

The Impact of International Trade, with Asian Newly Industrialized Countries, on Wages in the European Union

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I. Introduction

The impact of trade liberalization on wages, employment and income inequality is a controversial issue in the EU member states and other industrialized countries. Following the Heckscher-Ohlin-Samuelson (HOS) theoretical framework, a country that opens up to international trade will witness a decline in the reward of the production factor(s) the country is relatively poorly endowed with. This could explain the established deterioration of the income position of the low-skilled workers in the US or their high and increased unemployment rate in Europe, where labor market rigidities may have prevented wage adjustments like in the US. However, the odds of income by skill can alternatively be explained by skill-biased technological change. Lawrence and Slaughter (1993), for instance, observed that despite the increase in the skill premium in the US since the 1970s, the share of high-skilled workers in employment increased as well.

Most existing studies do not find much evidence in favor of the HOS trade hypothesis (see e.g. Leamer and Levinsohn, 1995; Brenton, 1998 and Feenstra and Hanson, 2001 for reviews). Conflicting with the common opinion, academic scholars seem agree on a limited effect of international trade on the wage gap between high- and low-skilled workers. Feenstra and Hanson (1999, 2001), in a contrary point of view, argue that trade in intermediate inputs has been neglected and show that by accounting for outsourcing, international trade can explain part of the increase in wage inequality. Irrespective of the latter consideration, the relative consensus resulted from studies, which almost solely focused on the United States. Little empirical work has been carried out to assess the extent to which the conclusions from these US studies can be generalized to other countries, i.e. the countries of the European Union, which in some aspects (e.g. labor markets) differ substantially from the United States.

With respect to recent empirical work on the effects of international trade on wages and wage inequality, we propose three extensions.

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First, using a more detailed geographical breakdown, we account for heterogeneity within the group of the newly industrialized countries (NICs). The implicit assumption that Latin American, East and South-East Asian, and Central and Eastern European countries are identical with respect to factor endowment and technological level, transportation costs and even trade liberalization (which depends on regional trade agreements with the EU), may be too heroic. Previous studies considered only a single NICs group which was assumed to be homogenous, at least with regard to the impact of international trade on industrialized countries. By distinguishing regional NIC groups and subgroups, we can estimate their respective impact and the impact of the (South-) East Asian NICs with the impact of the Latin American and Central and Eastern European countries.

Second, using a panel data approach, we account for intra-EU heterogeneity of the wage effects of trade liberalization. Most previous studies are restricted to individual countries (dominantly the US), where the regional distribution of the effects is of less importance, as a single country can be considered to constitute an optimal currency area. In the EU, labor mobility between member states is very low and countries are characterized by a 'North-South' divide in terms of factor endowment and technological level. Hence, the different extent to which countries are affected by international trade, may on the contrary be a first order policy issue (e.g. the debate on asymmetric shocks).

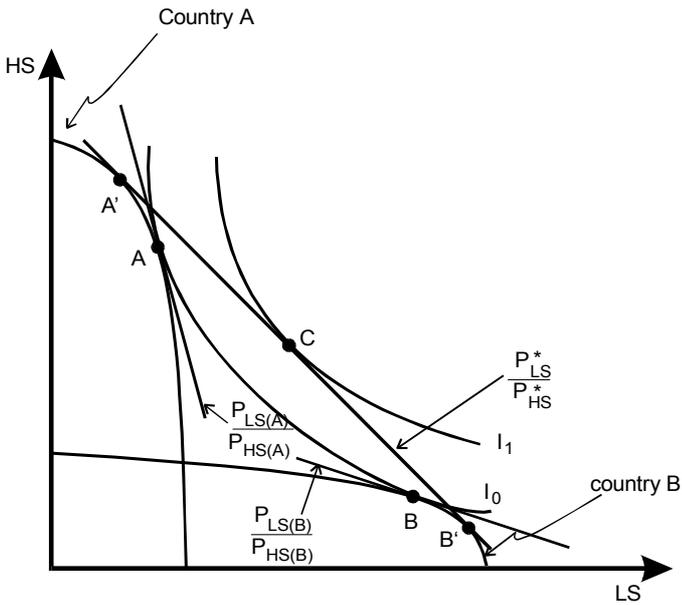
Finally, we use data on national and international R&D stocks for the estimation of the technology regression in the two-stage estimation procedure, proposed by Feenstra and Hanson (1997, 1999) and Haskel and Slaughter (1999, 2001), to disentangle the impact of international trade on factor rewards, from the effect of technological change. In the first stage, total factor productivity (TFP) is regressed on structural determinants. Feenstra and Hanson (1997, 1999) use data on outsourcing, computer equipment and other high-tech capital and Haskel and Slaughter (1999, 2001) data on innovation counts, industry concentration, union density, computer use and foreign prices to construct independent variables for the TFP regression. By using R&D stocks as structural determinants, we link the mandated wage methodology with the role of international R&D spillovers, as stressed in e.g. endogenous growth theory. Grossman and Helpman (1991) consider international trade as an important spillover mechanism and in an empirical application Coe and Helpman (1995) find evidence of substantial international spillovers. If trade is indeed an important channel for spillovers, the indirect effect of international trade on factor rewards (i.e. the trade induced technology effect pointed out by e.g. Wood (1994)) may be considerable. Incorporating spillovers may result in an improved specification of the estimation model and hence in a clearer assessment of the direct and indirect effect of international trade on wages.

We briefly present the theoretical framework in the next section. In section III, we give an outline of the “mandated wage” methodology, proposed by Leamer (1996), Feenstra and Hanson (1997, 1999), Lücke (1998) and Haskel and Slaughter (1999, 2001). In the following section we report our “mandated wage” estimation results for nine EU countries. We summarize our findings in the last section. The data that were used are described in detail in the data annex.

II. Trade and Wages in the Heckscher-Ohlin-Samuelson (HOS) Framework

The HOS model can be explained, in its most simple form, for two countries using two production factors (e.g. high-skilled labor L_{HS} and low-skilled labor L_{LS}) to produce two goods (HS and LS, with the skill-intensive good HS requiring relatively more L_{HS} than the less skill-intensive good LS). As shown in Figure 1, opening up to international trade will result in a shift of the production towards HS, in the skill-abundant country A and an opposite shift towards LS in country B.

Figure 1. Output and Relative Prices Shifts in Country A and B after Opening the Economies



The terms of trade are given by $p_{LS(B)} / p_{HS(B)} < p^*_{LS} / p^*_{HS} < p_{LS(A)} / p_{HS(A)}$ with p^*_{LS} / p^*_{HS} the relative price of good LS under free trade and $p_{LS(A)} / p_{HS(A)}$ and $p_{LS(B)} / p_{HS(B)}$ the relative price of good LS under autarky, in respectively country A and country B. The relative price of good LS is lower under free trade than the relative price under autarky in skill-abundant country A, which explains the shift away from the production of LS when markets are opened.

