that an increase in this variable positively influences sectoral labour demand. For the purpose of this paper, we relate this variable E to the export demand effect discussed earlier. For this reason, we measure E by total sectoral export demand (EXP).

3.3 The import competition effect

In our model, enhanced foreign competition is captured by an increase in the sectoral output of a foreign country j. With the aid of equations (1) and (9), we compute the impact of increased foreign output on sectoral employment of country i :

$$\frac{\delta \ln(L_i)}{\delta \ln(X_j)} = \frac{\delta \ln(L_i)}{\delta \ln(X)} . \frac{\delta \ln(X)}{\delta \ln(X_j)} = -(\sigma - 1) . \left(\frac{P_j.X_j}{E}\right)^{(\sigma-1)/\sigma} \prec 0 \qquad (10)$$

As seen in the above equation, this effect is negative. Moreover, the higher the foreign market share (as measured by $P_j.X_j/E$), the stronger the negative impact on domestic sectoral employment. In our empirical work, we measure foreign import competition by the import penetration ratio which is defined as imports divided by the difference between production and net exports.

3.4 The productivity-related and total effects of international trade on employment

In our theoretical model, A_i measures the impact of technology on employment. In the empirical work, we want to distinguish between the cases of labour-saving and labour-augmenting technological progress. In addition, we need an indicator that captures the role of technology. Following a similar methodology as Card, Kramarz and Lemieux (1996), we measure the A_i-variable of expression (9) by two productivity variables in the regression equation for sectoral employment. The first variable we use is value added per worker (VA) which reflects gains in average labour productivity. The other variable, total factor productivity (TFP)[3], measures gains that raise productivity of all production factors. Let $PROD_i$ represent the variable used (VA_i or TFP_i) to predict the A_i-variable of equation (9) :

$$(\sigma - 1) . \ln (A_i) = \lambda . \ln (PROD_i) + \varepsilon_i \tag{11}$$

Based on equations (9) and (11), we specify the sectoral employment equation :

$$\begin{aligned} \ln(EMPL_{it}) &= \alpha_{i1} + \beta_1 . \ln (EXP_{it}) + \chi_1 . \ln (IMP_{it}) \\ &\quad + \eta_1 . \ln (WAGE_{it}) + \lambda_1 . \ln (PROD_{it}) + u_{1it} \end{aligned} \tag{12}$$

In this expression, i and t now denote respectively industry and time, a_{i1} refers to a dummy which captures omitted industry specific effects and u_{it} is the error term which represents a combination of the error term of expression (11) and other error terms due to estimation of equation (12). This regression equation provides an estimate of the impact of productivity on employment which is one aspect of the productivity effect of international trade on employment. When λ is positive, increases in productivity are labour-augmenting. If λ is negative, we obtain the case of labour-saving productivity increases[4].

The other aspect of the productivity effect of international trade on employment concerns the impact of trade integration on productivity. For this purpose, we introduce a second equation where productivity is regressed upon trade and other variables :

$$\begin{aligned} \ln(PROD_{it}) &= \alpha_{i2} + \beta_2 . \ln(EXP_{it}) + \chi_2 . \ln(IMP_{it}) \\ &\quad + \delta_2 . \ln(RD_{it}) + \phi_2 PAT_{it} + \varphi_2 . \ln(CAP_{it}) + u_{2it} \end{aligned} \tag{13}$$

Our main focus in equation (13) is on the regression coefficients for the export and import variable. These coefficients can be positive or negative depending on whether companies successfully improve productivity when faced

[3]The construction of this variable is discussed in the Appendix.

[4]According to expression (9), it is also clear that the wage elasticity should be negative. Also remark that the capital costs are omitted from the regression equation. Capital costs can however be captured by time dummies. Introducing these time dummies did not significantly change our results. Therefore, we did not include time dummies in our regression equations.

with international competition or are instead struggling with internal restructuring. The CAP variable refers to the capital stock per employee and is included because labour-saving technologies are usually accompanied by investment in new machinery[5]. RD are R&D expenditures per employee which act as an input indicator of innovation and PAT are the relative granted patents which are a measure for innovative output[6].

Combining the two aspects just mentioned yields the productivity effects of international trade on employment. For this purpose, it is useful to substitute equation (13) into equation (12).

$$\begin{aligned}\ln(EMPL)_{it} = {} & \alpha_i + \beta.\ln(EXP_{it}) + \chi.\ln(IMP_{it}) \\ & +\eta.\ln(WAGE_{it}) + \delta.\ln(RD_{it}) + \phi.PAT + \varphi.\ln(CAP_{it}) \\ & +u_{it}\end{aligned} \tag{14}$$

with $\alpha_i = \alpha_{i1} + \lambda_1.\alpha_{i2}$, $\beta = \beta_1 + \lambda_1.\beta_2$, $\chi = \chi_1 + \lambda_1.\chi_2$, $\eta = \eta_1$, $\delta = \lambda_1.\delta_2$, $\phi = \lambda_1.\phi_2$, $\varphi = \lambda_1.\varphi_2$ and $u_{it} = u_{1it} + \lambda_1.u_{2it}$.

In this equation, the effect of an increase in export demand on employment which occurs via an increase in productivity equals $\lambda_1.\beta_2$. Analogously, $\lambda_1.\chi_2$ refers to the productivity effect of increased import competition on employment. Equation (14) also yields the total impact of export demand on employment as measured by the β coefficient. This total effect is the sum of the export demand effect, β_1, and the productivity effect of exports on employment, $\lambda_1.\beta_2$. Similarly, χ captures the total impact of import competition on trade and consists of the direct (χ) and the productivity induced effects ($\lambda_1.\chi_2$) of import competition on sectoral employment.

