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# *Foreign Outsourcing towards Newly Industrialised Countries and its Impact on the Relative Wages and Employment of Low-skilled Workers in the European Union*

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## 1 Introduction

Recently, some prominent researchers have questioned the academic consensus, which seemed to have been established, on the at most limited impact of international trade with low-skill abundant countries, on the deteriorated relative income position of low-skilled workers in high-skill abundant countries.

Slaughter (2000) argues that research has still, despite methodological progress, fundamental limitations as to answering how much international trade contributes to wage inequality.

Feenstra and Hanson (2001) counter-argue the three major reasons why economists do not hold international trade with low-wage countries as an important culprit of increased wage inequality.

The first reason is that import volumes from low-wage countries are still considered too modest to affect wages.

Leaving aside the debate between Leamer (1998), who argues that trade volumes do not matter as prices are set at the margin, and Krugman (2000) who claims that trade volumes are not irrelevant, Feenstra and Hanson (2001) argue that the ratio of trade to GDP, often used to measure changes in trade volumes, is biased as non-tradables have become increasingly important in industrialised countries[1].

A second argument for the academic consensus on the limited role of international trade follows from empirical studies (Lawrence and Slaughter, 1993; Neven and Wyplosz, 1996 and Leamer, 1998) in which no evidence is found that the relative prices of low-skill intensive goods in industrialised countries decreased, due to trade competition with countries that are relatively abundantly endowed with low-skilled workers, as would be expected within a standard Hecksher-Ohlin-Samuelson (HOS) theoretical framework.

Feenstra and Hanson (2001) argue that, given the increased importance of imports of intermediate inputs, prices should not be compared between industries but rather within industries and they show for Germany, Japan and the United States that, within industries, prices of domestic goods did actually increase more than prices of imported goods.

The third argument à décharge of international trade is that the ratio of low-skilled workers to high-skilled workers seems to change within industries and that workers do not seem to move between industries. OECD (1998) provides evidence for OECD countries that within-industry movements dominate between-industry movements of relative employment. The evidence of substantial within-industry movements in favour of high-skilled workers is often considered as an indication of pervasive

[1] Maußner (1999) shows that, in a sticky wage model, the non-tradables sector may have a dampening effect on the unemployment of low-skilled workers.

skill-biased technological change, which would explain increased wage inequality far more than international trade (e.g. Berman, Bound and Griliches 1994).

Feenstra and Hanson (2001), however, refer to plant-level evidence of Bernard and Jensen (1997), who show that a large part of within industry movements of relative wages and employment can be explained by between plant movements rather than within plant movements, which may still incriminate international trade.
Technological change may, moreover, be caused by trade liberalisation. This potential indirect effect of trade has been pointed out, by e.g. Martin and Evans (1981) and more recently by Wood (1994).
Haskel and Slaughter (2001) find evidence, for the UK, of trade-induced technological change but its effect on wage inequality was not found to be significant.

Feenstra and Hanson (1999) argue that international trade in intermediate inputs has been neglected and show that foreign outsourcing can explain a considerable part of the increase in wage inequality between high-skilled and low-skilled workers, in US industries, during the 1980s.

Haskel and Slaughter (2001) find that changes in prices were more important than technological change (total factor productivity) in explaining increased wage inequality in the UK in the 1980s.
Both Feenstra and Hanson (1999) and Haskel and Slaughter (2001) apply a two-stage mandated wage estimation procedure, in which the impact of international trade on wages can be disentangled from the impact of technological change. Anderton and Brenton (1999) conclude that in the period 1970-1983 foreign outsourcing towards low-wage countries accounted for 40 per cent of the increased relative wage and one third of the increase in relative employment of high-skilled workers in the UK textiles industry. Within a partial equilibrium framework, which focuses on short-run effects and labour market factors, Greenaway, Hine and Wright (2000) find a considerable impact of international trade on wages in the UK. Especially trade competition from (South) East Asian Newly Industrialised Countries (NIC) appears to have increased wage inequality.

In this paper I combine data on international trade; wages and employment of low-skilled and high-skilled workers; and imported intermediate inputs, to assess the impact of outsourcing by high-skilled abundant EU countries towards low-skilled abundant EU countries; Central and East European, (South-) East Asian and Latin American NIC on the relative wages or employment of low-skilled workers in the European Union in the period 1985-1996.
In section 2 some stylised facts on income inequality and foreign outsourcing are shown.

In section 3.1 reports a two-stage mandated wage procedure (Feenstra and Hanson, 1999; Haskel and Slaughter, 2001) used to estimate the impact of foreign outsourcing on the wages of low-skilled and

high-skilled workers in five EU countries (Belgium, Denmark, France, Germany, and the United Kingdom).

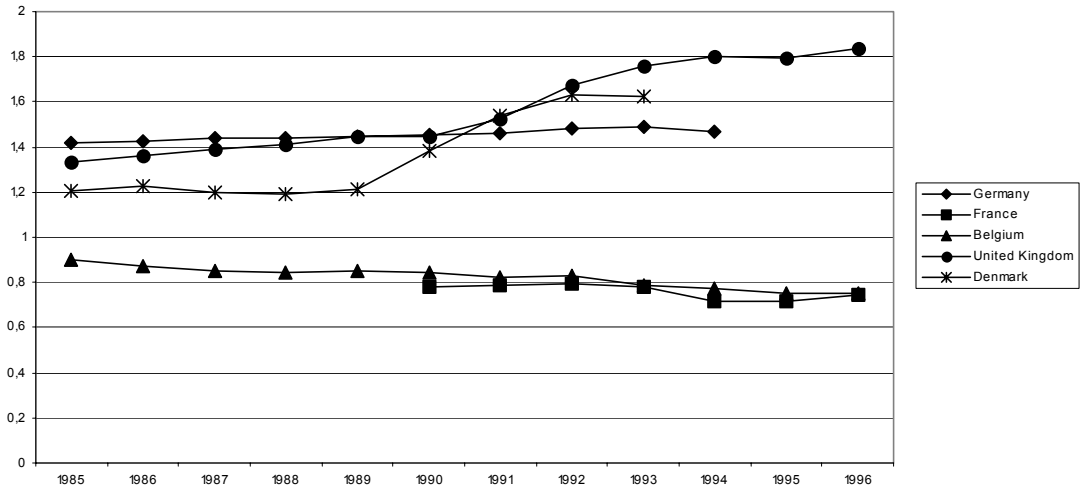
In a mandated wage estimation the focus is on long run general equilibrium Stolper-Samuelson effects of trade on wages. Howell (1997) observed some limitations of regressions with changes over a long time period. In section 3.2, I also estimate an empirical wage function as proposed by Greenaway, Hine and Wright (2000) to assess short run partial equilibrium effects and account for sticky wage adjustment.

In section 4 labour demand elasticity is computed within a flexible cost function framework (e.g. Morrison Paul and Siegel 1997, 2001) to estimate the impact of foreign outsourcing on the employment of low-skilled workers, under the assumption of sticky wages.

## 2 Whatever happened?

Most studies on the impact of international trade on wages or employment focus on the United States. In the US both the wages and the employment of non-production workers (proxy for high-skilled workers) increased considerably relative to the wages and employment of production workers, since the beginning of the 1980s (e.g. Feenstra, 2000: 2-3). Figure 1 shows the evolution of the wages of non-manual workers (proxy for high-skilled workers) to the wages of manual workers, in the period 1985-1996, for the five EU countries, for which sufficient data is available on all necessary variables to perform estimation. The wages are averaged over manufacturing industries using each sector's share in the total wage bill as a weight.

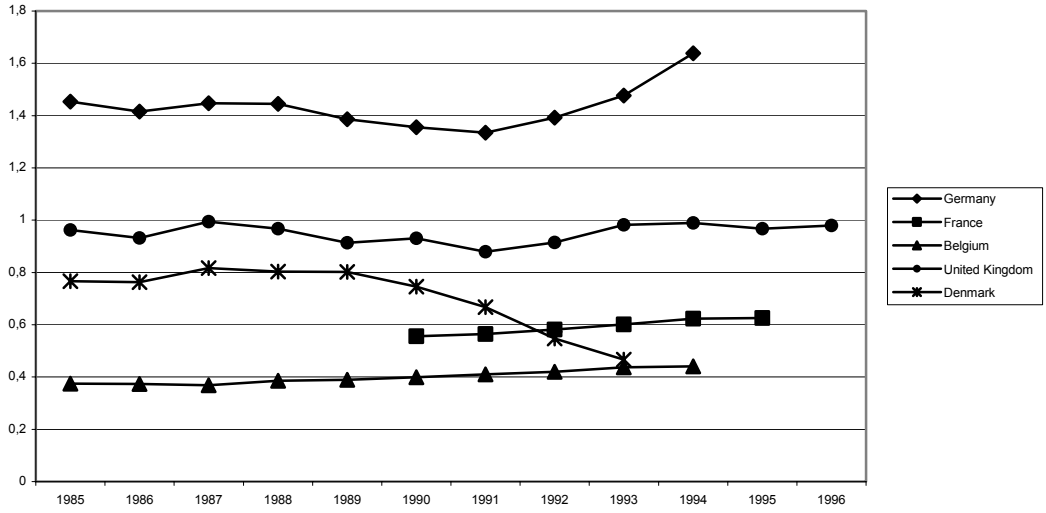
***Figure 1: The change in average relative wages of non-manual workers in manufacturing in the period 1985-1996***




**Source:** own calculations from the UNIDO General Industrial Statistics database, Labour Force Surveys data (Eurostat) and OECD Structural Analysis industrial (STAN) and International Sector database (ISDB).

The evidence for the five considered EU countries is mixed. Denmark, Germany and the UK, which in 1985 already had the highest wage inequality, witnessed an increase in the relative wages of non-manual workers, which was considerable especially in Denmark and the United Kingdom. On the contrary, in Belgium and France wage inequality appears to have decreased [2]. However, in the latter two countries the relative employment of non-manual workers slightly increased as can be seen in figure 2. Figure 2 shows the change in the average relative employment of non-manual workers, weighted by each sector's share in total employment. In Denmark relative employment of non-manual workers decreased substantially whereas in the UK this ratio hardly changed. Only for Germany is there evidence that both the relative wages and the relative employment of high-skilled workers increased as it did in the US.