The increased production of the skill-intensive good in country A will result in an increase of the relative wages of high-skilled workers. A change in international relative prices consequently

'mandates' a change in the wages of high-skilled workers relative to low-skilled workers. It is this aspect of the HOS framework (i.e. the effect of product price changes on factor income distribution predicted by the Stolper-Samuelson theorem) that underlies the mandated wage methodology, which will be discussed later on in this paper. As shown by Jones (1965), due to the magnification effect of good prices on factor prices, the Stolper-Samuelson theorem relates to changes in real wages. The price increase of good HS in country A will increase the wages of high-skilled workers by more than the price increase of any of the two goods, whereas wages of low-skilled workers will increase by less (or even fall) than the price increase of either goods (Jones, 1971).

An alternative explanation to trade competition for the deteriorated position of low-skilled workers is skill-biased technological change. Lawrence and Slaughter (1993) have shown that, in spite of an increase in the skill premium in the US since the 1970s, the share in employment of high-skilled workers increased as well. The Stolper-Samuelson theorem would lead us to expect the contrary, i.e. a rise in the skill premium resulting in a decreased share in employment of high-skilled workers. However, our data provide no overall evidence to corroborate this finding for nine EU countries. For Germany and the UK, we find indications that the relative demand for high-skilled workers increased, notwithstanding an increase in skill premium, but for the seven other EU countries the evidence of a simultaneous increase in relative wages and employment is far from convincing⁴.

A shortcoming Haskel and Slaughter (1999, 2001) decry in previous product-price studies (e.g. estimations in which product price changes are regressed on the industry high-skilled/ low-skilled employment ratio) is that these do not follow unambiguously from a HOS framework.

The authors also argue that by assuming that prices and technology are exogenous, all previous studies assume that domestic price changes are only determined by international trade and ignore the possible impact of trade liberalization on technological change, as pointed out by e.g. Wood (1994). In view of these problems, Feenstra and Hanson (1997, 1999) and Haskel and Slaughter (1999, 2001) propose a two-stage mandated wage estimation procedure through which the effects, of respectively international trade and technological change, on factor rewards, can be assessed.

Feenstra and Hanson (1997, 1999) found that the share of computer equipment in total capital can explain 35 percent and more of the increase in the relative wages of US non-production workers (proxy for high-skilled workers). In addition, international trade in intermediate inputs can explain 15 percent and more of the increase in the relative wages during the 1980s.

Haskel and Slaughter (1999, 2001), expanding the procedure by Feenstra and Hanson (1997, 1999), find for the UK, that changes in prices during the 1980s were the major cause of rising factor income

⁴ See Cuyvers et al. (2001) for a more detailed outline of the stylized facts that can be derived from the data.

inequality and not technological change. This conclusion holds only for a one-stage approach, in which the UK is assumed to be small country. The results of the two-stage approach (i.e. large economy setting) suggest that trade reduced the skill premium during the 1970s and had no significant effect during the 1980s.

III. The Mandated Wage Approach.

Following Leamer (1996), Feenstra and Hanson (1997, 1999) and Haskel and Slaughter (1999, 2001) use the zero profit condition (or a constant mark-up in case of imperfect competition) to model the relationship between changes in relative price and factor rewards. The zero profit condition for sector i is given as:

$$p_i^g = \sum_j a_{ji} w_j + \sum_k b_{ki} p_k^g \quad i, k = 1, \dots, I \quad (1)$$

Where p_i^g represents domestic gross output price; w_j the unit cost of the j th production factor; a_{ji} the quantity of factor j used per unit i ; p_k the domestic gross output price of intermediate good k and b_{ki} the quantity of intermediate good k used per unit of i . Given labor supply, changes in prices or technology will ‘mandate’ changes in factor rewards that will restore zero profits in all sectors. For a small open economy p_i^g equals the world price of good i and if perfect factor mobility across sectors is assumed, factor reward for any given production factor j is the same across sectors.

This adjustment process can be formalized by differentiating (1) which, following Leamer (1996), gives⁵:

$$\sum_j V_{ji} \Delta \log w_j = \Delta \log p_i + \Delta \log TFP_i \quad (2)$$

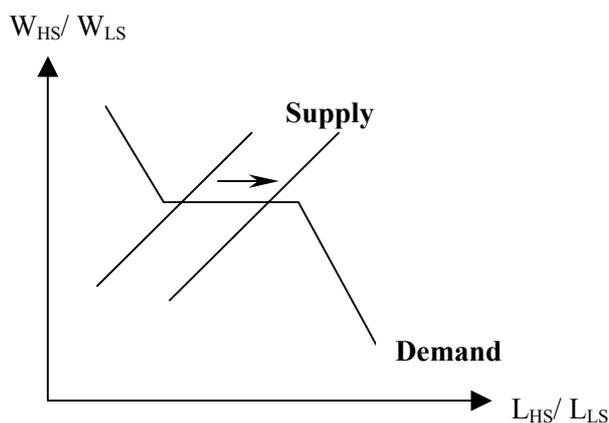
V_{ji} denotes the value-added share of factor j in sector i , $\Delta \log p_i$ the change in value added prices (i.e. $\Delta \log p_i = \Delta \log p_i^g - \sum_k V_{ki} \log p_k^g$) and TFP_i the total factor productivity in sector i .

In Figure 2 the demand for high-skilled workers, relative to the demand for low-skilled workers, is shown in a two-goods economy. From (1) we know that the slope of relative labor demand depends on industry prices and technology. As long as a country does not fully specialize in one of the two goods (i.e. as long as the equilibrium lies on the horizontal part of the relative demand curve), changes in the

⁵ Time subscripts are omitted to simplify the notation.

relative supply of high-skilled workers (e.g. an increase due to education efforts) will, following the Rybczynski theorem, not change relative wages. Therefore, under the assumption that a country does not fully specialize, changes in the relative supply can be excluded as an explanation for changes in relative wages (Haskel and Slaughter, 1999).

Figure 2. Relative Labor Demand (High-skilled/Low-skilled)



Source: adapted from Haskel and Slaughter (1999)

Equation (2) shows that the factor reward changes, which restore equilibrium, depend on the correlation between price and technology changes and the sector value added shares of the production factors. If the relative price of the high-skilled labor intensive good increases because of globalization or if technological change favors its production, the zero profit condition will imply an economy-wide increase of the wage of the high-skilled workers.

