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INTERNATIONAL OUTSOURCING AND THE DEMAND FOR SKILLS

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Abstract:

This paper explores empirically the impact of international outsourcing on the demand for skills in 4 selected EU countries. A model of variable cost and factor demand functions for different skill levels and imported as well as domestic materials is set up. International outsourcing is treated directly as a substitution process between labour of different skills (tasks) and imported inputs. The impact of international outsourcing on labour is measured by the cross price elasticities. The impact of technical change is measured by quasi-fixed capital stock (measured according to the EUKLEMS methodology) and a linear trend. The indirect impact of international outsourcing - determined by the consequences of the cost savings impact of outsourcing - is also taken into account.

Key words: International outsourcing, factor demand functions, skill demand

JEL Code: F16, F17, D5

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1. Introduction

International outsourcing of parts of the production activities in Europe to low-wage countries in Central and Eastern Europe or in the Far East has been a top issue in the economic policy debate for many years. Recently the emphasis has shifted from the phenomenon of outsourcing low skill-intensive stages of the value added chain to the aspect of outsourcing of high skill-intensive production stages like business services. The increasing importance of service outsourcing has given rise to various studies on this issue (Amit and Wei, 2004 and Falk and Wolfmayr, 2008 are two recent examples). Outsourcing of high-skilled services implies that other segments of the labour force might be affected by outsourcing than initially considered.

The impact of international outsourcing on labour in terms of employment shifts or changes in the wage distribution has been the subject of numerous studies during the last decade. Empirical research in this line started with the seminal studies of Feenstra and Hanson (1996 and 1999). Berman, et.al. (1994) introduced a research line, where demand shifts between different skills are assessed to technical change bias and international outsourcing in a factor demand function framework. A large body of empirical literature has emerged from that (Morrison-Paul and Siegel 2001, Strauss-Kahn, 2004, Hijzen, Goerg and Hine 2005, Eckholm and Hakkala, 2006 and Geishecker 2006, among others). All these studies have treated international outsourcing like an additional quasi-fixed factor and not as a direct substitution between imported intermediates and low skilled labour. In an overview article Feenstra and Hanson (2001) discuss work on the impact of technical change and international outsourcing on low skilled labour and estimate a similar equation with new data from the Census of Manufactures. The equations in most of these studies describe the share of low skilled labour in the total wage bill and are based on a Translog function for total labour cost.

One important shortcoming of this approach is that outsourcing is treated as an exogenous process and not as an outcome of lower communication and transport costs as the theoretical literature suggests. Another problem is that international outsourcing is measured as imported inputs at *current* prices. This can be seen as a biased measure of the real contribution of outsourcing, if prices for the outsourced inputs do not rise or even decline due to lower transport and communication costs. Another problem in some of these studies where labour by skill groups and materials are the variable factors and international outsourcing acts as a quasi-fixed factor (like in Hijzen, et.al., 2005) is double counting, because total material inputs already comprise international outsourcing measured by imported materials. There are only few examples in the literature where outsourcing is not treated as an exogenous factor but as a direct substitution process between labour and imported intermediates like Tombazos (1999) and Falk and Koebel (2002). On the other hand progress has been made during the last years in measuring outsourcing. Most recent studies use import matrices of input-output tables (see Daveri and Jona-Lasinio, 2008 for a comparison with the original Feenstra-Hanson measure) and part of the new literature even combines the input-output measure with trade statistics in order to differentiate between sourcing countries (Eckholma and Hakkala, 2006 as well as Falk and Wolfmayr, 2008). This is important as only sourcing to low-wage countries might be seen as a threat to low-skilled labour and some studies actually fail to find a negative impact of total international outsourcing on low-skilled labour. On the other hand the information about imported intermediates by country of origin can only be obtained by applying a proportionality assumption.

Summing up the empirical research on international outsourcing and labour so far has focussed either on wage effects or on labour demand effects by dealing with outsourcing as a quasi-fixed production factor besides other fixed factors measuring technical progress (stock of R&D capital, IT capital stock). Measuring international outsourcing by imported materials inputs at *current* prices and dealing simultaneously with material inputs as variable factors might have led to biased results in these studies. On the other hand the studies that dealt with outsourcing as a direct substitution process (Falk and Koebel, 2002 and Tombazos, 1999) were not able to use the data on imported material inputs from 1995 on, when large part of the increase in outsourcing to low wage – countries has happened.

Another line of research deals with potentially positive macroeconomic effects of international outsourcing, either via an impact on total factor productivity (Amiti and Wei, 2007 and Daveri and Jona-Lasinio, 2008) or generally via general equilibrium feedbacks (Baldwin and Robert-Nicoud, 2007 as well as Grossman and Rossi-Hansberg, 2006). The theoretical literature (e.g. Kohler, 2004) emphasizes the double role of international outsourcing exhibiting a factor savings effect as well as a cost savings effect on labour This cost savings effect creates a macroeconomic surplus similar to the 'immigration surplus'. This in turn has a feedback on labour demand and the total net effect can only be quantified in a macroeconomic/general equilibrium model. This holds especially in the case of a non-competitive labour market regime and would require an explicit modelling of the labour market like in Egger and Kreickemeier (2008). Although this is not fulfilled here, we calculate the full effect of outsourcing on variable costs, which can be thought of representing the 'outsourcing surplus' for the economy. Depending on the price elasticity of demand this has a repercussion on labour which is accounted for here.