***Figure 2: The change in relative employment of non-manual workers in manufacturing in the period 1985-1996***




**Source:** own calculations from the UNIDO General Industrial Statistics database, Labour Force Surveys data (Eurostat) and OECD Structural Analysis industrial (STAN) and International Sector database (ISDB).

The fact that despite an increase in the skill premium the demand for high-skilled workers increased in the US, has been put forward as an indication of a structural shift (e.g. due to skill-biased technological change) in favour of high-skilled labour (Lawrence and Slaughter, 1993; Berman, Bound and Machin, 1998; Katz and Autor, 1999). For the EU there is apparently little overall evidence of a similar positive correlation between the changes in the relative wages and employment of high-skilled workers. The conclusions of US studies therefore need not to be valid for the European Union. Moreover, the different patterns in figure 1 and 2 show that EU countries are not a homogenous group

[2] The remarkable finding that wages of non-manual would have been lower than wages of manual workers in Belgium and France may be due to the hours worked by manuals. For non-manual workers monthly wages are given whereas for manual workers only hourly wages are given (see annex for more details on data sources). Assuming the hours worked by manuals did not change substantially during the considered period the evolution of the level of relative wages should be unbiased. We have no knowledge of data to allow us to ascertain how reasonable this assumption is.

and that heterogeneity should be accounted for. That wage inequality actually would have decreased in Belgium and France does not imply that international trade may not have had a negative impact on the wages of low-skilled workers, as this negative impact may well have been counterbalanced by other country-specific determinants (e.g. institutional factors).

Figure A.1 in the annex shows, combining data on wages and employment, the change in the average value added share of non-manual workers relative to the average share of manual workers. In Germany and the UK non-manual workers took home an increasing share of value added relative to manual workers. The same occurred in Denmark but the increase was less substantial. In Belgium and France the relative value added share hardly changed.

In this paper I try to assess the impact of foreign outsourcing with regard to low-skill abundant NIC on the wages and employment in the European Union. Figure A.2 shows, for each of the five considered EU countries, the evolution of foreign outsourcing with regard to four groups of trade partners: low-wage EU countries (Ireland, Greece, Portugal and Spain); (South-) East Asian NIC (Hong Kong, Indonesia, South-Korea, Malaysia, Philippines, Singapore and Thailand); Central and East European NIC (Czech Republic, Hungary and Poland) and NIC from Central and South America (Argentina, Brazil, Chile and Mexico).
Imports of intermediate inputs from low-wage EU countries and from (South-) East Asian NICs increased substantially in all five considered EU countries. Foreign outsourcing with regard to Central and East European NICs increased sharply in Germany and to a lesser extent in Denmark. In Germany, at the end of the 1985-1996 period the considered Central and East European countries where the group with the highest foreign outsourcing share of the four groups, whereas low-wage EU countries and (South-) East Asian NICs hold respectively first and second place in the four other EU countries. Foreign outsourcing with regard to Central and South-American NICs hardly increased. The average percentage of foreign outsourcing in 1996 seems, despite considerable increases during the period 1985-1996, still rather modest but the averages conceal substantial foreign outsourcing in some individual industries.

## 3 Foreign outsourcing and wages

Greenaway, Hine and Wright (2000) point at the distinctive approach of trade and labour economists in assessing the impact of international trade on wages. Trade economists tend to focus on long run effects within a general equilibrium Heckscher-Ohlin-Samuelson (HOS) framework. The mandated wage methodology by Leamer (1998); Feenstra and Hanson (1999) and Haskel and Slaughter (2001), which is applied in section 3.1, clearly falls within this category, given its close link to the Stolper-Samuelson theorem. In HOS-based methodologies perfect competition is explicitly assumed although

Helpman and Krugman (1985) proposed a model of monopolistic competition that does not preclude Stolper-Samuelson wage effects[3]. Greenaway, Hine and Wright (2000) argue that the HOS approach is less appropriate for analysing short run effects or assessing the impact of market structure and bargaining on wages. Labour economists consider the impact of imperfection of labour and product markets on wages within a partial equilibrium framework, focusing on wage bargaining and short run adjustment. In section 3.2 the dynamic short run specification, proposed in Greenaway, Hine and Wright (2000), which allows for sticky wage adjustment, is estimated.

### 3.1 Mandated wage estimation

Feenstra and Hanson (1999) and Haskel and Slaughter (2001) expand the methodology proposed by Leamer (1998) in which product price changes are regressed on factor shares. This methodology fits within a HOS framework and follows the link between product prices and factor rewards put forward in the Stolper-Samuelson theorem.

Differentiating the zero-profit condition with regard to time, assuming perfect competition, results in the following relationship in differences over a given time period (Feenstra and Hanson, 1999: p. 910):

$$\Delta \ln p_i^{VA} = -TFP_i + s_i' \Delta \ln w_i \qquad i = 1...n \ \text{(industries)} \qquad (1)$$

$\Delta \ln p_i^{VA}$ : First difference of value added price

$TFP_i$ : Total Factor Productivity

$S_i$ : Vector of cost shares of the production factors

$\Delta \ln w_i$ : Vector of first difference of factor rewards

Feenstra and Hanson (1999) argue that when the dual Tornqvist TFP measure is used, equation (1) will hold as an identity. The more often used primal TFP measure is highly correlated with the dual TFP measure and will therefore also closely hold the identity.

To move from the identity to the price regression Feenstra and Hanson (1999) relax the assumption that factor prices are equal across industries, an assumption which is clearly not confirmed by real world data, and consider $\Delta \ln w_i$ as a random variable.

The authors regard variation in factor quality between industries as the main reason for wage differentials.

[3] Controlling for price-marginal cost mark-ups, the assumption of perfect competition can be relaxed in a mandated wage estimation (e.g. Feenstra and Hanson, 1999). However, in controlling it is generally assumed that market structure is exogenous. Mirza (2003) shows evidence that international trade affects industry concentration in OECD countries, especially in Europe.

Considering factor reward changes as a random variable and denoting ω as the vector of mean values of $\Delta \ln w_i$ over all industries equation (1) can be written as:

$$\Delta \ln p_i^{VA} = -TFP_i + s_i'\omega + s_i'(\Delta \ln w_i - \omega) \qquad (2)$$

The last term in (2) (i.e. "change in wage differentials") is in most studies implicitly treated as a residual term although it can be measured and thereby accounted for, avoiding a possible omitted variable bias.
Feenstra and Hanson (1999) define the difference between total factor productivity and the last term in (2) as effective total factor productivity and show that when this measure is used in regressing (2) there is a perfect fit ($R^2 = 0.999$).

Feenstra and Hanson (1999) propose a two-stage procedure to estimate the extent through which domestic price changes and technological change affect factor rewards. In a first stage prices and effective total factor productivity are regressed on structural determinants (e.g. foreign outsourcing and high-tech capital).

The first stage price regression is given by:

$$\Delta \ln p_i^{VA} = \lambda ETFP_i + \beta' \Delta z_i + \varepsilon_i \qquad (3)$$

Where λ denotes the pass-through of productivity changes into price changes. Krugman (2000) argued that λ may be significantly negative if a country is large enough to have an impact on the world economy or if technological change is pervasive over all countries. $\Delta Z_i$ denotes the vector of structural determinants.

The first stage TFP regression is given by:

$$ETFP_i = \alpha' \Delta z_i + \delta_i \qquad (4)$$

In this paper foreign outsourcing and R&D stocks are used as structural variables. Feenstra and Hanson (1999) use high-tech capital (e.g. computers) as structural determinant of productivity. Unfortunately, there is no sufficient data to construct this variable for the considered EU countries. I therefore use data on R&D expenditures to compute R&D stocks. Grossman and Helpman (1991) consider (international) trade as an important channel of knowledge spillovers. In an empirical estimation of spillover effects, within the Grosman and Helpman framework, Coe and Helpman

(1995) construct foreign R&D stocks as the weighted average of trade partners' R&D stocks (with the bilateral import shares as weights) and find evidence of international R&D spillovers, especially for small countries. By using both the domestic sector and non-sector R&D stocks as well as the foreign R&D stock the extent to which technological change is exogenously (i.e. internationally) determined can be assessed.

Possible heterogeneity with regard to the countries intermediate inputs are imported from is accounted for, by considering four distinctive country groups of low-skilled abundant countries (see section 2).

Feenstra and Hanson (1999) show that if $\lambda = -1$ and $\beta$' is found to be significantly positive this would point to skill-biased technological change. The approach thus allows Feenstra and Hanson to assess the extent to which the sector bias of technological change matters (Leamer, 1998) or the factor bias matters (Krugman, 2000).
Having estimated (3), each component of the change in domestic industry prices (i.e. each element of the estimated (kx1) $\beta'\Delta z_i$ vector) is, in a second stage, regressed separately on the shares of the primary production factors ($s_i$):

$$\beta_k^{'}\Delta z_{ik} = \delta_k^{'} s_i + \upsilon_i \qquad (5)$$

The estimated coefficients in the second stage ($\delta_k$) are considered as the changes in the respective factor rewards, mandated by price changes that are explained by the structural determinant $z_k$.

In their mandated wage estimation for the UK, Haskel and Slaughter (2001), consider the possibility of trade-induced technological change by incorporating, among other determinants, import prices in a TFP regression. (cf. Wood (1994) who argues that neglecting this indirect effect of trade may underestimate the actual impact of international trade on wages).
In the specification of the TFP regression (4) international trade is considered as a possible spillover mechanism (i.e. through the import-weighted foreign R&D stocks) but by including the outsourcing variables the extent to which foreign outsourcing stimulates technological change and how this affects factor rewards can be established as well. The latter impact can be estimated with the second stage TFP regression, in which similar as in equation (5), the structural variables are multiplied by their respective estimated first stage coefficients, to generate the dependent variables to be regressed on factor shares. The estimated second stage coefficients can then be considered as the changes in factor rewards, mandated by technological change, attributable to the considered structural determinants.
Feenstra and Hanson (1997) define intra-sector outsourcing as outsourcing in the narrow sense and outsourcing with regard to all sectors as outsourcing in the broad sense. In the estimation both

outsourcing in the narrow sense and inter-sector outsourcing (i.e. outsourcing in the broad sense minus outsourcing in the narrow sense) are used. A panel estimation procedure assesses the degree of heterogeneity among the five EU countries.