[5]Note that when we use total factor productivity as the productivity variable, capital per employee will not be included in the regression equation because this last variable is included in the total factor productivity variable.

[6]Under relative granted patents, we understand the granted patents in a certain year relative to the total granted patents in that year. Note that this variable is not expressed in logarithms because for certain years the data show a value of 0.

4 An empirical investigation

4.1 Data description and econometric methodology

We estimate regression equations (12) and (13) for ten EU-countries : Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Spain, Sweden and the United Kingdom. For each country, the data set covers 9 sectors of the manufacturing sector classified according to the 'International Standard Industrial Classification' (ISIC) revision 2. Except for Spain, the data set starts at 1978 and ends at 1994 for most countries. The sources and the construction of the data are discussed in Appendix A. Except for import penetration and relative granted patents, all variables are deflated.

Like other trade-related empirical work (e.g. Coe and Helpman, 1995), we first need to confirm whether our data are nonstationary. When the data are nonstationary, we need to use first differences for our estimations. However, using first differences when variables turn out to be cointegrated would be counterproductive, since the long-term relationship between these variables would become obscured (Greene, 1997). We therefore performed several unit root and cointegration tests. First, we computed Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests for the data of the individual industries of the different countries. In general, these DF and ADF-tests show that the hypothesis of the presence of a unit root cannot be rejected. However, the power of these tests is very low since we are dealing with only seventeen annual observations in our panel. The work of Im, Pesaran and Shin (1996) shows DF and ADF tests which are quite easy to compute when working with panels with a small time and cross-section dimension. Their tests are based on the mean of the unit root statistics of the individual industries. Using the unit root and cointegration tests based on the work of these authors, it turns out that in general the hypothesis of the presence of a unit root of the different variables could not be rejected. Moreover, the cointegration tests showed that the error terms of the regressions are nonstationary most of the time. We however decided to give the regression results as well in levels as in first differences (see Appendix B and C) since the econometrics on unit root and cointegration tests for panel data is still in progress and our emphasis is on the theoretical model and the interpretation of the estimated coefficients.

The employment and productivity regression constitute a recursive model because the productivity equation does not contain any endogenous variables from the labour demand equation, while this latter equation contains endogenous variables coming from the the former equation. More specifically, the employment equation depends on productivity which in turn is explained by a set of exogenous explanatory variables. To capture in the employment equation *only the productivity changes that are explained by import penetration, export demand, capital intensity and technology variables,* we use a two stage least squares approach by substituting the fitted values of the productivity measure obtained by the regression results of equation (13) into equation (12). We furthermore use a fixed effects approach. We deal with an exhaustive sample and Hausman tests show that this fixed effects approach in comparison with the random effects is appropriate (Matyas and Sevestre, 1996).

Early regression results pointed to autocorrelation. In order to combine two stage least squares and a correction for autocorrelation, we use the methodology of Fair (1970). The productivity equation is estimated with the aid of a Cochrane-Orcutt iterative technique. In order to estimate the labour demand equation, we first estimate equation (13) without a correction for autocorrelation. The fitted values of this equation are then substituted in equation (12). Then, this equation is also estimated with a Cochrane-Orcutt iterative method. When using this approach, the standard errors of the employment equation are corrected for the use of the generated regressors from the first stage.

To check the robustness of our results, we performed several consistency checks which are not reported but can be obtained from the authors. We estimated regressions taken lags of several explanatory variables. In our view, this was most of all necessary for the R&D variable because investments in R&D take a long time to mature. In general, our results did not significantly change when lagged variables were introduced so that we present the estimation results without any lags.

4.2 The export demand effect

One important theme of this paper is the contribution of international trade to total sectoral employment in the European economy. Tables B.1., B.2., B.3. and B.4. (see Appendix B) show the results for regression equation (12) expressed in levels and first differences when using value added or total factor productivity as the productivity variable. The estimated results of these tables are quite satisfactory. Except for Italy and Spain, estimated coefficients of the export demand, import penetration, productivity and labour cost variables usually carry the expected signs and are in most cases significant at the conventional confidence levels.

Table 1 focuses on the export demand effect in greater detail by presenting the regression coefficients for β_1 in equation (12), using various estimation techniques. This table finds evidence for a robust export demand effect in most European countries. When using either the estimation results in levels or in first differences, statistically regression coefficients for exports with VA are in general higher when TFP is used as productivity variable. Comparing elasticities across countries, statistically significant regression coefficients range from 0.06 in France to 0.49 in Denmark. Strong export demand effects are also found in Sweden and the UK. With the exception of this last country, export growth appears to create more jobs in the smaller than in the larger European countries although differences between estimation techniques blur this picture somewhat.