In the situation of a small country facing given international prices, the law of one price applies and all price changes will be of international origin, i.e. exogenous. Hence, factor reward changes can be linked to total price changes. However, in the situation of a large country, product prices may change for other reasons than international price adjustments. Feenstra and Hanson (1997, 1999) and Haskel and Slaughter (1999, 2001) account for the possible endogeneity of prices and technological change. In the first stage, domestic price changes are regressed on its underlying determinants ($Z_{pr,i}$) such as international price competition, and TFP changes are regressed on the underlying determinants of technological change ($Z_{tc,i}$):

$$\Delta \log p_i = \sum_{pr} Z_{pr,i} \delta_{pr} + \varepsilon_{pr,i} \quad (3)$$

$$\Delta \log TFP_i = \sum_{tc} Z_{tc,i} \delta_{tc} + \varepsilon_{tc,i} \quad (4)$$

The individual k_{pr} and k_{tc} parameters of, respectively, the vectors δ_{pr} and δ_{tc} give the impact of the associated k -th structural determinant on domestic price changes and TFP changes. In the second stage the estimated contribution of each k -th determinant ($\hat{\delta}_{k_{pr}} Z_{k_{pr},i}$ and $\hat{\delta}_{k_{tc}} Z_{k_{tc},i}$) is regressed separately on the factor shares:

$$\hat{\delta}_{pr} Z_{pr,i} = \sum_j V_{ji} \gamma_{j,pr} + \varepsilon'_{pr,i} \quad (5)$$

$$\hat{\delta}_{tc} Z_{tc,i} = \sum_j V_{ji} \gamma_{j,tc} + \varepsilon'_{tc,i} \quad (6)$$

The estimated second stage coefficients ($\gamma_{j,pr}$ and $\gamma_{j,tc}$) are then estimates of the changes in factor rewards “mandated” by each k -th structural determinant of domestic price and TFP changes.

IV. Estimation

The data allow us to create a panel of 9 EU countries and 12 industrial sectors⁶ for which first differences were computed over the period 1985-1995. We considered the differences over a longer period (ten years) as an approximation of the long run effects to which the Stolper-Samuelson theorem refers. More details concerning the data are given in the data annex.

We performed a panel data estimation on the 107 available observations. Because of the size of the EU economy, we considered price and technological change as not fully exogenous. Hence, before performing the mandated wage regression, we first have to isolate the share of total change caused by the forces of international trade liberalization and technological progress in a two-stage estimation procedure.

As regards the effect of *import price competition* on domestic price changes, we regressed in the first stage the domestic price changes on country specific fixed effects, import price changes and the change in total factor productivity (in order to control for the output price effect of technological change) :

$$\begin{aligned} \Delta \log p_{i,dom} = & \alpha_{0,i} + \alpha_{euh} \Delta \log p_{i,euh} + \alpha_{eul} \Delta \log p_{i,eul} + \alpha_{oere} \Delta \log p_{i,oere} + \alpha_{ash} \Delta \log p_{i,ash} \\ & + \alpha_{asl} \Delta \log p_{i,asl} + \alpha_{cee} \Delta \log p_{i,cee} + \alpha_{lat} \Delta \log p_{i,lat} + \alpha_{tfp} \Delta \log TFP_i + \varepsilon_{i,pr} \end{aligned} \quad (7)$$

⁶ Countries: Belgium, Denmark, Finland, France, Germany, Italy, Spain, Sweden and the UK. Sectors: Food, drink & tobacco (ISIC 31); Textile, footwear & leather (ISIC 32); Wood, cork & furniture (ISIC 33); Paper, printing & publishing (ISIC 34); Chemicals (ISIC 35); Non-metallic mineral products (ISIC 36); Basic Metal Industries (ISIC 37); Fabricated metal products (ISIC 381); Non-electrical machinery (ISIC 382); Electrical equipment (ISIC 383); Transport equipment (ISIC 384) and Precision instruments (ISIC 385).

Import price changes were broken down by seven country groups in order to take account of cross-regional heterogeneity in import competition and trade liberalization: the high-wage EU countries ($\Delta \log p_{i,euH}$), the low-wage EU countries ($\Delta \log p_{i,euL}$), the other OECD countries ($\Delta \log p_{i,oere}$), the high-wage (South-) East Asian NICs ($\Delta \log p_{i,ash}$), the low-wage (South-) East Asian NICs ($\Delta \log p_{i,asl}$), the most advanced Central and Eastern European countries ($\Delta \log p_{i,cee}$) and the Latin American NICs ($\Delta \log p_{i,lat}$)⁷. Table 1 shows the first stage estimation results.

Table 1 - Stage-one price regression

Dependent variable : $\Delta \log p_{i,dom}$		(7)
$\Delta \log p_{i,euH}$		-0.04 (-0.72)
$\Delta \log p_{i,euL}$		0.18 (2.22)
$\Delta \log p_{i,oere}$		-0.09 (-1.38)
$\Delta \log p_{i,ash}$		0.05 (1.14)
$\Delta \log p_{i,asl}$		-0.02 (-0.65)
$\Delta \log p_{i,cee}$		-0.01 (-0.73)
$\Delta \log p_{i,lat}$		0.03 (0.48)
$\Delta \log TFP_i$		-0.77 (-7.96)
R^2		0.64
<i>Note:</i> the results are fixed effects estimations - heteroskedastic-consistent t-statistics in brackets.		

Import price changes of the low-wage EU countries, the high-wage Asian and the Latin American countries are positively correlated with EU domestic price changes, but only for the low-wage EU countries does the coefficient significantly differ from 0. Import competition from high-wage countries either from inside or from outside the EU (other OECD countries, i.e. mainly the U.S. and Japan) has a negative effect on domestic price change, though not significantly different from zero. The effect of technological change on domestic price change is negatively signed as could be expected, clearly significantly different from zero and has a substantially more important effect on domestic price changes than import competition. Its value is consistent with a theoretically expected pass-through of technological progress between 0 and 1.

To control additionally for imperfect competition, we also tested a specification of the right hand side of (7) where the price changes were interacted with a pass-through variable (PT), reflecting market structure, i.e.