Feenstra and Hanson (1999) and Haskel and Slaughter (2001) consider long run changes. Inasmuch that imperfect labour mobility decreases with time, the Stolper-Samuelson theorem, with its assumption of perfect mobility, focuses on the long run (Haskel and Slaughter 2001: p. 169). Changes over the period 1985-1996 for 12 industries (2 digit ISIC industries 31-37 and three digit 38 industries) are used and the estimation is performed in TSP 4.5.

In table 1 the results of the first stage price regression (3) and the first stage TFP regression (4) for those variables, which have coefficients that are significant below the 10 % level are reported [4]. Four groups of low-skill abundant countries are considered: low-skill abundant EU countries (EULS); Central and East European countries (CEEC); (South-) East Asian NIC (ASIA) and emerging economies from Central and South America (LATIN). A group of high-skill abundant EU countries (EUHS) and high-skill abundant OECD (OERE) countries not included in any of the five previous groups is also considered (see data annex for details on the country groups).

The first F-statistic shows that a plain OLS specification (i.e. common slopes and a common intercept for all countries) is rejected for the price regression[5]. The second F-statistic shows that in both regressions a fixed effects specification is not rejected. In a fixed effects specification, differences between observation units (in our case the five EU countries) are captured in unit-specific intercepts (i.e. the fixed effects). Country-specific fixed effects imply a parametric shift (e.g. explained by institutional differences) of the regression function. In a random effects specification the unit-specific intercepts are assumed to be randomly distributed across units. Unlike in a fixed effects specification the unit-specific intercepts are considered to be uncorrelated with the other regressors. The Hausman test given in table 1 compares a random effects specification (null hypothesis) to a fixed effects specification. For both the first stage price and TFP regression the null hypothesis cannot be rejected which favours a random effects specification (Greene, 2000: 560-577).

Given the high level of non-rejection of the Hausman specification statistic the results of a random effects estimation of (3) and (4) are reported in table 1.

[4] The reported specification contains outsourcing variables in the narrow sense and the difference between outsourcing in the narrow sense and the broad sense (see Feenstra and Hanson 1997, 1999). With six groups of outsourcing countries this results in twelve outsourcing variables. Using sector dummies does not change the other coefficient estimates substantially. Leaving out the difference variables does not change the coefficient estimates of the narrow outsourcing variables.

[5] The F-statistic cannot be computed for the TFP regression due to a lack of degrees of freedom.

**Table 1: First stage price and TFP regression (1985-1996)** [6]

| **Dependent variable**: | $\Delta \ln p_i^{VA}$ | $ETFP_i$ |
|---|---|---|
| **Structural determinants:** | | |
| Outsourcing EUHS (narrow) | - 3.92 (-4.94) *** | |
| Outsourcing OECD (narrow) | | -1.14 (-3.38) *** |
| Outsourcing OECD (difference) | 5.21 (1.77) * | 1.14 (3.80) *** |
| Outsourcing CEEC (narrow) | | -1.41 (-2.03) ** |
| F-test plain OLS (p-value) | 0.02 | |
| F-test fixed effects (p-value) | 0.46 | 0.50 |
| Hausman test: Random effects vs. Fixed effects (p-value) | 0.99 | 0.72 |
| $R^2$ | 0.61 | 0.60 |
| Number of observations | 60 | 60 |

**Note**: the table reports the results of a random effects specification. White heteroskedastic-consistent t-values in brackets.

*** denotes significance at the 1% level.

The first stage price regression with the narrow outsourcing and the difference between broad and narrow outsourcing variables for the six country groups results in a significantly negative coefficient for intra-sector outsourcing (narrow) from high-wage EU countries. Inter-sector outsourcing (difference) with regard to high-wage OECD countries (primarily Japan and the US) has a significantly positive coefficient. In the theoretical model proposed in Feenstra and Hanson (1996) the outsourcing of the production of low-skill intensive intermediate inputs towards low-skill abundant countries will raise the demand for high-skilled workers in both the high-skill abundant and the low-skill abundant countries. Therefore the correlation between outsourcing and product price changes is assumed to be positive. Feenstra and Hanson (1999) find empirical evidence for such a positive correlation for the US. Working at a far more aggregated industry level than Feenstra and Hanson (1999) a negative correlation between intra-sector outsourcing from the five EU countries towards (mostly neighbouring) high-wage EU countries and domestic product price changes is found. For inter-sector outsourcing towards OECD countries a positive correlation is found, albeit that the

[6] The pass-through coefficient of TFP ($\lambda$) is –8.99 and highly significant. Feenstra and Hanson (1999) point out that since TFP is, by construction correlated with value added prices the estimated pass-through is likely to be biased. Unfortunately, the most appropriate instrumental variables are the structural variables, which are, if they are any good as determinants, also correlated with value-added prices. Our pass-through coefficient is suspiciously large which may indeed suggest a bias. The focus in this paper is not on the pass-through so that the possible bias is not that important.

coefficient is only significant at the 10 % level. There is no evidence at all of an impact of foreign outsourcing towards any of the four groups of emerging economies on product price changes.

There is no evidence of trade-related R&D spillovers neither. Contrary to most studies on international spillovers (e.g. Coe and Helpman, 1995; Lichtenberg and Van Pottelsberghe, 1996) the estimation in this paper is at the industry level rather than on the country level. Keller (1998), using randomly generated spillovers, casts some doubt on the Coe and Helpman (1995) results and argues that R&D spillovers are probably not related to international trade in a substantial way.

In table 2 the results of the second stage price regression are reported for those variables, which had a significant first stage coefficient

As the dependent variables in the second stage regression are generated from the estimated first stage coefficients, Feenstra and Hanson (1997) propose a procedure to correct the second stage standard errors to account for additional variance resulting from the use of generated rather than "true" regressands. The procedure, however, does not guarantee positive variances and, hence, corrected standard errors cannot always be computed. Dumont et al. (2003), show that the procedure may suffer from a negative bias and propose a correction procedure that warrants positive variances. I use this procedure to correct standard errors in the second stage.

**Table 2: Second stage price regression: estimated mandated wage changes, 1985-1996**

| **Dependent variable**: | Outsourcing EUHS (narrow) | Outsourcing OECD (difference) |
|---|---|---|
| High-skilled workers | -0.03 (-0.23) | - 0.04 (-0.85) |
| Low-skilled workers | -0.07 (-0.73) | -0.07 (-1.26) |
| F-test plain OLS (p-value) | 0.71 | 0.00 |
| F-test fixed effects (p-value) | 0.69 | 0.11 |
| Hausman test: Random effects vs. Fixed effects (p-value) | 0.50 | 0.89 |
| $R^2$ | 0.03 | 0.01 |

**Note**: The coefficients reflect the changes in the wages of high-skilled and low-skilled workers, mandated by industry price changes caused by the respective determinants (see text). The dependent variable in this second stage regression are generated from the structural determinants and their respective first stage estimated coefficients. White heteroskedastic-consistent t-values are given in brackets and have been corrected following the procedure proposed in Dumont et al. (2003).

None of the estimated wage changes are significant. Apparently, outsourcing by the five considered EU countries towards other high-wage countries had a significant impact on industry prices but the effect did not significantly carry on in the factor rewards. Abstracting from significance, outsourcing towards other high-wage countries appears to have decreased the wages of both high-skilled and low-skilled workers relative to capital remuneration and increase wage inequality between high-skilled and low-skilled workers.

In table 3 the second stage TFP regression results are given for the structural variables that had significant coefficients in the firs stage TFP regression.

**Table 3: Second stage TFP regression: estimated mandated wage changes, 1985-1996**

| **Dependent variable**: | Outsourcing OECD (narrow) | Outsourcing OECD (difference) | Outsourcing CEEC (narrow) |
|---|---|---|---|
| High-skilled workers | 0.01 (1.49) | -0.01 (-0.90) | -0.00 (-0.10) |
| Low-skilled workers | 0.01 (1.23) | -0.01 (-1.65) | -0.00 (-0.56) |
| F-test plain OLS (p-value) | 0.85 | 0.00 | 0.46 |
| F-test fixed effects (p-value) | 0.85 | 0.11 | 0.95 |
| Hausman test: Random effects vs. Fixed effects (p-value) | 0.90 | 0.90 | 0.02 |
| $R^2$ | 0.04 | 0.03 | 0.01 |

**Note**: See table 2.

Again, none of the second stage coefficients is significant.

The results of the two-stage mandated wage regression, focusing on the impact of foreign outsourcing, are in line with the estimations, considering international trade rather than specifically foreign outsourcing, on a larger set of EU countries by Cuyvers et al. (2003 a, b).

### 3.2 Sticky wage adjustment estimation

Given that Stolper-Samuelson effects are likely to be long run effects, a mandated wage regression with differences over a period of ten years seems justified. However, there may be a problem involved in such an approach. In one of the most cited studies on skill-biased technological change, Berman,

Bound and Griliches (1994) regress the change over a period of ten years (1980s) in the non-production workers' total employment share on the change in computer investment over the same period. They consider the significantly positive coefficient of computer investment as evidence in favour of a skill-biased technological change (SBTC) explanation of the increase in the relative employment of high-skilled workers in the US. Howell (1997) points out that the increase in the share of non-production workers in total employment almost entirely occurred in the period 1980-1982 whereas investment in computers only increased substantially after 1983, which casts some doubt on the SBTC conclusion by Berman, Bound and Griliches (1994). Howell (1997: p. 14) therefore argues that studies focusing on changes between business cycle peaks, although being appropriate for analysing long run trends and changes that are sensitive to business cycle effects, may submerge information about overall trends.