This study therefore attempts to fill different gaps in the existing literature. First of all outsourcing is treated as a direct substitution between imported material inputs (= outsourcing), skilled and unskilled labour as well as domestic materials. Imported materials are substituting these other factors depending on relative factor prices. We make use of the new EUKLEMS data set and include quality adjusted measures of the capital stock (as a quasi-fixed factor) and additionally allow for a linear trend. Measuring capital inputs was one of the main tasks in the construction of the EUKLEMS data set with a focus on quality-adjusted prices especially of ICT investment and adequate depreciation rates. Therefore the results presented here rely on a quality adjusted capital stock and measure more carefully the contribution of embodied technical change. This might be important in order to measure correctly the effective contribution of outsourcing on cost saving, which is another extension of this study compared to the existing literature. The EUKLEMS data set for 4 selected EU countries (Austria, Denmark, Italy and Netherlands) is complemented by time series of imported intermediate demand by industries from input-output and Supply and Use tables published by EUROSTAT. A careful deflation procedure using the COMTRADE database is applied in order to derive import deflators from the raw data. An efficient and parsimonious estimation procedure is chosen by estimating the cost function together with the factor share equations. That yields all the necessary parameters for calculating the feedback of the cost savings effect of international outsourcing on labour of different skill levels.

2. Cost and factor demand function

The impact of international outsourcing on labour is analysed here within the cost and factor demand function framework. The factor demand model starts from the general representation of the Translog cost function with variable factors: L (low- and medium-skilled labour), H (skilled labour), M^M (imported intermediates), and M^D (domestic intermediates) as well as fixed factors x_k (quality adjusted capital stock, aggregated over assets) and Y (real gross output) and the linear trend t. If homogeneity as well as constant returns to scale are assumed and directly imposed on the specification the Translog function for variable cost VC becomes:

$$\log VC = \alpha_0 + \alpha_Y \log Y + \sum_i \alpha_i \log(p_i / p_n) + (1-\alpha_Y)\log x_K + \alpha_t t + \frac{1}{2}\alpha_{tt} t^2$$
$$+ \sum_i \frac{1}{2}\gamma_{ii} \log(p_i / p_n)^2 + \sum_{i,j}\gamma_{ij} \log(p_i / p_n)\log(p_i / p_n)$$
$$+ \sum_i \rho_{Ki} \log\left(\frac{x_K}{Y}\right)\log(p_i / p_n) + \rho_{YK}\left(\log Y \log x_K - \frac{1}{2}(\log Y)^2 - \frac{1}{2}(\log x_K)^2\right) + \qquad (1)$$
$$+ \sum_i \rho_{ti} t \log(p_i / p_n) + \rho_{tK} t \log\left(\frac{x_K}{Y}\right)$$

In (1) due to the homogeneity restriction for the cross price parameters ($\sum_j \gamma_{ij} = 0$) the terms for the n[th] factor have been omitted and factor prices divided by the price p_n. As is well known, Shepard's Lemma yields the cost share equations $\frac{\partial \log VC}{\partial \log p_i} = \frac{\partial VC}{\partial p_i}\frac{p_i}{VC} = \frac{p_i x_i}{VC}$, which for the case of factor demand functions for L (unskilled labour), H (skilled labour) and M^M (imported intermediates) can be written as:

$$\frac{p_L L}{VC} = \left[\alpha_L + \gamma_{LL}\log(p_L / p_D) + \gamma_{HL}\log(p_H / p_D) + \gamma_{ML}\log(p_M / p_D) + \rho_{KL}\log\left(\frac{x_K}{Y}\right) + \rho_{tL} t\right]$$

$$\frac{p_H H}{VC} = \left[\alpha_H + \gamma_{HH}\log(p_H / p_D) + \gamma_{HL}\log(p_L / p_D) + \gamma_{HM}\log(p_M / p_D) + \rho_{KH}\log\left(\frac{x_K}{Y}\right) + \rho_{tH} t\right]$$

$$\frac{p_M M^M}{VC} = \left[\alpha_M + \gamma_{MM}\log(p_M / p_D) + \gamma_{HM}\log(p_H / p_D) + \gamma_{ML}\log(p_M / p_D) + \rho_{KM}\log\left(\frac{x_K}{Y}\right) + \rho_{tM} t\right] \qquad (2)$$

The full set of restrictions of the Translog function imply in this case:

$\sum_i \alpha_i = 1$, $\sum_i \gamma_{ij} = 0$, $\sum_j \gamma_{ij} = 0$, $\sum_i \rho_{ti} = 0$, $\sum_i \rho_{Ki} = 0$, with i,j = L, H, M^M, M^D (the variable factors). Additionally symmetry holds for the cross price parameters: $\gamma_{ij} = \gamma_{ji}$.

The omitted cost share equation for M^D can simply be derived as the residual and the missing parameters can be calculated using those restrictions imposed. In equations (2) we can identify two components of technical change on labour, namely the input-biases (measured by, ρ_{tH} and ρ_{tL}) and the impact of the quasi fixed capital stock (measured by ρ_{KL} and ρ_{KH}) on skill demand. The first set of parameters describes disembodied or autonomous technical change and the second embodied technical change brought about by the installation of new capital equipment. Positive parameter values for the ρ_{Ki} imply factor using embodied technical change and can also be interpreted as capital-labour complementarity.