⁷ A detailed country list of each group is given in the data appendix.

$$\begin{aligned}
\Delta \log p_{i,\text{dom}} = & \alpha_{0,i} + \Delta \log p_{i,\text{euh}} (\alpha_{\text{euh}} + \alpha_{\text{PT,euh}} * \text{PT}_{\text{euh}}) + \Delta \log p_{i,\text{eul}} (\alpha_{\text{eul}} + \alpha_{\text{PT,eul}} * \text{PT}_{\text{eul}}) \\
& + \Delta \log p_{i,\text{oere}} (\alpha_{\text{oere}} + \alpha_{\text{PT,oere}} * \text{PT}_{\text{oere}}) + \Delta \log p_{i,\text{ash}} (\alpha_{\text{ash}} + \alpha_{\text{PT,ash}} * \text{PT}_{\text{ash}}) \\
& + \Delta \log p_{i,\text{asl}} (\alpha_{\text{asl}} + \alpha_{\text{PT,asl}} * \text{PT}_{\text{asl}}) + \log p_{i,\text{cee}} (\alpha_{\text{cee}} + \alpha_{\text{PT,cee}} * \text{PT}_{\text{cee}}) \\
& + \Delta \log p_{i,\text{lat}} (\alpha_{\text{lat}} + \alpha_{\text{PT,lat}} * \text{PT}_{\text{lat}}) + \alpha_{\text{TFP}} \Delta \log \text{TFP}_i + \varepsilon_{i,\text{pr}}
\end{aligned} \tag{7'}$$

In order to test the validity of the pass-through assumption, we performed an F-test of the hypothesis that $\alpha_{\text{PT},i}$ ($i = \text{euh, eul, oere, ash, asl, cee, lat}$) were jointly zero. For the sake of robustness, we repeated the test for three possible proxies of the pass-through variable:

- The share of the cumulative turnover of the four largest companies in the sector turnover, given by the STAN or ISDB sector aggregate (C4a), or by the aggregate computed from the Amadeus database (C4b), which was the source for the company turnover figures (see data annex). We considered this second alternative in order to adjust for the consolidation status of the company figures
- The sector capital–labor ratio (K/L) from either STAN or ISDB.

Table 2 - Stage-one price regression with pass-through variable

Dependent variable :	(7')		(7')		(7')	
$\Delta \log p_{i,\text{dom}}$	PT = C4a		PT = C4b		PT = K/L	
$\Delta \log p_{i,\text{euh}}$	-0.05	(-0.48)	-0.11	(-1.33)	0.04	(0.43)
$\Delta \log p_{i,\text{eul}}$	-0.06	(-0.47)	0.12	(1.08)	0.11	(0.95)
$\Delta \log p_{i,\text{oere}}$	0.24	(1.97)	0.07	(0.60)	-0.03	(-0.18)
$\Delta \log p_{i,\text{ash}}$	-0.14	(-1.55)	0.01	(0.07)	0.03	(0.39)
$\Delta \log p_{i,\text{asl}}$	-0.06	(-0.85)	-0.08	(-1.37)	-0.03	(-0.48)
$\Delta \log p_{i,\text{cee}}$	0.06	(0.60)	-0.01	(-0.04)	-0.09	(-1.61)
$\Delta \log p_{i,\text{lat}}$	-0.02	(-0.23)	-0.03	(-0.29)	-0.12	(-0.86)
PT * $\Delta \log p_{i,\text{euh}}$	0.11	(0.29)	0.26	(1.00)	-0.00	(-0.76)
PT * $\Delta \log p_{i,\text{eul}}$	0.64	(1.86)	0.11	(0.36)	0.00	(0.16)
PT * $\Delta \log p_{i,\text{oere}}$	-1.13	(-2.27)	-0.77	(-1.42)	0.00	(0.00)
PT * $\Delta \log p_{i,\text{ash}}$	0.55	(2.09)	0.11	(0.58)	0.00	(0.52)
PT * $\Delta \log p_{i,\text{asl}}$	0.19	(0.81)	0.22	(0.98)	0.00	(0.36)
PT * $\Delta \log p_{i,\text{cee}}$	-0.20	(-0.63)	-0.02	(-0.10)	0.00	(1.30)
PT * $\Delta \log p_{i,\text{lat}}$	0.10	(0.38)	0.27	(0.78)	0.00	(1.02)
$\Delta \log \text{TFP}_i$	-0.65	(-6.52)	-0.74	(-7.46)	-0.85	(-7.47)
R ²	0.72		0.67		0.68	
F-test $\alpha_{\text{PT},i} = 0$	3.67	(0.00)	1.39	(0.22)	1.60	(0.14)

Note: the results are fixed effects estimations - heteroskedastic-consistent t-statistics in brackets. Significance levels of the F-test values in brackets

From Table 2, the hypothesis of zero pass-through cannot be rejected for two out of three proxies of the pass-through variable. We find a significant pass-through when using the first proxy (C4a), which is of all pass-through proxies most likely subject to measurement bias. It combines data from two sources (Amadeus and ISDB or STAN) and does not correct for the consolidation of the company figures that are used for the computation of the cumulative output of the four largest companies. Hence, the indications of additional market imperfection, on top of the deviations of the law of one price that we already allow, are insufficiently convincing. We therefore use estimates from (7) rather than from (7') in our second stage estimations.

In the second stage, each foreign competition determinant of $\Delta \log p_{\text{dom}}$ is regressed on the factor shares, in order to estimate its contribution to the change in inequality between high and lower skilled workers.

$$\alpha_j \Delta \log p_{i,j} = V_{\text{HS},i} \Delta \log w_{\text{HS}} + V_{\text{LS},i} \Delta \log w_{\text{LS}} + V_{\text{K},i} \Delta \log w_{\text{K}} + \varepsilon_{i,j} \quad (8)$$

(j = euh, eul, oere, ash, asl, cee, lat)

The variables $V_{f,i}$ represent the value added shares of factor f (high skilled labor -HS, lower skilled labor- LS- and capital-K) in sector i. Following Leamer (1996), $\Delta \log w_f$ are the parameters to be estimated in (8), reflecting the wage changes mandated by trade induced price changes to restore the zero profit condition. Transforming as in Lücke (1998) :

$$V_{\text{K},i} = 1 - V_{\text{HS},i} - V_{\text{LS},i}$$

we obtain :

$$\alpha_j \Delta \log p_{i,j} = \Delta \log w_{\text{K}} + V_{\text{HS},i} (\Delta \log w_{\text{HS}} - \Delta \log w_{\text{K}}) + V_{\text{LS},i} (\Delta \log w_{\text{LS}} - \Delta \log w_{\text{K}}) + \varepsilon_{i,j} \quad (9)$$

(j = euh, eul, oere, ash, asl, cee, lat)

The coefficient estimate of $V_{f,i}$ indicates to what extent the remuneration of factor f diverged from that of capital (if it is significant or not and, if so, in what direction). A comparison of the estimated parameters of $V_{\text{HS},i}$ and $V_{\text{LS},i}$ gives an indication of the change in wage inequality between high- and low-skilled workers in the period considered.

In the second stage, we deal with three additional estimation issues.

First, we explicitly add an F-test on the specification of the model. The presence of country specific intercepts or slopes determines the degree of (intra-EU) country heterogeneity with respect to trade liberalization. From (9), country specific intercepts would indicate country specificity of factor price evolutions and hence income divergence within the EU, caused by globalization. Country specific

slopes would in addition point to country differences in evolution of income inequality, which would exacerbate the income divergence trend. This may be especially problematic in an economic area with limited labor mobility.