Table 1: **The export demand effect**

	VA		TFP	
country	levels	first differences	levels	first differences
Belgium	0.16**	0.31**	0.09**	0.20**
Denmark	0.16**	0.40**	0.11*	0.49*
Finland	0.13**	0.41**	0.05	0.14*
France	0.06**	0.27**	0.07**	0.05
Germany	0.13**	0.12**	0.09*	0.22*
Italy	-0.02	0.05	-0.03	0.03
Netherlands	0.13**	0.29**	0.11**	0.11
Spain	0.03	0.07*	0.02	0.01
Sweden	0.19**	0.32**	0.12**	0.22**
UK	0.17**	0.34**	0.21**	0.26**

** significance at the 5 % level (two-tailed test)
* significance at the 10 % level (two-tailed test)

To get an idea of the importance of the export demand effect, we compute the accumulated export-induced employment creation in Denmark and

French manufacturing, the countries with the highest and lowest statistically significant elasticities. Tentatively applying an elasticity to the observed growth in real exports in the period 1978-1994 of 0.49 in the case of Denmark and 0.06 in the case of France, we obtain an accumulated employment creation of 143,850 jobs in Denmark and 186,357 jobs in France. This amounts to 28 % of the average workforce of 500,547 people during this period in Denmark and 3 % of the average workforce of 4,792,176 people during the same period in France. Those numbers are substantial and it is therefore unfortunate that the sectoral employment effects of export expansion receive scant attention in the trade-related literature.

4.3 The import competition effect

Turning to the import competition effect in Table 2, increased import penetration destroys sectoral employment in a number of countries. This effect is most present in the Scandinavian countries but also observed in the UK, the Netherlands and Belgium. Focusing again to the magnitude of the employment adjustments involved, we select Denmark with the strongest import competition effect of -0.82 and Belgium with the lowest statistically significant elasticity of -0.04. We note that import penetration in manufacturing grew by 24 % from 1978-1994 in Denmark and by 49 % in Belgium during this same period. From 1978-1994, import competition costs the job of 59,973 workers or 11 % of the average manufacturing labour force in Denmark. For Belgium, 16,034 jobs - which represents 1 % of the average labour force during 1978-1994 - were lost. These findings suggest that for some European countries import competition matters a lot, while for others import competition is not the main driving force for employment adjustments. This clearly is in contrast with the basic thrust of the literature where there is little evidence for the import competition effect. As argued earlier, most studies focus on the US which is less open than Europe. Therefore, employment effects caused by increased import competition may be higher in Europe than in the US.

Table 2: **The import competition effect**

	VA		TFP	
country	levels	first differences	levels	first differences
Belgium	-0.04**	-0.17**	-0.01	-0.05
Denmark	-0.45**	-0.66**	-0.49**	-0.82**
Finland	-0.18**	-0.18	-0.21**	-0.18**
France	0.007	-0.16*	0.003	-0.003
Germany	0.05	-0.03	0.06	-0.06
Italy	-0.01	-0.05*	-0.01	-0.06*
Netherlands	-0.10*	-0.34**	-0.08	-0.08
Spain	0.05	-0.04	0.05	-0.01
Sweden	-0.45**	-0.97**	-0.41**	-0.38**
UK	-0.12**	-0.27**	-0.16**	-0.20**

** significance at the 5 % level (two-tailed test)
* significance at the 10 % level (two-tailed test)

4.4 Trade and productivity

In the analysis of the productivity effects of international trade on employment one important condition related to the impact of exports and imports on productivity. The regression results of the productivity equation (13) are given in Tables C.1., C.2., C.3. and C.4. and summarised in Tables 3 and 4. From Table 3, exports emerge as a statistically significant source of productivity gains in virtually all cases. Belgium tops the list with the strongest impact of exports on productivity. The ranking of the other countries varies depending on which estimation method and productivity variable was chosen. Interesting and plausible are the consistently higher coefficients when the total productivity variable is used. Export growth appears to raise the efficiency of both capital and labour such that the adjustment in labour productivity captures only one fourth to half of the gains in total factor productivity.

Our evidence for productivity gains from export growth are in contrast with Bernard and Jensen's claim that in US manufacturing the causality goes the other way around. To check their hypothesis in our data set, we ran

Granger causality tests which suggest that, most often, the link goes from exports to productivity.

Table 3: **The productivity effect of exports**

	VA		TFP	
country	levels	first differences	levels	first differences
Belgium	0.33^{**}	0.38^{**}	0.82^{**}	0.83^{**}
Denmark	0.20^{**}	0.25^{**}	0.81^{**}	0.79^{**}
Finland	0.16^{**}	0.15^{**}	0.33^{**}	0.35^{**}
France	0.28^{**}	0.30^{**}	0.64^{**}	0.65^{**}
Germany	0.20^{**}	0.19^{**}	0.58^{**}	0.59^{**}
Italy	0.24^{**}	0.23^{**}	0.52^{**}	0.48^{**}
Netherlands	0.20^{**}	0.22^{**}	0.77^{**}	0.81^{**}
Spain	0.10^{**}	0.16^{**}	0.26^{**}	-0.15
Sweden	0.26^{**}	0.23^{**}	0.61^{**}	0.59^{**}
UK	0.18^{**}	0.14^{**}	0.44^{**}	0.39^{**}
** significance at the 5 % level (two-tailed test)				
* significance at the 10 % level (two-tailed test)				

Turning to the productivity effect of import penetration (see Table 4), we obtain negative regression coefficients that are statistically significant for all (several) countries when total factor productivity (value added per worker) is used as the dependent variable. Large negative effects are found in Sweden, the Netherlands and Denmark (in the regressions with TFP) and to a lesser extent in Belgium and Germany. Opposite to Wood's hypothesis, we conclude that increased import competition causes a loss in productivity. This supports the view that companies are unable to scale down their factor use at the same rate as rising foreign competition reduces their sales. Restructuring is a difficult process in Europe.