The own- and cross- price elasticities for changes in input quantity x_i can be derived directly or via the Allen elasticities of substitution (AES) and are given with:

$$\varepsilon_{ii} = \frac{\partial \log x_i}{\partial \log p_i} = \frac{s_i^2 - s_i + \gamma_{ii}}{s_i} \qquad (3)$$

$$\varepsilon_{ij} = \frac{\partial \log x_i}{\partial \log p_j} = \frac{s_i s_j + \gamma_{ij}}{s_i} \qquad (4)$$

Here the s_i represent the factor shares in equation (2) and the γ_{ij} the cross-price parameters.

It must be emphasized that these price elasticities are *compensated* elasticities, ie. they measure the impact of factor price changes on factor demand without a change in the aggregate (in that case total variable cost *VC*). The uncompensated elasticity would be given by additionally taking into account a change in *VC* (variable cost) and *Y* (output).

Implementing the cost savings effect of international outsourcing from the theoretical literature (e.g. Kohler, 2004) in this model would lead to a change in *VC*, which in fully competitive domestic commodity markets would be fully passed through to output prices. This in turn would lead to a change in output depending on the price elasticity of demand. This is one possible mechanism to account for the macroeconomic surplus of international outsourcing. Taking this into account a feedback mechanism of the cost savings effect on labour can be identified. Writing the demand for low- and medium-skilled and skilled labour as $\frac{L}{Y}Y$ and $\frac{H}{Y}Y$ respectively, the total impact of international outsourcing on labour is given with:

$$\frac{d\log L}{d\log p_M} = \frac{\partial \log(L/Y)}{\partial \log p_M} + \frac{\partial \log Y}{\partial \log p_M}; \quad \frac{d\log H}{d\log p_M} = \frac{\partial \log(H/Y)}{\partial \log p_M} + \frac{\partial \log Y}{\partial \log p_M} \tag{5}$$

The first term in equation (5) represents the change in the labour intensity without a change in output. This is in line with the concept of compensated elasticity, i.e. under the *ceteris paribus* – condition: $\frac{\partial \log Y}{\partial \log p_M} = 0$. Therefore the price elasticities of *L*/*Y*and *H*/*Y* are the same as the compensated price elasticities of *L* and *H*:

$$\varepsilon_{LM} = \frac{\partial \log(L/Y)}{\partial \log p_M} = \frac{s_L s_M + \gamma_{LM}}{s_L}; \qquad \varepsilon_{LM} = \frac{\partial \log(H/Y)}{\partial \log p_M} = \frac{s_H s_M + \gamma_{HM}}{s_H} \tag{6}$$

The term for the output change $\frac{\partial \log Y}{\partial \log p_M}$ can be further decomposed into the cost savings effect of international outsourcing and the reaction of output to a cost decrease, i.e. the price elasticity of demand η:

$$\frac{\partial \log Y}{\partial \log p_M} = \frac{\partial \log VC}{\partial \log p_M}\frac{\partial \log Y}{\partial \log VC} = \frac{\partial \log VC}{\partial \log p_M}\eta \tag{7}$$

Determining the cost savings effect of international outsourcing can be derived by differentiating the cost function (1) with respect to the price p_M which according to Shephard's Lemma simply gives the factor share s_M. This will not take into account all the cross price effects induced by a change in the price p_M. Alternatively the unit cost equation for a Translog model with constant returns to scale can be approximated by the Divisia price index:

$$\log VC = s_i \log p_i + \sum_{j \neq i} s_j \log p_j \tag{8}$$

In (8) i is the factor input in consideration (in our case M^M) and j are the other factors. A change in the price of i now has an effect of the magnitude s_i (according to Shephard's Lemma) on costs plus the quantity changes in all other factors weighted with their prices:[1]

$$\frac{\partial \log VC}{\partial \log p_i} = s_i + \sum_{j \neq i} \frac{\partial s_j}{\partial \log p_i} \log p_j \tag{9}$$

The second term in (9) is directly determined by the cross price parameters γ_{ij}. Making use of (5), (6), (7) and (9) the full impact of a change in the price of imported intermediates on labor can be written as:

$$\frac{d \log L}{d \log p_M} = \varepsilon_{LM} + \left[s_m + \sum_{j \neq M} \gamma_{ij} \log p_j \right] \eta ; \qquad \frac{d \log H}{d \log p_M} = \varepsilon_{HM} + \left[s_m + \sum_{j \neq M} \gamma_{ij} \log p_j \right] \eta \tag{10}$$

If international outsourcing substitutes domestic labour (ε_{LM}, $\varepsilon_{HM} > 0$) the negative costs savings effect must be large enough in order to get an overall negative sign for the expression in (10). This would imply that a decrease in the price for intermediate inputs would lead to an increase in international outsourcing and an increase in labour demand at the same time. A crucial parameter here is the price elasticity of demand, which is not estimated empirically in

[1] One could further think of taking also into account the own price effect of a change in p_i on s_i.

this study. It can only be shown, how the total labour impact of international outsourcing reacts to different assumptions about the magnitude of this elasticity.