Second, (8) and (9), as well as (2) are strictly valid in continuous time, but not for the approximate discrete time change used in an empirical test. For the latter, we have to take into account the interaction effect between the changes in factor input requirements and the changes in factor rewards (see e.g. Leamer 1996). The discrete time equivalent of (2) is:

$$\sum_j V_{ji} \Delta \log w_j (1 + \Delta \log a_{ji}) = \Delta \log p_i + \Delta \log TFP_i$$

In order to test whether our results are subject to an omitted variable bias because of using (9) instead of its discrete time equivalent, we regressed the residuals of (9) on the interaction terms of the value added shares and (the change in) unit factor input requirements and performed an F-test on their significance.. We report the results of these specification tests in Table 3.

Third, we have to take into account that the second stage dependent variables are estimated from the first stage regression instead of being effectively measured. Hence we have to correct the second stage estimated standard errors for this additional source of variance. Feenstra and Hanson (1997, appendix) propose a procedure to recover the “true” error variances. Unfortunately, their correction method does not warrant positive variances of the estimated parameters in the second stage regression. Besides the problem that in a number of cases standard errors cannot be determined (see Feenstra and Hanson, 1999 or Haskel and Slaughter, 2001) this may point to a negative bias in the corrected variances and hence, to an underestimation of the size in parameter significance tests. We will therefore apply the correction procedure proposed by Dumont et al. (2003), which always results in consistent and positive variances of the second stage parameters⁸.

The results of the second stage of the mandated wage regression are shown in Table 3.

⁸ The F-tests on model specification however are not affected by the estimated character of the second-stage dependent variable. The F-statistics only test for specification in the second stage conditional regression, i.e. conditional on a given first-stage effect. Changing the value of the estimated coefficient from the first stage in the second stage dependent variable changes the residual sum of squares by the same multiplicative factor for both the restricted and the unrestricted

Table 3 - Stage-two price regression

Dependent variable:	$\alpha_{\text{euh}}\Delta p_{\text{euh}}$	$\alpha_{\text{eul}}\Delta p_{\text{eul}}$	$\alpha_{\text{oere}}\Delta p_{\text{oere}}$	$\alpha_{\text{ash}}\Delta p_{\text{ash}}$	$\alpha_{\text{asl}}\Delta p_{\text{asl}}$	$\alpha_{\text{cee}}\Delta p_{\text{cee}}$	$\alpha_{\text{latin}}\Delta p_{\text{latin}}$
$\Delta \log w_{\text{HS}} - \Delta \log w_{\text{K}}$	-0.00 (-0.20)	-0.09 (-1.12)	-0.10 (-1.62)	0.09 (1.83)	0.01 (0.29)	0.02 (0.80)	n.r.
$\Delta \log w_{\text{LS}} - \Delta \log w_{\text{K}}$	-0.01 (-0.35)	0.02 (0.21)	-0.04 (-0.91)	-0.00 (-0.10)	0.00 (0.28)	0.01 (0.78)	n.r.
$\Delta \log w_{\text{K}}$	n.r.	n.r.	n.r.	n.r.	-0.01 (-0.12)	0.00 (0.06)	n.r.
R^2	0.21	0.23	0.22	0.26	0.02	0.03	n.r.
F-test : common intercept and slope versus country specific intercepts and slopes (p-values in brackets)	2.31 (0.00)	1.55 (0.08)	1.52 (0.09)	1.39 (0.14)	1.21 (0.26)	0.97 (0.52)	1.54 (0.08)
F-test : common slopes versus country specific and slopes, given country specific intercepts (p-values in brackets)	1.16 (0.32)	0.91 (0.56)	0.88 (0.59)	0.65 (0.83)	1.30 (0.22)	0.80 (0.69)	1.86 (0.04)
F-test: common intercept versus country specific intercepts, given a common slope (p-values in brackets)	4.48 (0.00)	2.86 (0.01)	2.84 (0.00)	3.04 (0.00)	0.97 (0.46)	1.35 (0.23)	0.79 (0.62)
F-test on zero slopes of $V_{ji} \Delta \log a_{ji}$	1.49 (0.23)	1.31 (0.28)	0.16 (0.85)	0.40 (0.67)	0.27 (0.77)	0.17 (0.84)	
<i>Note:</i> heteroskedastic-consistent t-statistics in brackets, based on standard errors accounting for estimated instead of measured dependent variables as explained in the text-n.r.: not reported. For F-tests see footnote 8.							

Concerning the model specification, we reject the plain OLS specification with common intercept and slope in five out of seven cases, in particular for trade with the low- and high wage EU countries, the other OECD countries and the higher wage Asian NICs

The F-tests are to some extent ambiguous in the three first cases, if we consider a 10% significance level.

However, the estimations with country specific slopes and intercepts (i.e. country specific OLS) may suffer from a lack of degrees of freedom (since we have only 12 observations by country).

Hence, we trust more in the result of the F-test on plain OLS versus the fixed effects specification, where the number of degrees of freedom is substantially higher. Because of its country specificity, we do not report the change in capital reward when we do not reject a fixed effects specification.

Trade liberalization with the lower wage newly industrialized countries appears to have affected factor rewards in a fairly homogenous manner across the EU in the considered period and apparently does not alter the relative intra-EU position of the member states. Intra-EU and intra-OECD trade liberalization, as well as trade liberalization with the higher wage Asian NICs on the contrary, would have country specific effects on income evolution, though not on income distribution. Yet, they might be at the origin of asymmetric cross-country income shocks within the EU.

The use of a continuous time specification did not pose a problem of omitted variable bias in all the cases considered. Overall, the direct influence of trade liberalization on *income distribution* in the EU and hence on wage inequality seems limited. Only if we allow a 10% error margin, we do not reject that trade with the higher wage East and (South-) East Asian NICs has ‘mandated’ a profit clearing increase of the high-skilled workers wage of about 9% relative to the wage of the lower skilled, between 1985 and 1995. In the same period, trade liberalization with the non-EU OECD countries would have mandated simultaneously a profit clearing relative *fall* of 10 % of the higher skilled labor reward. Hence, trade liberalization overall might well have remained neutral with respect to income distribution in the EU or have even reduced inequality⁹.

Increased trade with the lower wage NICs from Asia or the Central and Eastern European countries do not seem to have affected wage inequality. Hence, we find some indications of Stolper-Samuelson effects of trade in the EU, but not very strong. In addition, they are not necessarily related to trade with low wage countries. Concerning trade with the NICs, the (South-) East Asian NICs in particular, the indications we find of an impact of trade on wage inequality refer to the more developed and higher wage NICs (South Korea, Singapore and Hong Kong).