Table 4: **The productivity effect of import competition**

	VA		TFP	
country	levels	first differences	levels	first differences
Belgium	-0.15**	-0.16**	-0.35**	-0.34**
Denmark	-0.09	-0.17	-0.96**	-0.98**
Finland	-0.04	-0.04	-0.11**	-0.13**
France	-0.08	-0.14**	-0.21**	-0.22**
Germany	-0.14**	-0.20**	-0.33**	-0.35**
Italy	-0.04	-0.03	-0.23**	-0.20**
Netherlands	-0.30**	-0.30**	-0.85**	-0.87**
Spain	0.004	0.0009	-0.24**	0.39**
Sweden	-0.52**	-0.57**	-0.35**	-0.46**
UK	-0.13	-0.11*	-0.33**	-0.31**

** significance at the 5 % level (two-tailed test)
* significance at the 10 % level (two-tailed test)

As Lawrence (1999) points out, our results might reflect reverse causation as the link between international trade and productivity can go in both directions. Import and export competition can trigger higher productivity, while in the mean time sectors confronted with falling (growing) productivity may tend to have high levels of import competition (exports). One way to deal with this reverse causation is the use of an instrumental variables (IV) approach. As suggested by the HOS theory, skill- and capital intensity form appropriate instruments (see Lawrence (1999)). Because of data limitations, we have taken the lagged trade variables as instruments. The consistency checks indicate that the regression coefficients of the trade variables are no longer significant, especially when using estimations in first differences. As the standard errors of the IV-estimates are quite high, the obtained regression results might be attributed to the use of weak instruments[7].

[7] Especially for the data in first differences, the correlation between the current and lagged trade variables is extremely weak. This is a possible indicator of weak instrumental variables.

4.5 Productivity and employment

The second condition for a meaningful productivity effect of trade on employment concerns the employment adjustment to productivity changes. To capture this relationship, we estimate equation (12) where we instrument the productivity variable by using the fitted values for VA and TFP from the productivity regression (13). Based on the results in Appendix B, Table 5 present the relevant information. We obtain moderate to strong negative regression coefficients for the productivity effect on employment when value added per worker is used as the productivity variable, in particular when the employment equation is estimated in first differences. With a few exceptions, we do not find a statistically significant relationship between employment and productivity when TFP is considered. Apparently, shocks that raise labour productivity are labour-saving, most of all in the Scandinavian countries and in the UK. But factor neutral productivity changes do not destroy jobs.

Table 5: **Productivity and employment**

	VA		TFP	
country	levels	first differences	levels	first differences
Belgium	-0.10**	-0.71**	0.04	-0.15
Denmark	-0.17**	-1.45**	-0.02	-0.49**
Finland	-0.39**	-2.80**	-0.04	-0.42**
France	-0.09**	-0.71**	-0.01	-0.04
Germany	-0.13**	-0.34**	0.004	-0.29*
Italy	-0.04	-0.46**	-0.01	-0.17
Netherlands	-0.03	-0.85**	0.03	-0.03
Spain	-0.09	-0.26*	-0.04*	-0.07
Sweden	-0.15**	-1.61**	0.03	-0.19
UK	-0.13**	-1.34**	-0.03	0.005
** significance at the 5 % level (two-tailed test)				
* significance at the 10 % level (two-tailed test)				

4.6 Productivity-related and total effects of international trade on employment

In Table 6 we bring together direct and productivity-induced employment adjustments to export demand. We first reproduce our earlier estimates for the export demand where VA is used as the productivity variable. Subsequently, we compute the elasticities that measure the productivity effect of exports and import competition on employment from the parameter values reported earlier tables.[8]Since only changes in labour productivity affect employment, we only report estimates for the value added per worker productivity variable. Finally, we calculate the total elasticities of respectively export demand and import competition on employment by summing up the figures in the previous two columns.

Table 6: **The productivity and total effects of exports on employment with VA**

	levels			first differences		
County	export demand effect	productivity-related effect	total effect	export demand effect	productivity-related effect	total effect
Belgium	0.16	-0.03	0.13	0.31	-0.26	0.05
Denmark	0.16	-0.03	0.13	0.40	-0.36	0.04
Finland	0.13	-0.06	0.07	0.41	-0.42	-0.01
France	0.06	-0.02	0.04	0.27	-0.21	0.06
Germany	0.13	-0.02	0.11	0.12	-0.06	0.06
Italy	-0.02	-0.009	-0.029	0.05	-0.10	-0.05
Netherlands	0.13	-0.006	0.124	0.29	-0.18	0.09
Spain	0.03	-0.009	0.021	0.07	-0.04	0.03
Sweden	0.19	-0.03	0.16	0.32	-0.37	-0.05
UK	0.17	-0.02	0.15	0.34	-0.18	0.16

Table 6 makes an interesting point. Export growth raises labour productivity which offsets part of the employment created by rising export demand. While level estimates vary from country to country, export-induced gains in labour productivity typically destroy one out of every 5 to 7 jobs created

[8]This effect is not estimated directly so that no statistical significance tests can be reported.

by export expansion. This ratio rises to one out of three workers in France and even half of the employment creation in Finland. These export-related productivity effects are much stronger when using first differences in the estimations. This reduces considerably the positive employment effects of an expansion in export demand.

In Table 7 we provide similar information for the import competition variable. The positive productivity effect of import competition on employment is not as intuitive as the jobs lost when exporting firms adopt more efficient technologies. Most plausibly, we are capturing the lay-offs prevented by the inability of companies - when faced with stronger import competition - to smoothly readjust their labour force to falling output levels. In the case of estimations in levels, the productivity effect is - except for Belgium and France - relatively small in comparison with the import competition effect . When however using estimations in first differences, the opposite holds. For Belgium, Finland, Germany, the Netherlands, Sweden and the UK, half of the jobs lost by increasing import competition are compensated by the positive productivity effect.