3. Measuring outsourcing and technical change

In the beginning of the outsourcing literature measures had to be constructed only based on general external trade statistics and input statistics by industries. Since then it has become standard to use import matrices from input-output tables or supply-use tables. These matrices contain information about imported intermediate demand of industry *j* by commodity *i* (im_{ij}), so that the total imported input demand by an industry represents the column sum of this matrix: $M_j^M = \sum_i im_{ij}$. In our case this is related to the total variable cost made up by input costs of the two skill levels of labour (x_H,x_L) and input costs of total material input *m*.

$$\frac{p_{Mj} M_j^M}{VC_j} = \frac{\sum_j im_{ij}}{\sum_l x_{lj} + m_j}; \qquad l = H,L \qquad (11)$$

Unfortunately these tables are for a majority of EU countries only available for the benchmark years of input-output tables and are not delivered by statistical offices as a complement to supply-use tables. One methodology to overcome that and to increase the database is interpolating these import matrices. A simple methodology requiring only one benchmark year matrix has been developed and applied for Sweden by Eckholm and Hakkala (2006). This methodology is based on a constant structure of the import matrix along the row (i.e. across the different users of imports), so that an increase in the overall import intensity of commodities in relation to domestic output translates into a proportional increase in the import intensity of commodity *i* in industry *j*. This methodology could be refined in the case of different benchmark tables by interpolating the structure of the import matrix along the row between the benchmark years. In the end it is clear that this additional information on imported intermediates can only be gained by applying some proportionality assumptions.

The philosophy in this study was to mainly rely on existing time series of import matrices and picking EU countries for which these data are available and which are appealing for international outsourcing in terms of trade exposedness as well as links to Eastern European countries. That led to the choice of 4 selected EU countries: Austria, Denmark, Italy and Netherlands. This country group comprises small European economies with high shares of trade in output (Denmark, Netherlands) as well as countries that from their geographic position are assumed to having faced outsourcing to Eastern Europe during the 1990es (Austria, Italy). From the point of view of data availability on imported intermediates either from official supply-use tables or from existing studies (Eckholm and Hakkala, 2006 and Cadarso, et.al., 2008) also Finland, Spain and Sweden could have been included. For the 4 EU countries chosen here time series of import matrices from 1995 to 2004[2] have been available already in NACE 60 industries-classification or in a classification that could be converted to NACE 60.

This data set has then been complemented by import price indices calculated from import data in the COMTRADE database.[3] The raw data for imports in monetary and physical units have been converted to PRODCOM (NACE) 3 digit classification and unit value-based import price deflators have been calculated. These deflators have then been analysed together with the implicit deflator for each PRODCOM (NACE) 2 digit commodity. A band of variance for all deflators at 3 digit PRODCOM (NACE) commodities level within the same 2 digit level has been defined in order to detect statistical outliers. These outliers have been corrected by using information on another well behaved 3 digit commodity within the same 2 digit. That finally yields a full set of adjusted import price deflators at NACE 60 level.

[2] For Italy until 2003.

[3] Here invaluable research assistance from Irene Langer must be acknowledged.

The information on imported intermediates and import prices had in a next step to be integrated into the EU KLEMS database for the selected 4 EU countries. The most recent release (March 2007) of the EUKLEMS database has been used for this purpose. Imported intermediates had to be separated from total intermediate inputs in a first step. That yields domestic intermediate inputs (M^D) and the price deflator of domestic inputs (p_D) as a residual.[4]

Labour inputs as well as capital stock data have also been taken from the EUKLEMS database. Measuring the inputs of labour services and capital services for growth accounting has been the main focus in the construction of the EUKLEMS database (see Timmer et al. 2007 for an overview). For labour inputs hours worked and wages of the input of labour by different skill levels have been collected in each EU country in the EUKLEMS project. The detailed data on hours and wages by skills have then been aggregated to three skill levels according to the international ISCO classification (low, medium, high skill). For this study this has been further aggregated by dealing with the highest education level "high-skilled" separately while aggregating the other two categories to "low- and medium- skilled". For capital goods investment data at the level of 7 different assets have been collected in each EU country in the EUKLEMS project. This disaggregation of assets allowed for a detailed treatment of ICT goods (office and computing equipment, communication equipment and software) in investment. The nominal investment data have further been complemented by data on depreciation rates and deflators of investment goods. These two variables are crucial for measuring the effective contribution of capital goods in the production process during a period of high diffusion of ICT goods in investment. Depreciation rates for ICT are much

[4] Generally prices of aggregates have been calculated according to the Divisia price index, i.e. the weighted sum of logs of single prices with the value shares as weights.

higher than for traditional investment goods (e.g. buildings) and price deflators for these goods are measured according to the concept of quality adjusted prices. These measure the effective price of a unit of capital in terms of capacity in the production process. Information on quality adjusted prices in EUKLEMS has either been taken from national statistical sources or, where that has not been possible from the procedure described in Schreyer (2002). These data have then been used to calculate an aggregate capital stock by industry applying the Perpetual Inventory Method. Unfortunately disaggregated capital stock data (ICT and other) have not been vailable, so that the aggregate stock had to be used here. Nevertheless the aggregate stock should contain the high diffusion of ICT goods in investment during the last decades and should be an appropriate measure for skill-biased technical change.