As already mentioned before Greenaway, Hine and Wright (2000) consider a partial equilibrium framework to assess the short run effects and the impact of imperfect labour and product markets.
They consider an empirical wage function in which explanatory variables are incorporated:

$$\ln W_{i,t} = \lambda_i + \beta_0 X_{i,t} + \beta_1 \ln W_{i,t-1} + u_{i,t} \qquad \text{i: 1 …n (industries)} \qquad (6)$$

Where W denotes the wage rate, $\lambda_i$ is a fixed effect and X is the matrix of explanatory variables. The lagged dependent variable accounts for the sticky adjustment of wages. Greenaway, Hine and Wright (2000) consider import penetration and export intensity to estimate the impact of trade competition. Other variables like union density, labour productivity and employment growth account for labour market effects.
Given the lagged dependent variable they use a first-differenced Generalised Method of Moments (GMM) estimation, removing unit-specific effects $\lambda_i$ , as proposed by Arellano and Bond (1991). Lags of the variables are used as instruments such that the set of available instruments expands as time goes on (i.e. for the most recent year the number of available lags is the highest). The estimates are consistent if there is no second order serial correlation and a Sargan test of overidentifying restrictions tests for the validity of the used instruments. In table 4 the results of a first-differenced GMM estimation for three individual EU countries are given. Contrary to Greenaway, Hine and Wright (2000) I consider the relative wage rate of low-skilled workers as the dependent variable. The estimation was done with the ARELBON2 and LM2TEST (for second order serial correlation testing) procedures in TSP 4.5. Given the small sample only one lag is used, except for the dependent variable and only lags t-2 are considered as instruments, as a potentially more efficient GMM estimation with the full set of instruments, which as pointed out by Bond (2002) may be subject to severe overfitting biases in small samples, leads to highly unregulatory estimations.

There are, unfortunately, no sufficient data at the industry level on union density, concentration and other labour market variables, used by Greenaway, Hine and Wright (2000). For the rest the specification is as close to their specification, for reasons of comparability. For France there are insufficient data to perform GMM estimations. For Belgium, Germany and the UK both the Sargan test of the validity of instruments and the LM test of second order correlation are not significant at the 5% level. For Germany the Sargan test is significant at 6 %, but this test tends to overreject in small samples (Blundell, Bond and Windmeijer, 2000: p. 86). For Denmark both the Sargan test and the LM test for second order serial correlation are significant. Especially the significance of the latter is problematic given the key assumption of no second order serial correlation, so the results for Denmark are given with reserve.

**Table 4: First-differenced GMM estimation of an empirical wage function for the period 1985-1996**

| | Belgium | Denmark | Germany | UK |
|---|---|---|---|---|
| **Intercept** | 0.02 (2.71)*** | -0.01 (-0.68) | -0.01 (-4.90) *** | -0.05 (-3.45) *** |
| **Relative Wage rate (-1)** | -0.25 (-4.55) *** | 0.23 (3.75) *** | 0.07 (1.73) * | 0.31 (7.62) *** |
| **Relative Wage rate (-2)** | 0.25 (4.08) *** | 0.17 (2.89) *** | -0.05 (-1.78) * | 0.20 (4.61) *** |
| **Labour productivity** | 0.18 (5.59) *** | 0.54 (4.92) *** | 0.05 (1.73) * | 0.33 (3.05) *** |
| **Labour productivity (-1)** | 0.06 (2.66) *** | 0.10 (1.33) | 0.06 (5.42) *** | -0.05 (-0.92) |
| **Employment growth** | 0.02 (1.87) * | -0.22 (-6.72) *** | 0.01 (0.56) | -0.25 (-4.43) *** |
| **Employment growth (-1)** | 0.04 (2.91) *** | 0.17 (3.79) *** | -0.07 (-0.72) | 0.20 (4.59) *** |
| **Industry size °** | 0.00 (0.07) | -0.64 (-4.94) *** | -0.04 (1.98) ** | -0.19 (-1.64) |
| **Outsourcing EUHS** | 0.07 (1.80) * | 0.32 (9.79) *** | 0.01 (0.69) | 0.02 (0.35) |
| **Outsourcing EUHS (-1)** | -0.00 (-0.09) | (0.21) *** | 0.03 (3.97) *** | 0.11 (1.51) |
| **Outsourcing EULS** | -0.03 (-2.95) *** | 0.01 (0.49) | -0.02 (-2.67) *** | -0.05 (-1.43) |
| **Outsourcing EULS (-1)** | -0.03 (-4.10) *** | -0.01 (-0.28) | -0.01 (-1.89) * | -0.10 (-2.67) *** |
| **Outsourcing OERE** | -0.05 (-5.06) *** | 0.01 (0.51) | 0.01 (0.71) | 0.07 (3.01) *** |
| **Outsourcing OERE (-1)** | 0.04 (3.80) *** | -0.02 (-0.79) | -0.02 (-3.09) *** | -0.05 (-1.56) |
| **Outsourcing ASIA** | -0.00 (-0.29) | -0.00 (-0.88) | -0.00 (-0.40) | -0.05 (-3.02) *** |
| **Outsourcing ASIA (-1)** | 0.01 (1.31) | 0.00 (0.74) | 0.01 (3.04) *** | -0.01 (-0.36) |
| **Outsourcing CEEC** | 0.03 (4.46) *** | -0.06 (-4.03) *** | 0.00 (0.76) | -0.00 (-0.21) |
| **Outsourcing CEEC (-1)** | 0.01 (0.67) | -0.04 (-2.99) *** | 0.00 (0.91) | -0.01 (-0.34) |
| **Outsourcing LATIN** | -0.00 (-0.15) | 0.01 (0.78) | 0.00 (1.13) | 0.01 (0.61) |
| **Outsourcing LATIN (-1)** | 0.01 (1.91) * | 0.02 (3.79) *** | -0.05 (-1.78) * | 0.00 (0.28) |
| **Test of overidentifying restrictions (p-value)** | 50.66 (0.57) | 57.27 (0.09) * | 69.4892 (0.06) * | 64.22 (0.139) |
| **LM test for second order serial correlation (p-value)** | 0.49 (0.62) | 2.49 (0.01) *** | 0.16 (0.87) | -1.07 (0.28) |

**Note**: The table reports the results of a first-differenced GMM estimation with lags t-2 for instruments. The dependent variable is the relative wage rate of low-skilled workers. ° Value added and sector employment are alternatively considered for industry size, with little difference. The results are given for the estimation with value added. Heteroskedastic consistent t-values are reported in brackets. Unreported time dummies were included in the estimation.
***; ** ; * denotes significance at respectively 1% ; 5%; 10%.

The results for the UK are rather qualitatively similar but substantially higher than to those of Greenaway, Hine and Wright (2000) which may be explained by a bias due to omitting labour market variables. For all four EU countries there is a negative coefficient for outsourcing towards the relatively low-skilled abundant EU countries (Greece, Ireland, Portugal and Spain). Three of these countries joined the European Union, or had only been a member for a short time, at the beginning of the considered period 1985-1996. Apparently, integrating these relatively low-skilled abundant countries in the EU had a negative impact on the relative wages of the considered EU countries.
As mentioned before the group of low-skilled abundant EU countries had the highest outsourcing share of the four low-skilled abundant country groups and the most considerable increase in its share in the period 1985-1996 for most of the five considered EU countries (see also figure A.2).
Greenaway, Hine and Wright (2000) found a significantly negative coefficient for imports from EU countries. However, contrary to the negative coefficient for the relatively low-skilled abundant EU countries, the coefficient for outsourcing towards the relatively high-skilled EU countries is almost always positive and in three cases significantly so. Our results suggest that it is important to account for heterogeneity between EU countries. There are also significant coefficients for foreign outsourcing with regard to the other country groups but these effects seem to be more country specific.

Blundell, Bond and Windmeijer (2000) point out that a first-differenced GMM estimation may suffer from a considerable small sample bias if the time series are highly persistent and the number of observations in time is small. The data do suggest that the time series are indeed rather persistent. I have therefore also performed a system GMM, which adds equations in levels, for which lagged first-differenced variables are used as instruments, to the first-differenced equations. Arellano and Bover (1995) and Blundell and Bond (1998) have shown that, under relatively mild assumptions, a system GMM is appropriate and will result in less biased estimates. Unfortunately system GMM estimation is more demanding in terms of degrees of freedom, which given the small sample is rather problematic, and the results of a system GMM estimation are highly unsatisfactory and are therefore not reported.

**4. Foreign outsourcing and employment**

One of the fundamental assumptions in the Heckscher-Ohlin-Samuelson theory is that wages are fully flexible. If this assumption holds, wages will adjust to market-clearing levels, which guarantees full employment of all production factors. However, if wages are sticky, full employment of the relatively scarce production factor is no longer ascertained (e.g. Brecher, 1974, Krugman, 1995). Wage flexibility is often put forward to explain the increased wage inequality between high-skilled and low-skilled workers in the United States whereas sticky wages due to labour market rigidities are considered as an explanation for the relatively high unemployment (of low-skilled workers) in most

EU countries. The difference between the "money-less jobs" US and the "job-less money" EU would suggest that there exists a trade-off between inequality and unemployment (see e.g. Krugman, 2000). Howell and Huebler (2001) show that there is little evidence to support this view of a trade-off. They argue that institutional factors (e.g. social protection) may explain part of the difference across OECD countries in income inequality but do not seem to be the main source of unemployment. An increase in wage inequality is unlikely to decrease unemployment in the EU and decreasing wage inequality in the US need not raise unemployment.

Anyhow, if wages in EU countries are indeed sticky, lack of evidence on the impact of international trade on the relative wages of low-skilled workers in the European Union does not necessarily imply that the position of low-skilled workers may not be affected in terms of employment. To assess the potential effect of foreign outsourcing on employment elasticity of labour demand estimates are derived from a flexible cost function, assuming wages are sticky.