Table 7: **The productivity and total effects of import competition on employment with VA**

	levels			first differences		
Country	import competition effect	productivity-related effect	total effect	import competition effect	productivity-related effect	total effect
Belgium	-0.04	0.01	-0.03	-0.17	0.11	-0.06
Denmark	-0.45	0.01	-0.44	-0.66	0.24	-0.40
Finland	-0.18	0.01	-0.17	-0.18	0.11	-0.07
France	0.007	0.007	0	-0.16	0.09	-0.07
Germany	0.05	0.01	0.06	-0.03	0.06	0.03
Italy	-0.01	0.001	-0.009	-0.05	0.01	-0.04
Netherlands	-0.10	0.009	-0.09	-0.34	0.25	-0.09
Spain	0.05	-0.0003	0.04	-0.04	0.0002	-0.04
Sweden	-0.45	0.07	-0.38	-0.97	0.91	-0.06
UK	-0.12	0.01	-0.11	-0.27	0.14	-0.13

5 Conclusion

This paper deals with the sectoral employment effects of international trade in Europe. It offers several contributions to the rapidly expanding literature on trade, technology and employment.

First, we provide evidence that trade matters for employment in Europe. With this finding, we go against the thrust of the US-focused literature which attributes only a secondary role to trade-related labour market adjustment. The fact that most European countries are more open economies undoubtedly explains part of this result. But we also believe that, in a European context with rigid labour markets and limited intersectoral labour reallocation, our modelling of *sectoral* employment adjustments explains why we observe significant trade-related employment effects. Most importantly, our empirical work highlights the importance of export growth as a key engine of job creation. This point is often lost in the literature which focuses heavily on the detrimental impact of increased import competition on employment and wages.

As a second contribution, this paper puts in doubt the distinction between trade and technology as independent sources of employment changes. In most European countries of our sample, international trade affect productivity. More specifically, rising export demand increases labour and total productivity, a point frequently made by European business leaders. By contrast, sectors confronted with increased import competition experience a decline in productivity indicating that the reduction in factor use does not keep up with the loss in market share. This scenario of inflexible sectoral restructuring is consistent with the conventional view that European labour markets are rigid and constrained by stringent hiring and firing conditions.

The consequences for employment of the relationship between trade and productivity leads to a third major theme of this paper. We show that employment responds to trade-induced changes in average labour productivity. The possibility of such an indirect technology-related link from international trade to employment was already emphasised by authors such as Wood. Our contribution is to develop and to apply a framework that quantifies this productivity effect of international trade on employment. Perhaps the most striking outcome of this empirical exercise is that part of the employment created by an expansion of export demand is neutralised by the negative employment effect of an export-induced increase in labour productivity. Interestingly, this suggests that export growth rather than import competition encourages the introduction of labour-saving production methods that are so common in European industry.

The results of this paper leave open several paths for future research. One suggestion is a closer look at the differences in employment responses across countries. Quite often in our regression results, the Scandinavian countries but - to a lesser extent - also the UK and the Benelux countries, are affected more profoundly by trade and productivity than the other European countries of our sample. Another promising route would be to exploit the sectoral dimension of the panel and to compare the employment adjustments in sectors with different structural characteristics. Finally, one could geographically disaggregate trade flows to analyse the contribution of various trading partners to sectoral employment changes. We intend to address these issues in future work.

Appendix A

The following countries are covered in our data set : Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Spain, Sweden and the United Kingdom. 9 sectors of the manufacturing sector which are classified according to the 'International Standard Industrial Classification' (ISIC) revision 2 are used : food, beverages and tobacco (ISIC 31), textiles, apparel and leather (ISIC 32), wood products and furniture (ISIC 33), paper, paper products and printing (ISIC 34), chemical products (ISIC 35), non-metallic mineral products (ISIC 36), basic metal industries (ISIC 37), fabricated metal products (ISIC 38) and other manufacturing (ISIC 39). The starting year of the data set is 1978 for all countries except for Spain where it is 1980. Data are used until 1994 except for Denmark, Spain and Germany. The end points for the first two countries are 1992, whereas the data for Germany go until 1993.

The data for employment, labour costs, import, export, production and value added are obtained from the OECD Stan Database for Industrial Analysis (1997). The data for employment cover the number of employees as well as self-employed, working proprietors and unpaid family workers. The gross wage data per employee cover wages and various supplements such as employer's compulsory pension or medical payments. Except for the import penetration and the relative granted patents, all variables are expressed in constant prices. The deflators are calculated with the aid of value added in current and constant prices per industry.

For productivity, we have two variables : value added per worker and total factor productivity which is transformed into indices where 1990 is the base year. The percentage change of the total factor productivity can be expressed as follows :

$$\dot{A} = \left(\dot{Q} - \dot{L}\right) - \alpha.\left(\dot{K} - \dot{L}\right) \tag{15}$$