Most of the data required for this analysis were available for 60 NACE 2 digit industries for Austria, Denmark, Italy and Netherlands in the EUKLEMS database. Due to lack of detailed labour input and capital stock data at 60 NACE level the aggregation chosen was 28 industries out of which 13 are manufacturing sectors, to which the analysis has been limited here. Besides total intermediate inputs in current prices and their corresponding deflators, both of which have been split up into imported and domestic inputs as described above the following variables of the EUKLEMS database have been used for this study:

Values

$p_L L$ Labour compensation for low and medium-skilled labour input in hours (in millions of local currency)

$p_H H$ Labour compensation for high-skilled labour input in hours (in millions of local currency)

Prices & Volumes

Y Gross output, volume indices, 1995 = 100

x_K Real gross fixed capital stock, 1995 prices

p_L Price index of low and medium-skilled labour, 1995 = 100.

p_H Price index of high-skilled labour, 1995 = 100.

>>>>>>> *Table 1: Broad and narrow measures of outsourcing in manufacturing*

Table 1 shows that there was a slight and continuous increase in the share of broad outsourcing to gross output from 1995 on in all 4 EU countries, more pronounced in Austria and Denmark than in Italy and the Netherlands.[5] The input share (in current prices) of imported intermediates in total production amounts to 17 to 35% in the 4 selected EU countries. That underlines the choice of these countries for studying the impact of outsourcing on labour. The contribution of the narrow outsourcing measure has not changed significantly during this period in the 4 EU countries and lies between 35 and 45% of total imported intermediate inputs. Narrow outsourcing in current prices is therefore not increasing more rapidly than broad outsourcing.

>>>>>>> *Table 2: Input prices in manufacturing, Austria and Denmark*

>>>>>>> *Table 3: Input prices in manufacturing, Italy and Netherlands*

We must take into account that prices of imported intermediate inputs have been declining between 1995 and 2004 or at least not increasing as much as prices of other inputs, especially labour. Therefore the increase of outsourcing in real terms has been much more pronounced than in current prices. A striking fact of the data set used is that in this period the compensation per hour for low- and medium-skilled labour has risen more than for high-skilled labour in all the 4 EU countries (Table 2 and 3). This is the outcome of wage

[5] Import matrices are missing for Italy in 2004 and the narrow measure could not been calculated for Netherlands in 2002 and 2003 due to a different commodity classification of the available import matrices than the industry classification.

negotiations for each skill group and the effective hours worked. Prices for domestic intermediate inputs have increased less than the compensation for low- and medium-skilled labour but more than the compensation per hour for high-skilled labour.

4. Econometric results

The variable cost function (1) with constant returns to scale and the derived factor demand equations (2) constitute the system that has been estimated for the 4 EU countries. A system-estimation (SUR estimator) has been applied for each country pooling across the 13 manufacturing industries of the aggregate EUKLEMS classification. Additionally to the variables described above a time trend (measuring autonomous technical change) and industry dummies have been introduced.

>>>>>>>>>> Table 4: Summary statistics, input prices in manufacturing, 1995 - 2004

>>>>>>>>> Table 5: Summary statistics, cost shares in manufacturing, 1995 - 2004

The estimation results in Table 6 reveal that not all price parameters (γ_{ij}) are statistically significant. This is especially the case for Denmark. A Wald test for joint significance has been applied and yielded positive results for most parameters.

>>>>>>>>>>>>>> Table 6: Parameter estimation results, 1995 – 2004

The own price elasticities of factor demand all show the expected negative sign, although relying partly on insignificant parameter estimates for the γ_{ij} as shown in Table 6. For Italy some elasticities are very high, especially of domestic intermediate inputs and of high-skilled labour. This is mainly due to very small cost shares of high-skilled labour in some industries and Italy and has already been considered by excluding some industries with (almost) zero cost shares from the sample when calculating the elasticities shown in Table 7.

The own price elasticity of domestic intermediate inputs is also rather high for Austria and the Netherlands. As far as skill demand is concerned in two countries (Austria and Italy) the own price elasticity of high-skilled labour is much smaller than the elasticity of low- and medium-skilled labour. The possible impact of outsourcing on skill demand can be seen from the cross price elasticities between imported intermediates and both types of labour. Italy turns out as an exception concerning these elasticities, as they show negative values (relying on significant parameter estimates) of both low- and medium-skilled as well as high-skilled labour in Italy. Imported intermediates and labour could therefore be characterized as complements in Italy. In the other countries low- and medium-skilled labour clearly turns out as a substitute to imported intermediates. A decrease in transport and communication costs and in turn in import prices would therefore lead to enhanced outsourcing and lower demand for low- and medium-skilled labour. The cross price elasticity of high-skilled labour with respect to imported intermediates has a positive sign in Austria and Denmark and a negative sign (though a small absolute value) in the Netherlands. Therefore also high-skilled labour is a substitute to imported intermediates in Austria and Denmark. This is clearly a new result compared to other studies like Tombazos (1999) indicating that outsourcing also substitutes high-skilled labour. It is further interesting to note that imported and domestic intermediate inputs are also substitutes in all 4 EU countries. These elasticities therefore suggest a two-step interpretation of the production process. First the decision between home production and international outsourcing is taken. With decreasing transport and communication costs firms decide to reorganize the production process and increase international outsourcing, so that they require less inputs of domestic factors, both labour and domestic intermediates.