### 4.1 Flexible Cost Function

The demand for production factors (e.g. high-skilled and low-skilled labour) can rather straightforwardly be derived from a cost function, which reflects the cost-minimising behaviour of firms. In flexible cost functions the fact that certain production factors (e.g. capital) may be fixed in the short run is implicitly acknowledged. The most popular flexible cost functions, the Translog and the Generalized Leontief functions, are second order Taylor expansions of respectively a Cobb-Douglas and a Leontief function[7].

Morrison (1988) presents a generalization of a Leontief cost function (GL) in which quasi-fixed inputs can be incorporated. Quasi-fixed inputs are considered as fixed in the short run but flexible in the long run. For some input factors (e.g. capital) it may indeed take some time to adjust to a new optimal level. The demand for input factors can be derived from a dynamic cost function and the short-term and long-term (i.e. when quasi-fixed inputs have been adjusted) elasticity of demand with respect to own prices and the prices of other input factors can be computed. Morrison and Siegel (1997) show how the GL function can be extended to consider external effects. External determinants are exogenous factors that may affect the cost function and thereby shift the demand for production factors. The impact of external factors can be derived by using a "total scale measure", which is based on total differentiation of the cost function with respect to output. Cost-output changes can then be decomposed into short-run effects, long-run effects and shifts in the cost curve due to exogenous forces (Morrison and Siegel, 1997: p. 648).

Morrison Paul and Siegel (2001) consider high-tech capital, R&D investment and outsourcing as potential external determinants. The interest of the external factors lies in their overall impact on

[7] Barnett (1985) and Barnett, Lee and Wolfe (1985) showed that both functions tend to violate regularity conditions, even within the region of the data, and argues that functional forms based on a more elaborative second-order Laurent series expansion are well-behaved.

industries, which as Morrison Paul and Siegel (2001) point out joins with endogenous growth theories (e.g. Romer 1986 and Grossman and Helpman 1991) in stressing the importance of spillovers and other sources of increasing returns.

With a dynamic cost function interactions between input factors and external factors can be estimated through second derivative elasticity.

An extended GL variable cost function can be written as (see e.g. Morrison Paul and Siegel, 2001)[8]:

$$C(p, Y) = Y\left[\sum_i \sum_j \alpha_{ij} p_i^{1/2} p_j^{1/2} + \sum_i \sum_m \delta_{im} p_i s_m^{1/2} + \sum_i p_i \sum_m \sum_n \gamma_{mn} s_m^{1/2} s_n^{1/2}\right] \qquad (6)$$

The variables p denote the prices of input factors, $s_{m(n)}$ stands for output (Y) and the external determinants.

Applying Shephard's lemma, the demand for the j-th input factor can be obtained by differentiating (6) with regard to its own price:

$$D_j = \partial C / \partial p_j \qquad (7)$$

Differentiating the demand for an input factor given in equation (7) with respect to the n-th element of vector X gives the elasticity of demand for that factor with respect to the considered external factor:

$$\varepsilon_{D_j X_n} = \partial \ln D_j / \partial \ln X_n \qquad (8)$$

In table 5 the elasticity of demand for respectively low-skilled (LS) and High-skilled (HS) workers for each individual industry are reported. GMM estimation is performed on the system of the simultaneous factor demand equations. The long run elasticity has been computed using the ANALYZ procedure in TSP. The high-skilled abundant EU and OECD countries are regrouped in country group HSC and the (South-) East Asian, Central and East European and Latin American countries in the NIC group, as the GL estimation is rather demanding in terms of degrees of freedom.

Except for high-skilled workers in sector 385, own price elasticity is always negative and almost always significantly so. Cross elasticity suggests, in six out of the twelve sectors, that high-skilled and low-skilled labour are complements rather than substitutes whereas the highly significant positive elasticity of both factors with regard to capital point at substitution between both groups of labour and capital. Foreign outsourcing towards high-skilled abundant countries appears to have increased relative demand for low-skilled workers in the five considered EU countries. Outsourcing towards the low-skilled EU countries seems to have decreased the absolute demand for both low-skilled and high-

[8] We focus on the long run effects and therefore consider a specification in which capital is flexible.

skilled workers and following the magnitude of the significant elasticity measures decreased relative demand for low-skilled workers.

**Table 5 – Elasticity of the Demand of Low-skilled (LS) and High-skilled (HS) Workers (1985-1996)**

| | $\varepsilon_{LS,wLS}$ | $\varepsilon_{LS,wHS}$ | $\varepsilon_{LS,wK}$ | $\varepsilon_{LS,outs\ HSC}$ | $\varepsilon_{LS,outs\ EULS}$ | $\varepsilon_{LS,outs\ NIC}$ | $\varepsilon_{LS,RDS}$ |
|---|---|---|---|---|---|---|---|
| ISIC 31 | -0.13 * | -0.37 *** | 0.50 *** | 0.67 *** | -1.49 *** | 0.60 *** | 0.42 *** |
| ISIC 32 | -0.73 *** | -0.21 * | 0.95 *** | 0.21 | -0.12 | -0.54 ** | -0.52 ** |
| ISIC 33 | -0.44 *** | 0.20 *** | 0.26 *** | 0.39 *** | -0.32 *** | 0.42 *** | 0.03 |
| ISIC 34 | -0.63 *** | 0.22 *** | 0.42 *** | 0.43 *** | -0.25 | -0.26 * | -0.00 |
| ISIC 35 | -0.58 *** | 0.85 | 0.50 *** | 0.68 *** | 0.26 | 0.20 | -0.68 |
| ISIC 36 | -0.18 *** | -0.22 *** | 0.40 *** | 0.39 *** | -1.22 *** | 1.25 *** | 1.02 *** |
| ISIC 37 | -0.26 *** | -0.01 | 0.27 *** | -0.58 *** | -0.33 | 0.10 | -0.44 * |
| ISIC 381 | -0.08 | -0.32 *** | 0.39 *** | 0.49 | -0.11 | 0.20 | -0.30 *** |
| ISIC 382 | -0.12 ** | 0.05 | 0.08 | 0.23 ** | -0.58 *** | 0.61 *** | -0.08 |
| ISIC 383 | -0.17 *** | -0.20 *** | 0.36 *** | 0.56 *** | -0.37 *** | -0.41 *** | 0.08 |
| ISIC 384 | -0.46 *** | -0.00 | 0.46 *** | 1.06 *** | -0.63 | 0.05 | -0.07 |
| ISIC 385 | -0.01 | -0.51 *** | 0.52 *** | -0.28 | -0.02 | 0.97 *** | 0.34 |

| | $\varepsilon_{HS,wHS}$ | $\varepsilon_{HS,wLS}$ | $\varepsilon_{HS,wK}$ | $\varepsilon_{HS,outs\ HSC}$ | $\varepsilon_{HS,outs\ EULSC}$ | $\varepsilon_{HS,outs\ NIC}$ | $\varepsilon_{HS,RDS}$ |
|---|---|---|---|---|---|---|---|
| ISIC 31 | -0.17 * | -0.35 *** | 0.52 *** | -0.77 *** | -0.34 ** | 0.52 *** | -0.13 |
| ISIC 32 | -0.50 ** | -0.27 * | 0.77 *** | -0.93 *** | 0.14 | 0.20 | -0.76 *** |
| ISIC 33 | -0.54 *** | 0.18 *** | 0.26 *** | -0.37 *** | -0.18 * | 0.71 *** | 0.35 *** |
| ISIC 34 | -0.66 *** | 0.19 *** | 0.47 *** | -0.38 *** | -0.16 | 0.97 *** | -0.02 |
| ISIC 35 | -0.33 ** | 0.05 | 0.28 *** | 0.25 | -0.75 * | 0.34 | 0.61 |
| ISIC 36 | -0.46 *** | -0.29 *** | 0.75 *** | -0.41 *** | -1.18 *** | 1.81 *** | 0.64 ** |
| ISIC 37 | -0.35 *** | -0.01 | 0.36 *** | -0.38 *** | -0.42 * | -0.03 | 0.07 |
| ISIC 381 | -0.55 *** | -0.08 | 0.63 *** | -0.09 | -0.55 *** | 0.80 *** | 0.44 *** |
| ISIC 382 | -0.58 *** | 0.05 | 0.53 *** | -0.24 * | -0.32 *** | 0.88 *** | 0.01 |
| ISIC 383 | -0.43 *** | -0.15 *** | 0.58 *** | 0.36 *** | -0.76 *** | 0.04 | 0.25 ** |
| ISIC 384 | -0.48 *** | -0.00 | 0.48 *** | -1.00 * | 1.05 * | -0.34 | -0.31 |
| ISIC 385 | 0.07 | -0.27 *** | 0.20 ** | -0.24 ** | -0.12 | 0.20 | -0.05 |

**Note**. Elasticity is derived from the results of a GMM estimation of the cost function equation and the demand equations.
*; **; *** denotes significance at respectively the 10%; 5% and the 1% level

Foreign outsourcing towards the NIC group significantly increased demand for high-skilled workers in six sectors and demand for low-skilled workers in five sectors. In three sectors outsourcing towards the NIC significantly decreased demand for low-skilled workers. Overall, the magnitude of the significant coefficients suggests that outsourcing towards the NIC appears to have decreased relative demand for low-skilled workers.

There is some evidence of a skill-bias in R&D activities though the evidence is not overwhelming[9]. The negative sign of cross price elasticity and the equal signs of elasticity of outsourcing towards the low-skill abundant countries (EULS and NIC) for low-skilled and high-skilled labour, in a number of

[9] Investment in R&D activities significantly raised the demand for high-skilled workers in four industries and the demand for low-skilled workers in two industries and significantly decreased demand for low-skilled workers in two industries and demand for high-skilled workers in one industry.

industries, shows that the relationship between the two labour categories is complementary rather than one of substitution in a number of industries.