In this expression, the first term refers to the percentage change in the output-labour ratio. In the second term, α refers to the capital share in production. Therefore, $(1-\alpha)$ refers to the labour share in production which is calculated as the share of labour costs in value added. For some sectors, labour costs exceed value added due to the existence of e.g. losses in these sectors or because the industry receives significant net subsidies. Therefore, an average is calculated[9]. $\left(\dot{K}-\dot{L}\right)$refers to the percentage change in the capital-labour ratio. For the capital data, we distinguish two series. For Belgium, Denmark, Finland, France, Germany and Sweden gross capital stock data expressed in 1990 prices are obtained from the International Sectoral Data Base from the OECD Statistical Compendium 1998/2. For Italy, the Netherlands, Spain and the UK, capital data are constructed with the aid of deflated investment data (I_t) from the OECD Stan Database for Industrial Analysis (1997)[10]. Following Griliches (1979), we first compute an initial capital stock for 1978 (and 1980 for Spain). If we assume that both the depreciation rate (δ) and the annual growth rate (η) of the past investments are constant, the initial capital stock (K_{1978}) equals :

$$\begin{aligned} K_{1978} &= I_{1978}+(1-\delta).\lambda.I_{1978}+(1-\delta)^2.\lambda^2.I_{1978} \\ &\quad +(1-\delta)^3.\lambda^3.I_{1978}+... \\ &= I_{1978}.\left(\frac{1}{1-\lambda.(1-\delta)}\right) \end{aligned} \tag{16}$$

with $\lambda = 1/(1+\eta)$ where η is the mean annual rate of growth of investments over the period 1970-1978. Like Schott (1998) and Maskus (1991), we use a depreciation rata of 13.33 percent. After having obtained the initial capital stock, deflated investments series are accumulated and depreciated from 1978 onwards.

Our patent variable measures the relative granted patents. Under relative granted patents, we understand the granted patents in one industry relative to all granted patents in a certain year. The patent data cover patents within the EPO (European Patent Office). The classification is the International Patent Classification (IPC). The conversion to the ISIC-classification is computed with the aid of the correspondance table of Verspagen, van Moergastel and Slabbers (1994). Except for Belgium, the data for expenditures in R&D come from the Analytical Business Enterprise Research and Development (ANBERD) series from 'Research and Development Expenditure in Industry' (OECD, 1995). For Belgium, data for 1978-1991 are obtained from

[9]Another way to calculate the cost shares of capital is to construct a figure for capital services using the concept of user cost of capital (see Griliches and Ringstad, 1971).

[10]A more complete description of how the second capital series is constructed is available from the authors upon request.

the Official Business Enterprise Research and Development (OFFBERD) series and for the period 1994-1995 we use data of the DWTC (Dienst voor Wetenschappelijke, Technische en Culturele Aangelegenheden). All data are converted to the ISIC revision 2 according to the correspondance table in OECD (1994). With the aid of a spline interpolation technique, missing observations are filled in.

Appendix B

Table B.1. : **The regression results of the employment equation with VA estimated in levels**

country	ln(IMP)	ln(EXP)	ln(WAGE)	ln(VA)	R^2
Belgium	-0.04**	0.16**	-0.15**	-0.10**	0.99
	(-2.09)	(5.20)	(-4.55)	(-3.70)	
Denmark	-0.45**	0.16**	-0.15**	-0.17**	0.99
	(-4.49)	(2.82)	(-2.25)	(-3.56)	
Finland	-0.18**	0.13**	-0.14**	-0.39**	0.99
	(-3.26)	(3.76)	(-2.30)	(-7.42)	
France	0.007	0.06**	-0.09**	-0.09**	0.99
	(0.17)	(2.45)	(-2.22)	(-3.50)	
Germany	0.05	0.13**	-0.22**	-0.13**	0.99
	(1.11)	(3.18)	(-2.42)	(-2.67)	
Italy	-0.01	-0.02	-0.04	-0.04	0.99
	(-0.45)	(-1.09)	(-0.84)	(-1.57)	
Netherlands	-0.10*	0.13**	-0.23**	-0.03	0.99
	(-1.85)	(3.86)	(-5.16)	(-0.80)	
Spain	0.05	0.03	-0.05	-0.09	0.99
	(1.53)	(0.90)	(-0.58)	(-1.18)	
Sweden	-0.45**	0.19**	-0.22**	-0.15**	0.99
	(-6.36)	(4.96)	(-4.22)	(-4.71)	
UK	-0.12**	0.17**	-0.31**	-0.13**	0.99
	(-2.26)	(4.83)	(-4.95)	(-3.88)	

** significance at the 5 % level (two-tailed test)
* significance at the 10 % level (two-tailed test)

Table B.2. : **The regression results of the employment equation with VA estimated in first differences**

country	ln(IMP)	ln(EXP)	ln(WAGE)	ln(VA)	R^2
Belgium	-0.17**	0.31**	-0.04	-0.71**	0.24
	(3.33)	(3.85)	(-0.77)	(-3.72)	
Denmark	-0.66**	0.40**	-0.01	-1.45**	0.07
	(-2.53)	(2.19)	(-0.07)	(-2.64)	
Finland	-0.18	0.41**	-0.06	-2.80**	0.12
	(-1.21)	(2.22)	(-0.36)	(-2.62)	
France	- 0.16*	0.27**	-0.05	-0.71**	0.17
	(-1.95)	(3.58)	(-0.71)	(-3.54)	
Germany	-0.03	0.12**	-0.17*	-0.34**	0.31
	(-0.66)	(2.43)	(-1.81)	(-2.30)	
Italy	-0.05*	0.05	-0.01	-0.46**	0.17
	(-1.69)	(1.03)	(-0.22)	(-2.05)	
Netherlands	-0.34**	0.29**	-0.21**	-0.85**	0.45
	(-3.15)	(4.05)	(-3.83)	(-3.04)	
Spain	-0.04	0.07*	-0.03	-0.26*	0.43
	(-1.44)	(1.82)	(-0.31)	(-1.92)	
Sweden	-0.97**	0.32**	0.03	-1.61**	0.14
	(-3.20)	(2.34)	(0.19)	(-3.30)	
UK	-0.27**	0.34**	-0.18	-1.34**	0.34
	(-3.15)	(4.91)	(-1.37)	(-3.45)	