>>>>>>>>>>>>>>> Table 7: Cross price elasticities of factor demand (sample means)

As far as embodied technical change is concerned - measured by the parameters ρ_{Ki} - we find for all 4 countries a positive and significant impact of the total capital stock on low- and medium-skilled labour. The parameter value is also positive but much smaller and statistically insignificant for the impact of capital on high-skilled labour. That suggests characterizing embodied technical change as labour using rather than labour saving and capital as a complement to both types of labour. It is not clear from the parameter values, if there is a skill bias in embodied technical change. This could only be answered by deriving the elasticities of skill demand to capital (which is a combination of the parameter ρ_{Ki} and the factor share). A skill bias of technical change can be found in autonomous technical change measured by the parameters ρ_{ti}. This parameter is significant and negative in all countries for low- and medium-skilled labour and significant and positive in all countries except Italy for high-skilled labour. These results suggest the conclusion that it is the reorganization of the production process accompanied by the introduction of new technologies rather than installing new capital goods itself that has a skill-bias. On the other hand it must be noted that the parameter values for autonomous technical change (ρ_{ti}) are very small compared to the parameter values for embodied technical change (ρ_{Ki}). In the light of these results one could conclude that an approach taking into account embodied technical change only leaves a small part of technical change explained by the autonomous component. This result is analogous to the outcome of the growth accounting exercise in EUKLEMS (Timmer et.al., 2007), namely that an appropriate measurement of capital services considerably reduces the contribution of autonomous TFP to growth.

It must be noted again here that these elasticities are compensated elasticities measuring the *ceteris paribus* impact of a change in input prices. In our case that means that total variable costs do not change. The uncompensated elasticities would also take into account these changes in the aggregate brought about by changes in single factor prices. In equation (10) in section 2 we have proposed a methodology of additionally taking into account changes in total variable costs and in output. These additional reactions depend on the price elasticity of total output η (demand) which is not estimated here. In order to take into account the sensitivity of these results on this parameter two assumptions have been made for this elasticity (η = -1 and η = -0.5). Table 8 shows the individual components of the total effect of a change in the price of imported intermediates on both types of labour. The pure partial factor demand effect is given as above by the cross price elasticity ε_{LM}. The effect of a change in the price of imported intermediates on total variable costs is given by the expression $\left[s_m + \sum_{j \neq i} \gamma_{ij} \log p_j\right]$ measuring the weight of lower input prices (the cost share s_M) plus the quantity changes in all other factors weighted with their prices. This lower variable cost leads to output changes depending on the price elasticity.

In the case of low- and medium-skilled labour we see that even in the case of a relatively inelastic demand (η = -0.5) the partial factor demand effect can be considerably reduced in those countries where imported intermediates and low- and medium-skilled labour are substitutes. An initial partial decrease in the demand for low- and medium-skilled labour of 0.23% in Austria, 0.29% in Denmark and 0.15% in the Netherlands (induced by a 1% decrease in the price of imported intermediates) can be reduced to 0.07%, 0.15% and 0.03% respectively. The effect can even be reversed in Austria and the Netherlands in the case of elastic demand (η = -1) and becomes practically zero in Denmark. The feedback effect of outsourcing therefore reverses the initial negative impact of outsourcing on low- and medium skilled-labour in this case. The results are similar in the case of high-skilled labour for those countries, where high-skilled labour and imported intermediates are substitutes (Austria and Denmark). In the Netherlands and in Italy the demand for high-skilled labour would rise considerably as a consequence of lower prices for imported intermediates.

This exercise clearly reveals the importance of feedback effects of outsourcing on labour demand, although no full accounting of general equilibrium effects of outsourcing as in Baldwin and Robert-Nicoud (2007) or in Grossman and Rossi-Hansberg, (2006) has been provided here.

>>>>>> Table 8: Total impact of changes in the price of imported intermediates on labour

5. Conclusions

In this study the impact of international outsourcing on the demand for different skills has been analysed empirically for 4 selected EU countries (Austria, Denmark, Italy and Netherlands). We make use of the new EUKLEMS data set and complement that by time series of imported intermediate demand by industries from input-output and Supply and Use tables published by EUROSTAT. International outsourcing is not treated as a fixed factor as usually in the literature, but as a direct substitution between imported material inputs (= outsourcing), high-skilled and low- and medium-skilled labour as well as domestic materials. Therefore prices of imported intermediates had also to be collected by applying a careful deflation procedure using the COMTRADE database. A second extension to the existing literature consists in estimating a full system of the cost function and the factor share equations. These systems have been estimated for the manufacturing sector in each country pooling across the manufacturing industries in the sample 1995 – 2004.

The estimation results reveal the factors of influence on the demand for different skills. The evidence for the impact of technical change is mixed. We find that both skill levels are complementary to capital and embodied technical change is therefore labour-using rather than labour-saving. Autonomous technical change is clearly labour-saving for low- and medium-skilled labour and labour-using for high-skilled labour. An important general result is that the margin left for the influence of autonomous technical change is very small when embodied technical change is considered.