In the first stage of the *total factor productivity growth* regression, we regressed TFP change on potential technological determinants and on international competition, allowing for country specific effects. Following Coe and Helpman (1995), we use the total period change in the sector domestic R&D stock ($\Delta \log \text{SRD}$), the total period change in the non-sector domestic R&D stock ($\Delta \log \text{NSRD}$) and the total period change in the foreign R&D stock ($\Delta \log \text{FRD}$). A proxy for non-sector and foreign knowledge is included to capture national and international knowledge spillover effects on technological progress (see Grossman and Helpman, 1991 for the theoretical framework and Coe and Helpman, 1995 for empirical evidence on international spillovers at the aggregate country level). To test the effect of international competition on technological change we also included the import prices changes relative to the base period domestic price ($p_{\text{dom}, 85}$) in order to avoid a potential simultaneity bias:

$$\Delta \log \text{TFP}_i = \beta_{i,0} + \beta_{\text{srd}} \Delta \log \text{SRD}_i + \beta_{\text{ns}} \Delta \log \text{NSRD}_i + \beta_{\text{for}} \Delta \log \text{FRD}_i + \frac{1}{p_{\text{dom},i,85}} \left(\beta_{\text{euh}} \Delta \log p_{\text{euh},i} + \beta_{\text{eul}} \Delta \log p_{\text{eul},i} + \beta_{\text{oere}} \Delta \log p_{\text{oere},i} + \beta_{\text{ash}} \Delta \log p_{\text{ash},i} \right) + \varepsilon_{i,\text{tc}} \quad (10)$$

Table 4 - Stage-one TFP regression

Dependent variable: $\Delta \log \text{TFP}_i$	(10)
$\Delta \log \text{SRD}_i$	0.02 (0.37)
$\Delta \log \text{NSRD}_i$	0.01 (0.11)
$\Delta \log \text{FRD}_i$	0.24 (2.32)
$(\Delta \log p_{\text{euh},i}) / p_{\text{dom},i,85}$	0.16 (2.26)
$(\Delta \log p_{\text{eul},i}) / p_{\text{dom},i,85}$	-0.11 (-1.35)
$(\Delta \log p_{\text{oere},i}) / p_{\text{dom},i,85}$	0.24 (3.13)
$(\Delta \log p_{\text{ash},i}) / p_{\text{dom},i,85}$	-0.13 (-2.57)
$(\Delta \log p_{\text{asl},i}) / p_{\text{dom},i,85}$	-0.02 (-0.51)
$(\Delta \log p_{\text{cee},i}) / p_{\text{dom},i,85}$	-0.09 (-1.86)
$(\Delta \log p_{\text{lat},i}) / p_{\text{dom},i,85}$	-0.05 (-0.74)
R^2	0.46
<i>Note:</i> see Table 1	

⁹ Our wage data show that in a number of EU countries wage inequality, if anything actually decreased in the period 1985-1995.

As in previous estimations (e.g. Coe and Helpman, 1995; Lichtenberg and van Pottelsberghe, 1996), we find significantly positive international R&D spillovers. The impact of international trade on TFP seems to operate through import price pressure as well as through facilitating international spillovers.

Table 5 - Stage-two TFP regression.

Determinant	Tech	M_{euh}	M_{eul}	M_{oere}	M_{ash}	M_{asi}	M_{cee}	M_{latin}
$\Delta \log w_{HS} - \Delta \log w_K$	n.r.	-0.00 (-0.03)	0.04 (0.69)	0.16 (1.85)	-0.23 (-2.81)	0.01 (0.39)	-0.08 (-1.40)	-0.01 (-0.51)
$\Delta \log w_{LS} - \Delta \log w_K$	n.r.	0.06 (0.87)	-0.01 (-0.16)	0.12 (1.72)	0.01 (0.12)	0.01 (0.49)	-0.06 (-1.34)	-0.01 (-0.53)
$\Delta \log w_K$	n.r.	n.r.	n.r.	n.r.	n.r.	-0.01 (-1.56)	-0.00 (-0.07)	-0.01 (-0.54)
R^2		0.32	0.19	0.19	0.26	0.01	0.04	0.02
F-test: common intercept and slope versus country specific intercepts and slopes (p-values in brackets)	11.11 (0.00)	2.25 (0.00)	1.44 (0.12)	1.16 (0.30)	1.28 (0.20)	1.26 (0.22)	1.26 (0.22)	1.17 (0.30)
F-test: common slopes versus country specific and slopes, given country specific intercepts (p-values in brackets)	2.27 (0.01)	0.89 (0.58)	1.09 (0.38)	0.69 (0.79)	0.54 (0.92)	1.44 (0.15)	0.92 (0.55)	1.43 (0.15)
F-test: common intercept versus country specific intercepts, given a common slope (p-values in brackets)	23.76 (0.00)	5.06 (0.10)	2.10 (0.04)	2.20 (0.03)	3.00 (0.01)	0.85 (0.56)	1.97 (0.06)	0.60 (0.78)
F-test on zero slopes of $V_{ji} \Delta \log a_{ji}$ (p-values in brackets)		0.21 (0.81)	1.59 (0.21)	0.04 (0.97)	1.10 (0.44)	1.21 (0.30)	0.35 (0.71)	3.63 (0.03)
<p><i>Note:</i> see Table 3. The estimation results for the common intercept ($\Delta \log w_K$) or the common slopes are not reported when the plain OLS or fixed effects specification was rejected respectively. For F-tests see footnote 8.</p> <p>The <i>Tech</i> variable captures the combined effect of the three R&D stocks that are considered. M_{oecd} stands for $\beta_{oecd}(\Delta \log p_{oecd,i})/p_{dom,i,85}$; M_{asia} for $\beta_{asia}(\Delta \log p_{asia,i})/p_{dom,i,85}$; M_{cee} for $\beta_{cee}(\Delta \log p_{cee,i})/p_{dom,i,85}$; M_{latin} for $\beta_{latin}(\Delta \log p_{latin,i})/p_{dom,i,85}$</p>								

The effect of increased trade with high-wage (South-) East Asian NICs has the expected sign and is significant. This would represent evidence of trade induced technological change, as pointed out in Wood (1994). Though of the expected sign, increased trade with NICs of other continents seems to have no significant influence on technological innovation, except for Central and East-European NICs at the 10 % level. Increased intra-EU or intra-OECD import competition on the contrary would decrease TFP change.