** significance at the 5 % level (two-tailed test)

* significance at the 10 % level (two-tailed test)

Table B.3. : **The regression results of the employment equation with TFP estimated in levels**

country	ln(IMP)	ln(EXP)	ln(WAGE)	ln(TFP)	R^2
Belgium	-0.01	0.09^{**}	-0.15^{**}	0.04	0.99
	(-0.74)	(2.48)	(-4.25)	(1.61)	
Denmark	-0.49^{**}	0.11^{*}	-0.12^{*}	-0.02	0.99
	(-4.83)	(1.88)	(-1.85)	(-0.47)	
Finland	-0.21^{**}	0.05	-0.12^{*}	-0.04	0.99
	(-3.66)	(1.46)	(-1.83)	(-0.72)	
France	0.003	0.07^{**}	-0.12^{**}	-0.01	0.99
	(0.08)	(2.37)	(-2.79)	(-0.49)	
Germany	0.06	0.09^{*}	-0.12	0.004	0.99
	(1.35)	(1.94)	(-1.45)	(0.11)	
Italy	-0.01	-0.03	-0.04	-0.01	0.99
	(-0.55)	(-1.32)	(-0.93)	(-0.87)	
Netherlands	-0.08	0.11^{**}	-0.23^{**}	0.03	0.99
	(-1.39)	(2.70)	(-4.76)	(1.22)	
Spain	0.05	0.02	-0.09	-0.04^{*}	0.99
	(1.55)	(0.57)	(-1.11)	(-1.67)	
Sweden	-0.41^{**}	0.12^{**}	-0.24^{**}	0.03	0.99
	(-5.46)	(2.84)	(-4.32)	(1.02)	
UK	-0.16^{**}	0.21^{**}	-0.34^{**}	-0.03	0.99
	(-3.06)	(5.66)	(-5.32)	(-0.87)	

** significance at the 5 % level (two-tailed test)
* significance at the 10 % level (two-tailed test)

Table B.4. : **The regression results of the employment equation with TFP estimated in first differences**

country	ln(IMP)	ln(EXP)	ln(WAGE)	ln(TFP)	R^2
Belgium	-0.05	0.20^{**}	-0.12^{**}	-0.15	0.55
	(-1.54)	(2.68)	(-4.02)	(-1.61)	
Denmark	-0.82^{**}	0.49^{*}	-0.07	-0.49^{**}	0.23
	(-3.79)	(2.83)	(-1.01)	(-2.35)	
Finland	-0.18^{**}	0.14^{*}	-0.04	-0.42^{**}	0.27
	(-3.36)	(1.87)	(-0.68)	(-2.08)	
France	-0.003	0.05	-0.06^{*}	-0.04	0.58
	(-0.10)	(1.05)	(-1.94)	(-0.58)	
Germany	-0.06	0.22^{*}	-0.13	-0.29^{*}	0.27
	(-0.85)	(2.23)	(-1.47)	(-1.87)	
Italy	-0.06^{*}	0.03	-0.02	-0.17	0.17
	(-1.81)	(0.54)	(-0.53)	(-1.18)	
Netherlands	-0.08	0.11	-0.16^{**}	-0.03	0.39
	(-0.60)	(0.97)	(-3.73)	(-0.22)	
Spain	-0.01	0.01	-0.08	-0.07	0.30
	(-0.27)	(0.34)	(-0.88)	(-1.06)	
Sweden	-0.38^{**}	0.22^{**}	-0.14^{**}	-0.19	0.49
	(-3.87)	(2.55)	(-2.85)	(-1.45)	
UK	-0.20^{**}	0.26^{**}	-0.44^{**}	0.005	0.50
	(-2.60)	(3.03)	(-6.65)	(0.02)	

** significance at the 5 % level (two-tailed test)
* significance at the 10 % level (two-tailed test)

Appendix C

Table C.1. : **The regression results of the productivity equation with VA estimated in levels**

country	ln(IMP)	ln(EXP)	ln(R&D)	PAT	ln(CAP)	R^2
Belgium	-0.15**	0.33**	0.01	0.001	0.50**	0.98
	(-4.07)	(7.01)	(0.63)	(0.001)	(6.92)	
Denmark	-0.09	0.20**	0.03	-0.19	0.12	0.93
	(-0.65)	(3.65)	(1.26)	(-1.27)	(1.18)	
Finland	-0.04	0.16**	-0.008	0.002	0.44**	0.98
	(-0.77)	(4.72)	(-0.35)	(0.03)	(5.08)	
France	-0.08	0.28**	-0.03*	-0.06	0.58**	0.98
	(-1.02)	(5.78)	(-1.87)	(-0.24)	(6.47)	
Germany	-0.14**	0.20**	-0.05	-0.73	0.39**	0.98
	(-2.23)	(3.55)	(-1.32)	(-1.39)	(3.29)	
Italy	-0.04	0.24**	0.005	-0.16*	0.03	0.98
	(-1.12)	(7.49)	(0.96)	(-1.74)	(0.49)	
Netherlands	-0.30**	0.20**	0.02*	0.23	0.04	0.98
	(-3.19)	(3.83)	(1.88)	(0.74)	(0.52)	
Spain	0.004	0.10**	0.03**	-0.02	0.05**	0.99
	(0.14)	(2.56)	(2.54)	(-0.19)	(2.64)	
Sweden	-0.52**	0.26**	0.01	0.08	0.87**	0.98
	(-3.37)	(3.80)	(0.52)	(0.28)	(5.97)	
UK	-0.13	0.18**	0.05**	-0.02	0.13*	0.97
	(-2.05)	(3.97)	(2.03)	(-0.11)	(1.93)	