A decrease in transport and communication costs that leads to a lower price of imported intermediates and therefore induces international outsourcing has a clear *partial* negative impact on low- and medium-skilled labour except in Italy. This impact also holds for high-skilled labour in the case of Austria and Denmark and is even larger. In order to extend further the existing empirical literature it has also been attempted here to take macroeconomic feedback effects of international outsourcing on labour demand into account. That showed that – depending on the price elasticity of demand – the cost saving effect of international outsourcing can considerably reduce the partial negative effect on labour demand or even reverse it.

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Table 1: Broad and narrow measures of outsourcing in manufacturing

Broad measure as percentage of gross output				
	Austria	Denmark	Italy	Netherlands
1995	23.6	19.9	17.2	30.8
1996	24.0	20.9	16.0	30.4
1997	26.3	20.8	16.7	30.2
1998	26.8	21.1	16.7	29.2
1999	26.8	21.0	16.9	29.3
2000	29.4	22.6	19.6	32.4
2001	30.3	22.5	19.8	31.8
2002	28.7	22.5	19.1	35.1
2003	29.4	22.4	19.0	35.5
2004	30.4	23.1		31.9
Narrow measure as percentage of broad measure				
	Austria	Denmark	Italy	Netherlands
1995	44.2	36.9	40.4	35.3
1996	43.8	35.9	39.6	33.9
1997	44.1	37.3	39.8	33.4
1998	45.9	36.8	40.2	36.1
1999	45.9	36.0	40.3	34.9
2000	45.2	34.4	38.8	33.2
2001	45.9	36.1	39.7	33.3
2002	45.4	35.0	40.3	-
2003	45.7	37.1	40.1	-
2004	46.3	35.0		34.5

Import matrices are not available in 2004 for Italy and the narrow measure cannot be calculated for Netherlands in 2002 and 2003 due to different commodity classification of import matrices

Table 2: Input prices in manufacturing, Austria and Denmark

Austria	pM	pL	pH	pD
1995	100	100	100	100
1996	92.4	101.2	100.5	104.7
1997	85.6	102.3	101.4	111.7
1998	82.5	106.7	102.6	117.4
1999	81.5	116.0	111.5	117.6
2000	76.9	120.8	114.7	134.8
2001	74.2	124.2	118.3	145.1
2002	76.9	128.3	119.1	137.1
2003	90.7	133.0	123.7	122.9
2004	100.0	136.2	125.7	118.2
Denmark	pM	pL	pH	pD
1995	100	100	100	100
1996	93.5	104.2	102.4	105.2
1997	87.3	108.0	105.4	113.7
1998	85.7	111.0	108.2	111.9
1999	81.3	113.9	109.3	113.7
2000	80.2	116.1	109.8	131.6
2001	71.9	121.6	115.2	142.5
2002	76.2	127.0	119.6	135.5
2003	85.7	132.3	123.0	125.1
2004	95.7	136.3	127.4	125.8

Table 3: Input prices in manufacturing, Italy and Netherlands

Italy	pM	pL	pH	pD
1995	100	100	100	100
1996	102.0	105.2	103.5	99.6
1997	94.8	110.0	106.0	103.6
1998	88.7	107.8	102.2	105.7
1999	84.8	110.3	101.6	108.4
2000	88.4	113.0	101.1	120.2
2001	85.6	117.1	102.8	123.9
2002	87.2	120.0	104.7	123.4
2003	98.8	123.3	104.3	119.7
2004				
Netherlands	pM	pL	pH	pD
1995	100	100	100	100
1996	96.1	102.0	105.3	107.8
1997	92.6	105.8	106.2	116.8
1998	83.2	111.0	112.4	122.4
1999	87.2	114.5	117.3	121.2
2000	96.4	121.6	123.8	157.1
2001	91.9	125.5	129.5	165.8
2002	112.9	135.3	134.9	129.6
2003	107.1	144.8	127.5	137.0
2004	115.9	148.9	131.0	138.3

Table 4: Summary statistics, input prices in manufacturing, 1995 - 2004

	Mean	Maximum	Minimum	Std. Dev.
Austria				
p_M	0.8714	1.7655	0.6367	0.1649
p_L	1.1773	1.6864	0.9948	0.1546
p_H	1.1118	1.4701	0.9535	0.1198
p_D	1.2225	2.6448	0.5684	0.2702
Denmark				
p_M	0.8716	2.0423	0.6141	0.1794
p_L	1.1791	1.5399	1.0000	0.1245
p_H	1.1493	1.5855	0.9624	0.1312
p_D	1.2994	3.6459	0.9580	0.3440
Italy				
p_M	0.9063	1.6124	0.7163	0.1409
p_L	1.1193	1.3398	0.9855	0.0886
p_H	1.0131	1.2614	0.7841	0.0888
p_D	1.2013	5.1607	0.9503	0.5281
Netherlands				
p_M	0.9463	2.1569	0.6786	0.2418
p_L	1.2019	1.5550	0.9459	0.1701
p_H	1.1831	1.5127	0.9626	0.1287
p_D	1.3488	2.6567	0.9316	0.3701