We tested additionally for market imperfection by interacting the relative price variables with a proxy for sector competition pass-through in a similar manner as for the direct effect of international trade, but could not reject the zero restriction on the pass-through parameters for any of the proxies used¹⁰. This implies that the second stage regressions use the estimated effects from (10). How these determinants of technological change influence factor rewards is reported in Table 5

The factor reward effect of the ‘pure’ technical determinant (tech) and the indirect effect of intra-EU and intra-OECD internationalization, as well as the indirect effect of high-wage Asian NICs are apparently rather country specific. For the first, even the fixed effects specification (common slopes) is rejected. This would point to country specific *growth differentials* between factor rewards, i.e. national differences in the evolution of factor reward inequality, caused by the ‘pure’ technical effect. The factor reward effect of total factor productivity growth, due to increased competition of the low-wage emerging economies, seems again much more homogeneous. Independent from their regional origin, we did not reject a plain OLS specification, i.e. a common effect on the factor rewards and hence on inequality between lower- and high-skilled workers in the EU.

If we allow for a more substantial type I error of 10%, we notice that technological change, induced by trade competition from the other OECD countries as well as from the high-wage South-East Asian countries would have affected factor rewards in the EU. This mirrors our findings for the direct, price competition effect from trade on factor rewards. Technological change induced by trade competition from the other OECD countries apparently affected high- and lower skilled labor in the EU in a similar way. Hence, it has apparently improved labor’s income position with respect to capital, without worsening the intra-labor wage inequality. Technological change, induced by trade competition with high-wage (South-) East Asian NICs is also significant for lower type I errors (one percent or less) and is larger in absolute value, compared to the impact in the EU of trade competition with the other OECD countries. The annual decrease of 2% is rather substantial and underscores the view of Wood (1994) that trade may induce technological change. This effect has influenced wage inequality between high- and lower-skilled labor but, somewhat surprisingly, it seems to have favored low-

¹⁰ Results available from the authors upon request.

skilled workers and would have reduced wage inequality in the EU. This would point to a sector bias in technological change towards the lower-skilled labor-intensive sectors, due to increased trade competition, which improves the income position of the low-skilled workers.

V. Conclusions.

Bhagwati and Deheijia (1994) argued against the expectation of Stolper-Samuelson effects of trade liberalization with lower wage countries, that this is only valid for a common cone of diversification. In the absence of competition between lower and higher wage countries (i.e. a situation of complete specialization), factor owners in the latter countries would on the contrary experience a “lifting all boats” effect, i.e. a global increase in real wage because of cheaper import goods. Were they right? Perhaps at least partially they were. From our estimations, we find weak indications of Stolper-Samuelson effects but then in particular from the most developed Asian NICs. Trade with low-wage NICs, especially from Asia or Central and Eastern Europe seemed fairly neutral regarding the wage inequality between the higher- and lower-skilled. This underscores the relevance of considering the factor reward effects of trade at a sufficient level of geographical detail. In addition, we find -equally weak- evidence of a dampening effect of international trade with the non-EU OECD countries on wage inequality. This would explain that, in sum, international trade competition did not affect relative factor reward in the EU, however in a more complex manner than commonly assumed. In addition, the effect of globalization on relative wages in the EU is apparently rather country specific in particular regarding intra-EU relative income levels, yet not national income distribution. This applies for the intra-EU trade, the intra-OECD trade and trade with the higher wage Asian NICs, for the direct as well as for the trade induced technological change effect. ‘Pure’ technological change would moreover induce country specific changes in factor reward inequality. Increased trade with the lower wage NICs from Asia and Central and Eastern Europe in particular, would affect the EU in a much more fairly homogeneous manner, directly as well as indirectly. We find weak evidence of a positive and homogenous impact of technological change induced by trade competition with the non- EU OECD countries on labor reward in the EU. In addition, we find strong evidence of a rather substantial negative impact of technological change induced by trade with high-wage Asian NICs on the wages of high-skilled workers in the EU. Hence the indirect effect of international trade on wages seems less neutral compared to the direct, price competition effect, but would have reduced rather than increased wage inequality.

References.

- Bhagwati, J. and V. Dehejia (1994). Freer Trade and the Wages of the Unskilled — Is Marx Striking Again ? In Bhagwati J and M. Kosters (Eds.), *Trade and Wages. Levelling Wages Down ?* Washington : The AEI Press.
- 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.
- Brenton, P. (1998). Rising Trade and Falling Wages: A Review of the Theory and the Empirics. In Brenton P. and J. Pelkmans (Eds.), *Global Trade and European Workers*. Basingstoke : Macmillan.
- Coe, D.T. and E. Helpman (1995). International R&D Spillovers. *European Economic Review* 39: 859-87.
- Cuyvers, L., M. Dumont, G. Rayp, K. Stevens and D. Van Den Bulcke (2001). Analysis of the Influence of the Trade Flows between the Community and the Emerging Economies, Differentiated According to Sectors and Countries of Origin and Destination, on Wage and Employment Developments in the EU, final report VC/2000/0012, European Commission (DG Employment, Industrial Relations and Social Affairs), Brussels
- Dumont M., G. Rayp, O. Thas and P. Willemé (2003). Correcting Standard Errors in Two-Stage Estimation Procedures with Generated Regressands. Universiteit Gent Working Paper 03/172.
- Feenstra, R. C. and G. 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 (MA)
- (1999). The Impact of Outsourcing and High-Technology Capital on Wages : Estimates for the US 1972-1990. *Quarterly Journal of Economics* 114. 907-940.
- (2001). *Global Production Sharing and Rising Inequality: a Survey of Trade and Wages*, NBER Working Paper 8372, Cambridge (MA).
- Freeman, R. and A. Revenga (1999). How Much Has LDC Trade Affected Western Job Markets?, in: M.Dewatripont et al. (Eds.) *Trade and Jobs in Europe: Much Ado about Nothing?* Oxford: Oxford University Press.
- Grossman, G.M. and E. Helpman (1991). *Innovation and Growth in the Global Economy*. Cambridge (MA): MIT Press.
- Haskel, J. and M. Slaughter (1999). *Trade, technology and UK wage inequality*, NBER Working Paper 6978, Cambridge (MA).
- (2001). Trade, Technology and U.K. Wage Inequality. *The Economic Journal* 111. 163-187.
- Jones, R.W. (1965). The Structure of Simple General Equilibrium Models, *Journal of Political Economy* 73: 557-572
- (1971). A Three-Factor Model in Theory, Trade, and History, in: Bhagwati, J. et al. (Eds.), *Trade, Balance of Payments, and Growth*. Amsterdam: North-Holland publishing.

