Cross-border sourcing and outward processing in EU manufacturing

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Abstract

With the help of a standard 2 × 2 trade model, we develop several hypotheses on the effects of cross-border sourcing on skill intensity in production. The focus is on cross-border sourcing of low-skill-intensive components of exports and import-competing products. We test the aforementioned hypotheses with panel data for manufacturing in the European Union (EU). We find that outward processing is more prevalent in import-competing industries, which are also the EU's relatively intensive users of low-skilled labor. Outward processing in export industries is found to reduce the skill-to-low-skill ratio in EU industries, while outward processing in import-competing industries has more ambiguous effects.

Cross border outsourcing: A general equilibrium perspective and evidence for outward processing in EU manufacturing

Hartmut Egger[a] and Peter Egger[b]

Abstract

Using a 2x2 production framework, we theoretically analyze the implications of cross border outsourcing for the skill intensity in production. We explicitly allow for cross border outsourcing of low-skilled labor intensive parts of production within both sectors. Empirically, we investigate whether the predicted outsourcing effects coincide with our findings for outward processing of both exporting and import competing EU manufacturing industries.

JEL classification: C33; F14; F15; F16

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1. Introduction

In the last decades, the phenomenon of globalization has gained attention of both politicians and economists at large scale. Trying to answer the question on whether globalization can explain part of the labor market developments observed in industrialized countries, economists have focused mainly on the macroeconomic consequences of trade and migration (Abowd and Freeman, 1991, etc.). More recently, additional specialization possibilities via cross border outsourcing and their consequences came into the limelight of research (see Arndt, 1997; 1998a; 1999; Feenstra, 1998; Feenstra and Hanson 1996a; 1996b; 1999; Jones and Kierzkowski, 2000; 2001; etc.).

So far, the theoretical analysis is mainly based on the Heckscher-Ohlin framework (compare Deardorff, 1998, 2001; etc.). Following this tradition, we give a detailed overview on the possible labor market effects of cross border outsourcing within the convenient 2x2 production framework. Since we are interested in the labor maket effects, we focus on high-skilled and low-skilled labor as the two factors of production. We concentrate on an industrialized country's cross border outsourcing of low-skilled labor intensive parts of production and come along with two important findings. First, the skill intensity and wage effects critically depend on whether the outsourcing industry is initially high-skilled or low-skilled labor intensive. Second, there is a number of possible diversified equilibria if cross border outsourcing becomes attractive within both sectors.

Due to the ambiguity of the theoretical implications, we search for the empirical evidence for outward processing (as a narrow measure of cross border outsourcing) of the EU manufacturing industries into non-EU countries. First and in line with the traditional Heckscher-Ohlin model, we find that the net

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exporting industries are indeed more high-skilled labor intensive than the net importing ones.[1] Second, the engagement in outward processing of import competing industries is about twice as high as in their (net) exporting counterparts.

In the econometric analysis, we allow for the interaction between outward processing in exporting and import competing industries. Our empirical findings confirm the theoretical priors concerning the direct (own) and the cross sector effects of outward processing on the high-skilled to low-skilled labor ratio. Outward processing increases the high-skilled to low-skilled labor ratio in both the exporting and the import competing industries in favor of high-skilled labor.

Finally, in a simulation analysis we show that outward processing alone can explain about 4 percent of the observed change of skill intensities in overall EU manufacturing and about 18 percent of the change in the import competing industries for the period 1995-1997.

The paper is organized as follows. Section 2 presents the theoretical analysis. Section 3 deals with the empirical investigation. Section 4 concludes.

2. Cross border outsourcing in a 2x2 production model

We consider an economy (*Home*) producing two final goods. Production of both final goods X and Y uses high-skilled H and low-skilled L labor at wages w_H and w_L, respectively. Home is presumed to be high-skilled labor abundant. On *every* stage of production, technologies are linear homogeneous, guaranteeing zero profits. Cross border outsourcing becomes attractive for firms if and only if there exists a cost-saving potential for production abroad. In line with the literature, we assume that this cost saving potential arises due to lower wages rather than specialization effects or technological differences in the outsourced production process (compare Deardorff, 1998). Thus, by assumption factor prices are not internationally equalized by final goods trade. Noteworthy, we consider that only low-skilled labor intensive parts of production are object of outsourcing decisions. To simplify the analysis, we assume that trade in final goods X and Y is free, whereas outsourcing across borders may be prohibited for reasons as tariffs, non-tariff barriers or communication and transport costs. Finally, concerning the production technologies, we assume that Y is produced relatively high-skilled labor intensive as compared to X.[2] We refrain from factor intensity reversal at given technologies.[3] Our assumptions on skill intensities can be formalized as

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[1] Noteworthy, the theoretical priors critically depend on the skill intensity of the respective industry. In the empirical analysis, we distinguish between net exporter and net importer industries. To make our empirical findings comparable with our theoretical priors we have to identify, which types of industries (net exporter or net importer) produce more skill intensive.