Table 5: Summary statistics, cost shares in manufacturing, 1995 - 2004

	Mean	Maximum	Minimum	Std. Dev.
Austria				
M^M/VC	0.3302	0.7500	0.1175	0.1465
L/VC	0.2457	0.3520	0.0672	0.0618
H/VC	0.0199	0.0370	0.0053	0.0077
M^D/VC	0.4041	0.6806	0.1513	0.1207
Denmark				
M^M/VC	0.2844	0.4752	0.1306	0.0750
L/VC	0.2773	0.3637	0.0143	0.0881
H/VC	0.0147	0.0637	0.0009	0.0132
M^D/VC	0.4236	0.6961	0.2692	0.0865
Italy				
M^M/VC	0.2364	0.7804	0.1009	0.1415
L/VC	0.1802	0.2506	0.0419	0.0466
H/VC	0.0081	0.2353	0.0010	0.0218
M^D/VC	0.5753	0.7523	0.1685	0.1173
Netherlands				
M^M/VC	0.2523	0.4357	0.1312	0.0656
L/VC	0.1619	0.3754	0.0128	0.0763
H/VC	0.0430	0.1084	0.0035	0.0211
M^D/VC	0.5428	0.6707	0.3765	0.0575

Table 6: Parameter estimation results, 1995 – 2004

	Austria	standard errors	Denmark	standard errors	Italy	standard errors	Netherlands	standard errors
γ_{LL}	0.0560	0.0134***	0.0181	0.0127*	0.0519	0.0071***	0.0130	0.0064**
γ_{LM}	-0.0228	0.0092**	0.0013	0.0074	-0.0761	0.0080***	-0.0099	0.0044**
γ_{MM}	0.0013	0.0125	-0.0052	0.0117	-0.0144	0.0129	0.0197	0.0065***
γ_{HH}	0.0150	0.0020**	-0.0001	0.0081	0.0028	0.0040**	0.0061	0.0045*
γ_{HL}	-0.0136	0.0059**	0.0048	0.0085	0.0271	0.0050***	0.0053	0.0048
γ_{HM}	0.0009	0.0037	0.0008	0.0028	-0.0437	0.0047***	-0.0080	0.0027***
ρ_{KL}	0.0496	0.00113***	0.0463	0.0143***	0.0771	0.0184***	0.0413	0.0104***
ρ_{KH}	0.0063	0.0046	0.0021	0.0057	0.0050	0.0113	0.0169	0.0069**
ρ_{KM}	-0.0422	0.0300	0.0743	0.0241***	-0.0440	0.0248*	-0.0187	0.0203
ρ_{tL}	-0.0068	0.0006***	-0.0018	0.0005***	-0.0058	0.0006***	-0.0005	0.0003**
ρ_{tH}	0.0010	0.0002***	0.0005	0.0002***	-0.0020	0.0004***	0.0007	0.0002***
ρ_{tM}	0.0070	0.0010***	-0.0003	0.0010	0.0008	0.0009	0.0008	0.0005*
Observations	130		130		117		130	
R^2								
VC	0.996		0.998		0.999		0.999	
L	0.980		0.987		0.962		0.994	
H	0.906		0.986		0.501		0.983	
M^M	0.958		0.923		0.987		0.955	

R^2 is given for the single equations of the system (*VC*, *L*, *H* and M^M); *, ** and *** represent 10%, 5% and 1% of significance respectively.

Table 7: Cross price elasticities of factor demand (sample means)

Austria	p_M	p_L	p_H	p_D
M^M	-0.664	0.162	0.019	0.483
L	0.230	-0.440	-0.107	0.317
H	0.308	-1.484	-0.067	1.243
M^D	0.125	1.761	0.156	-2.042
Denmark	p_M	p_L	p_H	p_D
M^M	-0.735	0.282	0.018	0.435
L	0.293	-0.605	0.046	0.266
H	0.393	0.919	-0.995	-0.317
M^D	0.049	-0.596	0.931	-0.384
Italy	p_M	p_L	p_H	p_D
M^M	-0.839	-0.220	-0.224	1.283
L	-0.253	-0.487	0.180	0.559
H	-7.678	5.110	-0.071	2.639
M^D	8.770	-4.404	0.114	-4.481
Netherlands	p_M	p_L	p_H	p_D
M^M	-0.664	0.120	0.009	0.535
L	0.153	-0.720	0.096	0.472
H	-0.061	0.367	-0.707	0.401
M^D	0.573	0.233	0.602	-1.408

For Italy some industries with very low shares of high skilled labour have been excluded from the sample mean for the elasticities of *H* with respect to other factors.

Table 8: Total impact of changes in the price of imported intermediates on labour

	Austria		Denmark		Italy		Netherlands	
ε_{LM}	0.230		0.293		-0.253		0.153	
$s_M + \gamma_{ij} \log p_j$	0.330		0.285		0.247		0.249	
$\eta = -1$	-1.0		-1.0		-1.0		-1.0	
$\eta = -0.5$		-0.5		-0.5		-0.5		-0.5
Total Impact, *L*	-0.100	0.065	0.007	0.150	-0.499	-0.376	-0.096	0.028
	Austria		Denmark		Italy		Netherlands	
ε_{HM}	0.308		0.393		-7.678		-0.061	
$s_M + \gamma_{ij} \log p_j$	0.330		0.285		0.247		0.249	
$\eta = -1$	-1.0		-1.0		-1.0		-1.0	
$\eta = -0.5$		-0.5		-0.5		-0.5		-0.5
Total Impact, *H*	-0.022	0.143	0.108	0.251	-7.925	-7.802	-0.310	-0.185