## 5. Conclusions

Only in Germany did both the relative wages and relative employment of high-skilled workers seem to have increased as they did in the US. In Denmark and the UK relative wages of high-skilled workers increased but relative employment decreased or did not change. In Belgium and France wage inequality between high-skilled and low-skilled workers seems to have decreased in the period 1985-1996 whereas relative employment of high-skilled workers increased. In the considered period the share in value added of high-skilled workers increased substantially in Germany and the UK but hardly changed in Belgium, Denmark and France. These stylised facts should caution for generalizing conclusions of US based studies or studies based on a single EU country. The substantial heterogeneity of EU countries should be accounted for.

The results of a two-stage mandated wage regression suggest that there have been no long run Stolper-Samuelson effects of outsourcing towards low-skill abundant countries in the five considered EU countries in the period 1985-1996. There is some evidence that foreign outsourcing, though with high-skill abundant countries and not with low-skill abundant NIC, had an impact on domestic prices but this did not seem to carry on in wage changes.
The estimation of an empirical wage function, on the other hand, points at significant and substantial effects of foreign outsourcing on relative wages of low-skilled workers. There is overall evidence, for Belgium, Denmark, France and the UK, of a significant negative impact of outsourcing towards the group of low-skilled abundant EU countries (Greece, Ireland, Portugal and Spain) in the period 1985-1996, i.e. a period at the beginning of which most of these countries had only just become a member of the EU or nit been a member for a long time. As the data on outsourcing also show integrating these countries in the EU increased outsourcing and this affected the wages of low-skilled workers in the other EU countries. Outsourcing towards other groups of countries also significantly affected the relative wages of low-skilled workers but apparently in a less consistent and a more country-specific way.

The elasticity of labour demand derived from a Generalized Leontief cost function suggests considerable employment effects of foreign outsourcing. Outsourcing towards high-skilled abundant countries (i.e. countries at the same or a higher technological level) appears to have increased the relative demand for low-skilled workers and would even have decreased the absolute demand for high-skilled workers in a considerable number of industries. Outsourcing towards the group of low-skill abundant EU countries would have decreased the demand for both high-skilled and low-skilled

workers and decreased the relative demand for low-skilled workers whereas outsourcing towards Central and East European, (South-) East Asian and Latin American NIC would have increased the demand for both labour groups but again decreased relative demand for low-skilled workers.
The estimated cross wage elasticity and the equal signs of elasticity with regard to outsourcing, in a number of industries, hints at the relationship between high-skilled and low-skilled being complementary rather than one of substitution whereas both low-skilled and high-skilled labour would substitute for capital, contrary to the empirical evidence on capital-skill complementarity in the US (Tyers and Yang (2000). There is some though not overwhelming evidence that R&D activities in a number of industries would have increased the relative demand for high-skilled workers.

The results of the estimations show the importance of accounting for heterogeneity of countries, countries of origin as well as countries of destination.
There is evidence of substantial short-run effects of foreign outsourcing on relative wages of low-skilled workers and long-run effects on employment.
In this paper I have used a number of different methodological approaches. The mandated wage approach and a flexible cost function framework adhere to the tradition of trade economists whereas a wage function methodology would be preferred by labour economists.
I endorse the view of Slaughter (2000) that research, despite methodological progress, has yet fundamental limitations in answering how much international trade contributes to wage inequality but I believe that a complete assessment of the impact of international trade competition of low-wage countries on the position of low-skilled workers in high-wage countries would benefit from a deliberate synthesis of both, as pointed out by Greenaway, Hine and Wright (2000), as yet still distinctive approaches of trade and labour economists.

**References**


Anderton, B. and P. Brenton (1999),'Did Outsourcing to Low-wage Countries Hurt Less-skilled Workers in the UK?', in Brenton, P. and J. Pelkmans (eds.), *Global trade and European workers*, Macmillan: Basingstoke.

Arellano, M. and S. Bond (1991),'Some Test Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Data', *Review of Economic Studies*, 58: 277-297.

Arellano, M. and O. Bover (1995),'Another Look at the Instrumental-Variable Estimation of Error-Components Models'. *Journal of Econometrics*, 68: 29-52.

Barnett, W.A. (1985),'The Minflex-Laurent Translog Flexible Functional Form', *Journal of Econometrics*, 30: 33-44.

Barnett, W.A., Lee, Y.W. and M.D. Wolfe (1985),'The Three-Dimensional Global Properties of the Minflex Laurent, Generalized Leontief, and Translog Flexible Functional Forms', *Journal of Econometrics*, 30: 3-31.

Berman, E., Bound, J. and Z. Griliches (1994), 'Changes in the Demand for Skilled Labor Within US Manufacturing Industries: Evidence from the Annual Survey of Manufacturing', *Quarterly Journal of Economics*, 109 (2): 367-397.

Berman, E., Bound, J. and S. Machin (1998), 'Implications of skill-biased technological change: international evidence', *Quarterly Journal of Economics*, 113 (4): 1245-1279.

Bernard, A.B and J.B. Jensen (1997), 'Exporters, Skill upgrading and the Wage Gap', *Journal of International Economics*, 42: 3-32.

Berndt, E.R. and D. Hesse (1986),' Measuring and Assessing Capacity Utilisation in the Manufacturing Sector of Nine OECD Countries', *European Economic Review* , 30(5): 961-989.

Bond, S. (2002), *Dynamic Panel Data Models: A Guide to Micro Data Methods and Practice*, Cemmap Working Paper CWP 09/02, Institute for Fiscal Studies: London.

Blundell, R. and S.R. Bond (1998),'Initial Conditions and Moment Restrictions in Dynamic Panel Data Models', *Journal of Econometrics*, 87: 115-143.

Blundell, R., Bond, S. and F. Windmeijer (2000),'Estimation in Dynamic Panel Data Models: Improving on the Performance of the Standard GMM Estimator', in: B.H. Baltagi (ed.), *Nonstationary Panels, Panel Cointegration, and Dynamic Panels* (Advances in Econometrics Volume 15). Elsevier Science: New York.

Brecher, R. (1974),'Minimum Wage Rates and the Pure Theory of International Trade', *Quarterly Journal of Economics*, 88: 98-116.

Coe, D.T. and E. Helpman (1995), 'International R&D Spillovers', *European Economic Review,* 39: 859-87.

Cuyvers, L., Dumont, M., Rayp. G and K. Stevens (2003), 'Wage and Employment Effects in the EU of International Trade with the Emerging Economies', *Weltwirtshaftliches Archiv*, 139: forthcoming.

Cuyvers, L., Dumont, M. and G. Rayp (2003), 'International Trade and the Income Position of Low-skilled and High-skilled Workers in the European Union', in: Anderton, B., Brenton, P. and J. Whalley (eds.), *Globalisation and Social Exclusion: Trade, Technology and Unskilled Workers in Europe and the United States*, Routledge: London, forthcoming.

Dumont M., G. Rayp, O. Thas and P. Willemé (2003). *Correcting Standard Errors in Two-stage Estimation Procedures with Generated Regressands* , mimeo.

Feenstra R.C. (2000), 'Introduction', in: R.C. Feenstra (ed.), *The Impact of International Trade on Wages*, University of Chicago Press: Chicago.

Feenstra, R. C. and G. Hanson (1996). Foreign Investment, Outsourcing, and Relative Wages. in: Feenstra R.C., Grossman, G.M. and D.A. Irwin (eds.), *Political Economy of Trade Policy*. MIT Press: Cambridge (MA).

Feenstra, R.C., and G.H. Hanson (1997), *Productivity measurement and the impact of trade and technology on wages: estimates for the US , 1972-1990*, NBER Working Paper 6052, NBER: Cambridge.

Feenstra, R. C. and G. H. Hanson (1999), 'The Impact of Outsourcing and High-technology Capital on Wages: Estimates for the United States', *Quarterly Journal of Economics*, 114 (3): 907-940.

Feenstra, R.C. and G.H. Hanson (2001), *Global production sharing and rising inequality: a survey of trade and wages*, NBER Working Paper 8372, NBER: Cambridge (MA).

Greenaway, D., R. Hine and P. Wright (2000), 'Further Evidence on the Effect of Foreign Competition on Industry Level Wages', *Weltwirtshaftliches Archiv*, 136 (3): 522-538.

Greene, W.H. (2000), *Econometric Analysis*, Prentice Hall: Upper Saddle River (NJ).

Grossman, G.M. and E. Helpman (1991), *Innovation and Growth in the Global Economy*, MIT Press : Cambridge (MA).

Haskel, J. and M. J. Slaughter (2001), 'Trade, Technology and UK Wage Inequality', *The Economic Journal*, 111(1): 163-187.

Helpman, E. and P. Krugman (1985), *Market Structure and Foreign Trade: Increasing Rerurns, Imperfect Competition and the International Economy*, MIT Press: Cambridge (MA).

Howell, D.R. (1997), 'Institutional Failure and the American Worker: The Collapse of Low-Skill Wages', *Public Policy Brief*, The Jerome Levy Economics Institute of Bard College: Blithewood (NY):

Howell, D.R., and F. Huebler (2001), *Trends on Earnings Inequality and Unemployment Across the OECD: Labor Market Institutions and Simple Supply and Demand Stories*, CEPA Working Paper No. 23, Center for Economic Policy Analysis: New York (NY).

Katz, L.F. and D. Autor (1999),'Changes in the Wage Structure and Earnings Inequality', in: Ashenfelter, O. and D. Card (eds.), *Handbook of Labour Economics* (Volume 3A), Elsevier Science: Amsterdam.

Keller, W. (1998), 'Are International R&D Spillovers Trade-related? Analyzing Spillovers Among Randomly Matched Trade Partners', *European Economic Review*, 42: 1469-1481.

Krugman, P. (1995 ),'Growing World Trade : Causes and Consequences', *Brookings Papers on Economic Activity* Macroeconomics, 1: 327- 362.

Krugman, P. (2000), 'Technology, Trade and Factor Prices', *Journal of International Economics*, 50: 51-71.

Lawrence, R. and M. Slaughter (1993), 'Trade and US Wages: Great Sucking Sound or Small Hiccup?', *Brookings Papers on Economic Activity: Microeconomics*, 2: 161-226.