** significance at the 5 % level (two-tailed test)
* significance at the 10 % level (two-tailed test)

Table C.2. : **The regression results of the productivity equation with VA estimated in first differences**

country	ln(IMP)	ln(EXP)	ln(R&D)	PAT	ln(CAP)	R^2
Belgium	-0.16**	0.38**	0.008	0.01	0.54**	0.51
	(-3.94)	(8.51)	(0.33)	(0.17)	(4.22)	
Denmark	-0.17	0.25**	0.006	-0.18	0.25	0.29
	(-1.04)	(4.96)	(0.23)	(-1.21)	(1.61)	
Finland	-0.04	0.15**	-0.01	-0.01	0.15	0.16
	(-0.75)	(4.64)	(-0.56)	(-0.16)	(1.53)	
France	-0.14*	0.30**	-0.02	-0.06	0.78**	0.35
	(-1.69)	(6.09)	(-1.35)	(-0.27)	(3.84)	
Germany	-0.20**	0.19**	-0.03	-0.21	0.008	0.16
	(-3.40)	(3.57)	(-1.01)	(-0.73)	(0.04)	
Italy	-0.03	0.23**	0.005	-0.14	0.12**	0.38
	(-0.96)	(7.00)	(1.02)	(-1.60)	(1.98)	
Netherlands	-0.30**	0.22**	0.01	0.20	0.15**	0.17
	(-3.33)	(4.37)	(1.48)	(0.75)	(1.96)	
Spain	0.009	0.16**	0.05**	0.02	0.07**	0.46
	(0.02)	(4.27)	(3.62)	(0.16)	(3.51)	
Sweden	-0.57**	0.23**	0.005	0.05	0.64**	0.19
	(-3.70)	(3.48)	(0.16)	(0.22)	(3.65)	
UK	-0.11*	0.14**	0.05*	-0.01	0.17**	0.22
	(-1.87)	(3.28)	(1.91)	(-0.06)	(2.61)	

** significance at the 5 % level (two-tailed test)

* significance at the 10 % level (two-tailed test)

Table C.3. : **The regression results of the productivity equation with TFP estimated in levels**

country	ln(IMP)	ln(EXP)	ln(R&D)	PAT	R^2
Belgium	-0.35** (-11.50)	0.82** (21.15)	0.009 (0.46)	0.01 (0.27)	0.96
Denmark	-0.96** (-7.88)	0.81** (19.97)	0.04** (2.13)	-0.18 (-1.59)	0.96
Finland	-0.11** (2.10)	0.33** (9.65)	0.05** (2.42)	0.01 (0.23)	0.87
France	-0.21** (-2.92)	0.64** (15.33)	-0.02 (-1.53)	-0.28 (-1.23)	0.89
Germany	-0.33** (-5.03)	0.58** (10.31)	-0.01 (-0.45)	-0.27 (-0.59)	0.89
Italy	-0.23** (-3.62)	0.52** (10.34)	0.008 (1.05)	-0.27* (-1.81)	0.90
Netherlands	-0.85** (-9.85)	0.77** (15.56)	0.01 (1.25)	-0.30 (-1.03)	0.92
Spain	-0.24** (-3.33)	0.26** (2.41)	0.01 (0.35)	0.35 (0.86)	0.73
Sweden	-0.35** (-3.42)	0.61** (11.99)	-0.001 (-0.04)	-0.09 (-0.43)	0.92
UK	-0.33** (-4.42)	0.44** (8.46)	0.10** (3.11)	-0.24 (-0.80)	0.91

** significance at the 5 % level (two-tailed test)
* significance at the 10 % level (two-tailed test)

Table C.4. : **The regression results of the productivity equation with TFP as productivity variable**

country	ln(IMP)	ln(EXP)	ln(R&D)	PAT	R^2
Belgium	-0.34** (-11.75)	0.83** (23.15)	0.009 (0.47)	0.004 (0.07)	0.83
Denmark	-0.98** (-8.27)	0.79** (20.89)	0.05** (2.50)	-0.17 (-1.52)	0.83
Finland	-0.13** (-2.39)	0.35** (10.40)	0.04** (1.97)	- 0.02 (-0.29)	0.48
France	-0.22** (-3.15)	0.65** (15.95)	-0.01 (-0.84)	-0.19 (-0.91)	0.70
Germany	-0.35** (-5.57)	0.59** (11.08)	-0.01 (-0.53)	-0.29 (-0.94)	0.54
Italy	-0.20** (3.34)	0.48** (9.70)	0.003 (0.50)	-0.23* (-1.64)	0.47
Netherlands	-0.87** (-10.80)	0.81** (17.08)	0.008 (0.85)	-0.09 (-0.37)	0.71
Spain	0.39** (2.33)	-0.15 (-1.09)	0.002 (0.04)	0.333 (0.75)	0.09
Sweden	-0.46** (-4.06)	0.59** (11.51)	-0.02 (-0.95)	-0.009 (-0.04)	0.55
UK	-0.31** (-4.21)	0.39** (7.72)	0.11** (3.40)	-0.26 (-0.91)	0.41

** significance at the 5 % level (two-tailed test)

* significance at the 10 % level (two-tailed test)

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