- Lawrence, R. and M. Slaughter (1993). Trade and U.S. Wages: Great Sucking Sound or Small Hiccup? *Brookings Papers on Economic Activity* Microeconomics 2: 161-226.
- Leamer, E.E. (1996). In Search of Stolper-Samuelson Linkages between International Trade and Lower Wages. NBER Working Paper 5427. NBER. Cambridge (MA).
- Leamer, E.E. and J. Levinsohn (1995). International Trade Theory: The Evidence, in: Grossman, G.M. and K. Rogoff (Eds.) *Handbook of International Economics* (Volume 3). Amsterdam: Elsevier Science.
- Lichtenberg, F and B. Van Pottelsberghe de la Potterie (1996). International R&D Spillovers: a Re-examination. NBER Working Paper 5668. NBER. Cambridge (MA).
- Lücke, M. (1998). Trade with Low-income Countries and the Relative Wages and Employment Opportunities of the Unskilled - An Exploratory Analysis for West-Germany and the UK. In: Brenton P. and J. Pelkmans (Eds.) *Global Trade and European Workers*. Basingstoke: Macmillan.
- OECD (1994). The International Sectoral Database, *OECD Statistical Compendium on CD ROM*. Rheinberg: Data Service & Information (DSI).
- OECD (1998). OECD Data on Skills: Employment by Industry and Occupation. STI Working Paper 1998/4. OECD. Paris.
- Oscarsson, E. (2000). Trade, Employment and Wages in Sweden 1975-93. Working Paper 2000:8. Department of Economics. Stockholm University.
- Wood (1994). North-South Trade, Employment and Inequality: Changing Fortunes in a Skill-Driven World. Oxford: Clarendon Press..

Data Appendix.

- Labor shares

For the computation of the value added shares of high-skilled labor, low-skilled labor and capital it proved impossible to stick to a single data source to compute the shares for a sufficient number of EU countries for the whole period. In most studies the distinction of high-skilled/ low-skilled workers is proxied by the classification manual/ non-manual – production/ non-production – operatives/ non-operatives or blue-collar/ white-collar.

For the period 1985-1991 data on the wage sum of operatives were taken from the UNIDO General Industrial Statistics (Vol I) database. This information was available for Germany, Italy, the UK, Denmark, Spain and Finland, although not always for the entire period. The breakdown by operatives/ non-operatives is no longer provided by UNIDO after 1991. From 1992 onwards we used data from the Labour Force Surveys (LFS), provided by Eurostat. For some countries the LFS data start in 1992 but for most countries only in 1993.

The data source only contains information on the number of workers, not on wages. For data on wages we used Eurostat NewCronos (Theme 3- Harmonized earnings), which contains gross hourly earnings of manual workers and gross monthly earnings of non-manual workers.

The LFS data do not match the OECD data on total employment, which was also established by the OECD. The OECD secretariat adjusted the data to STAN data or data in the OECD National Accounts (OECD 1998, p.5). As the LFS data are the results of surveys, we held to the OECD STAN data on total employment and rescaled the ISCO numbers following the white-collar/ blue-collar ratio of LFS.

The value-added share of non-manuals was computed using the monthly wages of non-manuals and the rescaled numbers of white-collar workers. From this the value-added shares of manuals were computed. In general this led to intuitively acceptable results, except for Italy. For *Italy*, data on the number of hours worked by operatives were taken from the OECD Industrial Survey results, which for Italy is given only for 1992-94. The number of hours worked by operatives (i.e. blue-collar workers in the ISCO classification) and the gross hourly wages of manuals from NewCronos and the total wage sum from OECD STAN allowed us to compute the value added share of manuals. The results appeared to be more reliable. For *Belgium* we used social security data, on the number of manual and non-manual workers, provided by the National Office for Social Security (RSZ) for the entire period 1985-96. For *Sweden* Eva Oscarsson (Department of Economics-University of Stockholm) kindly provided us with data on employment and wages for the period 1970-1993, as used in Oscarsson (2000).

- 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 we computed monthly wages of manuals 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).

- 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 δ_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, we only used r_t .

For $q_{i,t}$ we computed sector-specific deflators 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.

- Unit value import prices

Unit value import prices were computed at the sector level (ISIC). This involved aggregation and conversion. We aggregated data on imports by EU countries from the OECD International Trade by Commodities (ITCS) into seven geographical groups of exporting countries: high wage EU countries (Austria, Belgium-Luxembourg; Denmark; Finland; France; Germany, Italy, the Netherlands; Sweden and the United Kingdom); low wage EU countries (Ireland; Greece; Portugal and Spain); non-EU OECD countries (Australia, Japan; New Zealand; Norway and the United States); higher wage South-East-and East Asian NICS (Hong Kong, Republic of Korea and Singapore), lower wage South-East and East Asian NICS South-East-and East Asian NICS (Indonesia, Malaysia, Philippines and Thailand), Central and East European emerging economies (Hungary, Czech Republic and Poland) and Latin American NICS (Argentina, Brazil, Chile and Mexico).

As ITCS data are given for SITC commodity classes and the estimation is done for ISIC sectors we had to convert the data from SITC to ISIC, with a table provided by OECD. Prices were computed for the period 1985-96.

As pointed out by Freeman and Revenga (1999) unit value prices are a 'mishmash' of aggregate prices of commodities. They find however, that sectors that experienced increased import penetration showed relative price declines which suggests that imports price changes are good proxies for import pressure.

A caveat of unit value price changes that is often put forward is, that as it concerns aggregates, the changes might reflect a change of the commodity mix rather than a change of commodity prices. To preclude this possibility we computed, following the shift-share approach¹¹, unit value prices, keeping the commodity structure fixed.

- 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 we computed it, from data on gross fixed capital formation and employment (STAN/ ISDB), using the formula given in OECD (1994).

- R&D stock

Haskel and Slaughter (1999) use innovation counts as a determinant variable of total factor productivity. This information is not available for enough EU countries to be used in our estimation. Instead we used R&D stocks. We computed national sector R&D stocks 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.

- Concentration

To control for the effects of imperfect competition on price setting, the share of the four largest firms in the output of a given sector (C4) was computed from firm data contained in the Amadeus database (containing financial data on the largest EU companies and which is provided by Bureau Van Dijk) and data on sector output from STAN. To correct for errors due to the use of consolidated data we also computed an alternative measure of concentration using STAN data.

- Capital/labor ratio

As an alternative control variable for imperfect competition sector capital/labor ratio's were computed from OECD STAN data.

¹¹ The shift-share approach decomposes changes in unit value prices into three components. A first component measures the part due to changes in the commodity mix, keeping commodity prices fixed at their begin of period values. A second component measures the part of unit value price changes that can be explained by changes in commodity prices, keeping the commodity mix fixed at its begin structure. Finally, the interaction component that measures the changes of the commodity mix *and* commodity prices. We took the second component as a measure for unit value price changes.