Leamer, E. (1998),'In Search of Stolper-Samuelson Linkages between International Trade and Lower Wages', in: S.M. Collins (ed.), *Imports, Exports, and the American Worker*, Brookings Institution Press: Washington (DC).

Lichtenberg, F and B. Van Pottelsberghe de la Potterie (1996), *International R&D Spillovers: a Re-examination*, NBER Working Paper 5668, NBER: Cambridge (MA).

Martin, J.P. & J.M. Evans (1981),' Notes on Measuring the Employment Displacement Effects of Trade by the Accounting Procedure', *Oxford Economic Papers*, 33 (1): 154-164.

Maußner, A. (1999),'Wage Gaps in Textbook Models: Do they Account for the German Unemployment Experience?', *Jahrbuch für Wirtschaftswissenschaften*, 50 (2) : 156-177.

Mirza, D. (2003), *How Much Trade Contributes to the Formation of Market Structure*, GEP Research Paper 2003/4, GEP- Leverhulme Centre: Nottingham.

Montuenga, V., I. García and M. Fernández (2003), 'Wage Flexibility: Evidence from Five EU Countries Based on the Wage Curve', *Economics Letters* , 78: 169-174.

Morrison, CJ. (1988),'Quasi-fixed inputs in U.S. and Japanese Manufacturing: A Generalized Leontief Cost Function Approach', *Review of Economics and Statistics*, 70 (2): 275-287.

Morrison , C. J. and D. Siegel (1997), 'External Capital Factors and Increasing Returns in U.S. Manufacturing', *Review of Economics and Statistics*, 79 (4): 647-654.

Morrison Paul, C. and D. Siegel (2001), 'The impacts of technology, trade and outsourcing on employment and labour compensation', *Scandinavian Journal of Economics* ,103 (2): 241-264.

Neven, D. and C. Wyplosz (1996), *Relative prices, trade and restructuring in European industry*, Centre for Economic Policy Research Discussion Paper 1451, CEPR: London .

OECD (1998), *OECD Data on Skills: Employment by Industry and Occupation*, STI Working paper 1998/4, OECD: Paris.

Romer, P. M. (1986), 'Increasing Returns and Long-run Growth', *Journal of Political Economy*, 94 (5): 1002-1037.

Slaughter, M. J. (2000),'What are the Results of Product-Price Studies', in: R.C. Feenstra (ed.) *The Impact of International Trade on Wages*, NBER-University of Chicago Press: Chicago.

Tyers, R and Y. Yang (2000),'Capital-Skill Complementarity and Wage Outcomes following Technical Change in a Global Model', *Oxford Review of Economic Policy*, 16(3): 23-41.

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

## Annex

**Data** (Except for foreign outsourcing the data are the same as those used in Cuyvers et al. (2003 a, b))

- Employment

Data on employment of operatives and non-operatives is taken from the the UNIDO General Industrial Statistics database for the period 1985-1991 and from 1992 onwards data for manual and non-manual workers from the Labour Force Surveys data, provided by Eurostat.
For Belgium data on the number of manual and non-manual workers are provided by the National Office for Social Security (RSZ) for the entire period 1985-96.

- Wages

Data on monthly wages of non-manual workers were taken from NewCronos. For manual workers this data source gives gross hourly wages. The data on the hours worked per month by manual workers are too scarce to compute monthly wages. For the period 1985-91 the UNIDO data gives the wage sum of operatives and the number of operatives, which allows for a straightforward way of computing monthly wages of operatives. From 1992 onwards, monthly wages of manuals are computed with the wage sum of manual workers (total wage sum-wage sum non-manual workers (LFS + NewCronos)) and the rescaled number of manual workers (LFS).

- Foreign outsourcing

Foreign outsourcing is measured using data from the OECD Input-Output database. At present the OECD data cover the period 1973-1990 but the OECD is in the process of updating the database.
The database contains separate matrices of flows of imported intermediate inputs. For Belgium, the input-output data from the Federal Planning Bureau are used. Bilateral import shares (from the OECD Trade by Commodities database) are considered to decompose flows of imported intermediate inputs into flows imported from six country groups: Central- and East-European emerging economies (Czech Republic, Hungary and Poland); (South-) East Asian Newly Industrialized Countries (Hong Kong, Indonesia, Republic of Korea, Malaysia, Philippines, Singapore and Thailand); Latin-American Newly Industrialized Countries (Argentina, Brazil, Chile and Mexico); low-skill abundant EU countries (Greece, Ireland, Portugal and Spain); high-skill abundant EU countries (Austria, Belgium-Luxembourg, Denmark, France, Finland, Germany, Italy, the Netherlands and Sweden) and high-skill abundant OECD countries (Australia, Japan, New Zealand, Norway and the US ). There is sufficient data to construct all necessary variables for Belgium, Denmark, France, Germany and the United

Kingdom for the period 1985-1995. The flow matrices of imported intermediate inputs of 1990 are used as no more recent data were available.

- Price of capital

In Berndt and Hesse (1986) the price of capital is calculated as: $P_{Ki,t} = q_{i,t}*(r_t + \delta_i)$,
with $q_{i,t}$: investment deflator of *i*th type capital (e.g. capital in sector i) in year t ;$r_t$: long-term government bond yield and $\delta_i$: depreciation rate of *i*th type capital.
Data on long-term government bond yields were taken from the IMF International Financial Statistics. The same source contains data on fixed capital consumption from which depreciation rates can be computed. Unfortunately this information is given for few countries, sectors and years. Rather than using the sector depreciation rate for just a couple of observations, and disregarding it for most observations, only $r_t$ is used.
For $q_{i,t}$ sector-specific deflators are computed from the value added data given in STAN.

- Capital stock

Data on capital stocks were taken directly from the OECD International Sectoral Database (ISDB) or were estimated from ISDB annual investment data using the perpetual inventory method.

- Domestic prices

Domestic prices were computed from the OECD STAN data on sector value added.

- Total Factor Productivity

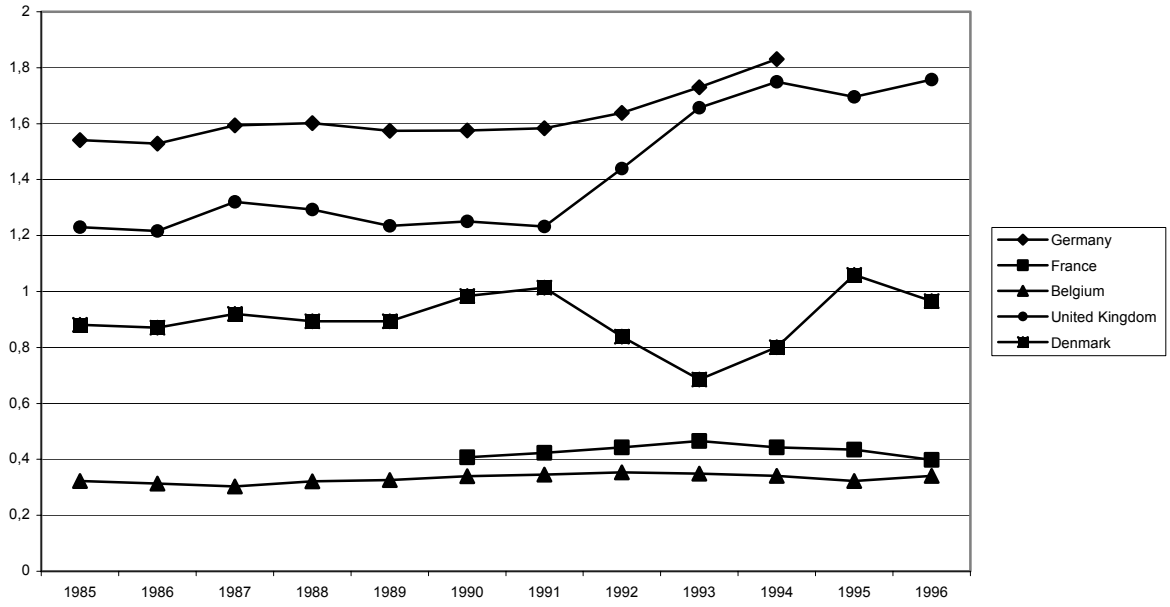
TFP was taken from the OECD International Sectoral Database (ISDB) if available. For those countries for which ISDB does not provide data on TFP it is computed, from data on gross fixed capital formation and employment (STAN/ ISDB), using the formula given in OECD (1994).

- R&D stock

National sector R&D stocks are computed with data from ANBERD, completed with BERD data (both from OECD). The 1973 stock was taken as the initial stock and computed with the formula given by Coe and Helpman (1995). For each sector, three R&D stocks were computed: the national R&D stock of the given sector; the total national R&D stock (minus the sector R&D stock) to estimate

national inter-sector spillovers and a foreign R&D stock which was weighted according to the procedure proposed by Lichtenberg and van Pottelsberghe de la Potterie (1996). As it concerns sector R&D stocks the foreign R&D stocks were weighted by total imports over the GDP of the exporting country times the share of the sector in the national output.

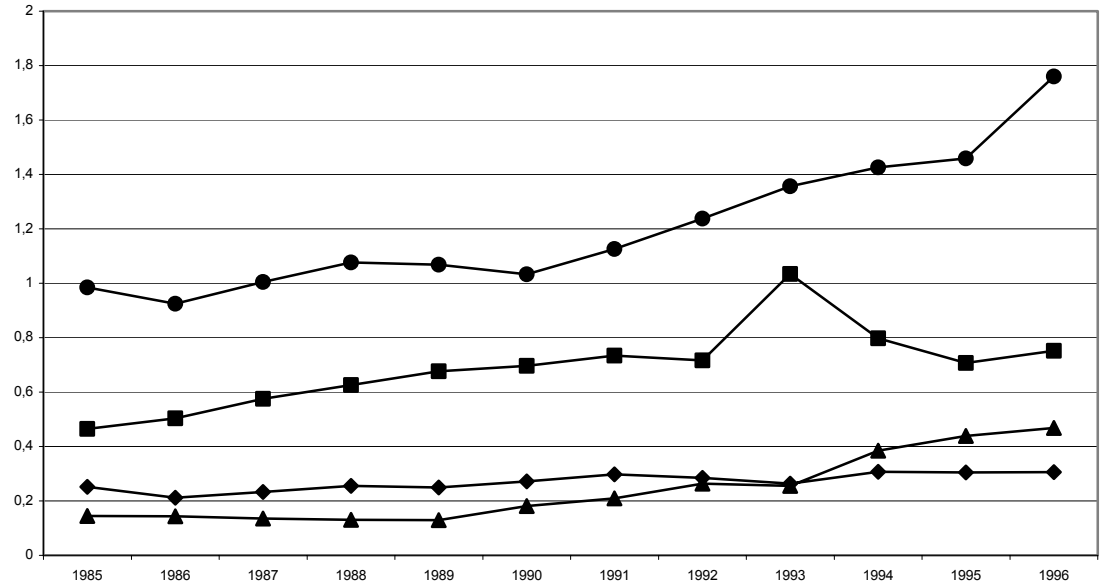
**Figure A.1 Evolution of ratio VA share non-production workers to VA share production workers in five EU countries in the period 1985-1996**



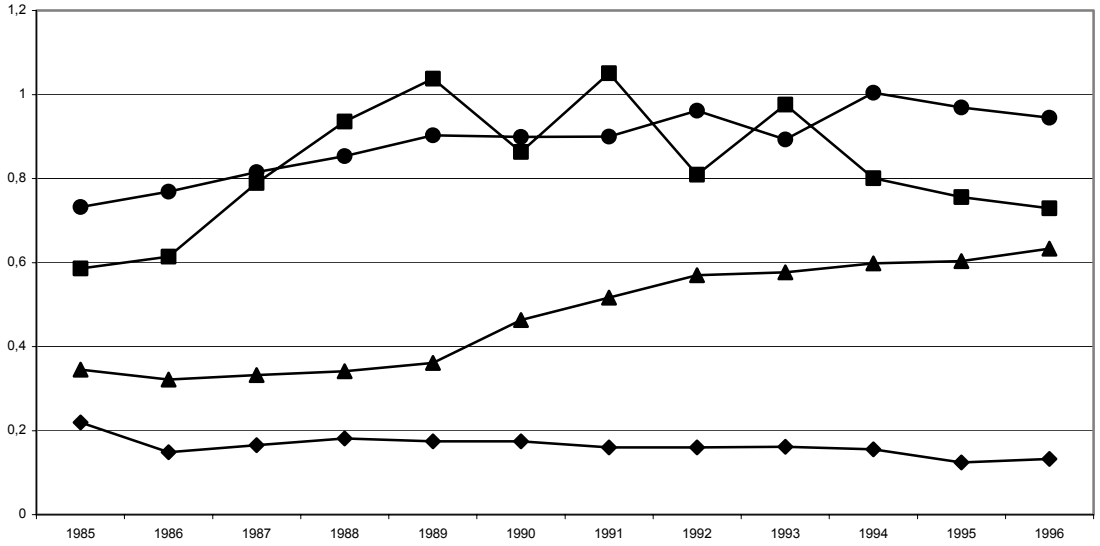

**Source:** own calculations from the UNIDO General Industrial Statistics database, Labour Force Surveys data (Eurostat) and OECD Structural Analysis industrial (STAN) and International Sector database (ISDB).

**Figure A.2: Average percentage of foreign outsourcing from NIC in the period 1985-1996**

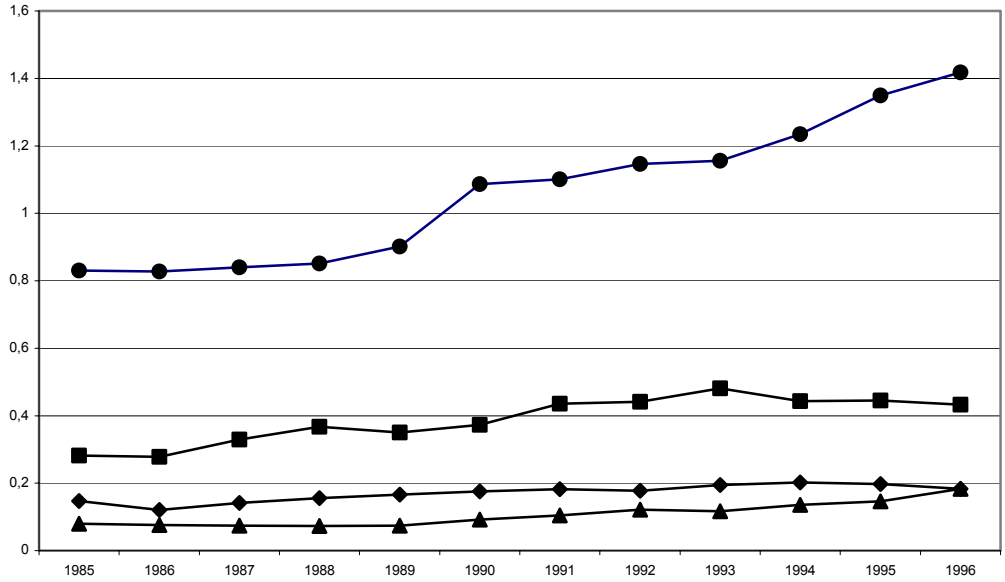
BELGIUM



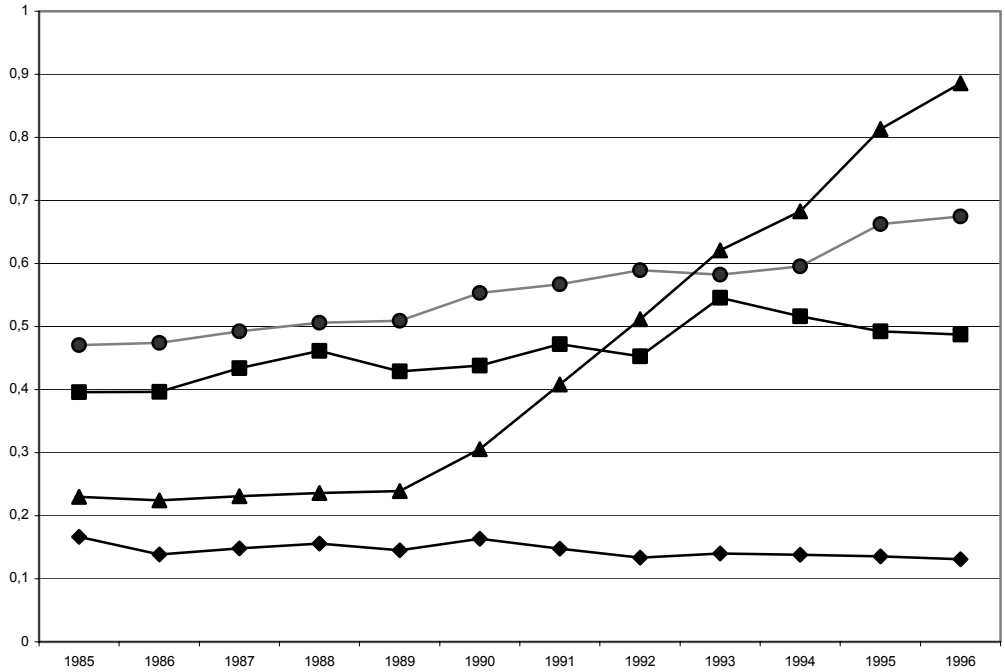

DENMARK



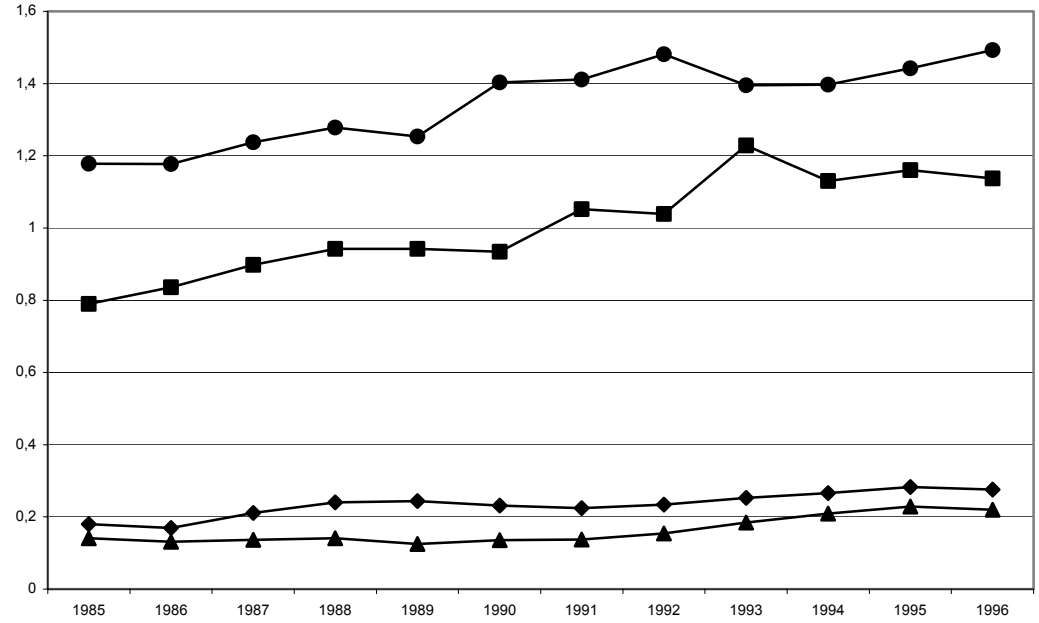
FRANCE




GERMANY



UNITED KINGDOM




**Source**: OECD DSTI Input/Output database and International Trade by Commodities Statistics (ITCS)

**Country Groups**

- Greece, Ireland, Portugal and Spain
- (South-) East Asian NIC
- Czech Republic, Hungary and Poland
- Argentina, Brazil, Chile and Mexico