[2] Without technological differences across countries, X and Y denote outputs of the import competing and the exporting sector, respectively, according to the Heckscher-Ohlin model. But, if technological differences across countries occur, output of the import competing industry may be produced more skill intensive than the output of the exporting industry. Thus, whether X or Y can be associated with the output of the import competing (exporting) sector is an empirical question, which will be answered below.

[3] Compare Egger and Falkinger (2001) for a formal characterization.

$$k_Y > k_X, \tag{1}$$

where k_Y and k_X denote the skill-intensities of Y and X, respectively and $k_i \equiv (H_i/L_i)$, for i=X, Y, is used. For notational simplicity, we refer to activities/equilibria before and after cross border outsourcing becomes attractive for firms as *pre-outsourcing* and *post-outsourcing* activities/equilibria, respectively. Throughout the text, pre- and post-outsourcing equilibria are indicated by a "~ " and a "*", respectively. The focus of this paper lies on diversified pre- and post-outsourcing equilibria. Hence, at least part of the production in both sectors is undertaken in Home. In section 2.1 we give a short overview on the theoretical literature dealing with cross border outsourcing in one sector. In section 2.2 we extend this literature by allowing for cross border outsourcing in both sectors to occur.

2.1 Cross border outsourcing in one sector

Assume that cross border outsourcing of low-skilled labor intensive parts of production becomes attractive within one sector due to a decline in tariff barriers and other trade costs[4] and that the economy under consideration is small. Then, the effect on relative wages turns out to be sector-biased if both sectors are active in the pre-outsourcing and the post-outsourcing equilibrium.[5] This sector-biased impact of cross-border outsourcing in 2x2 Heckscher-Ohlin type models was worked out by Arndt (1998b) and intensively discussed in Kohler (2001). The main point is that independent of which factor is substituted by cross border outsourcing, it is the factor intensively used in the outsourcing sector which gains relative to the other sector (compare Arndt 1997, 1998a, 1999).[6] Concerning the relative factor employment within each sector, it turns out that skill-intensities in the production of *both* sectors necessarily increase if international outsourcing takes place in the low-skilled labor intensive sector. If, in contrast, cross border outsourcing becomes attractive for the high-skilled labor intensive sector, the skill intensity in the low-skilled labor intensive sector declines, whereas the impact on the skill intensity within the high-skilled labor intensive sector is ambiguous. For a detailed discussion on possible equilibria compare Egger and Falkinger (2001).

With respect to the output structure, it turns out that in the outsourcing sector only the production of the up-stream fragment (including assembling activities) survives at home, if outsourcing is cost-saving and equilibria are diversified (compare the formal discussion in Egger and Falkinger, 2001). As pointed out by Arndt (1998b), production of the outsourcing sector increases and production of the other sector declines if the low-skilled labor intensive sector X gets access to low-skilled labor saving cross border outsourcing. In the case of low-skilled labor saving outsourcing in the skill-intensive sector Y, the impact on outputs is ambiguous.[7]

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[4] For example, Jones and Kierzkowski (2001) argue that there has been a marked reduction in the cost of cross-border service links between different components of the value added chain.

[5] Final assembly is thereby assumed to remain at home.

[6] Note that $\tilde{k}_Y > \overline{H}/\overline{L} > \tilde{k}_X$ must hold, according to (1), if the pre-outsourcing equilibrium is diversified.

[7] In both cases cross border outsourcing implies an outward shift of the production possibility frontier.

Finally, if in contrast to our assumption at the beginning of section 2.1 a large country is considered, terms of trade effects arise. For example, an increase in the output of commodity X and a decline in the output of commodity Y induce a downward pressure on prices of good X and an upward-pressure on prices of good Y, implying an increase in the terms of trade. The opposite result is obtained if the output of sector Y increases and the output of sector X declines. The commodity price changes induce further adjustment in factor prices and in factor allocation and may augment or offset the changes derived above (compare Arndt, 1998a; 1998b.) In addition, since cross border outsourcing affects income and welfare, there will be also demand-side effects on world market prices for commodities X and Y (see Arndt, 1998b).

In the following section, we allow for cross border outsourcing to occur in both sectors. Since we focus on the difference between small and large economies, we assume that the skill intensity implications derived include any price adjustment effects.

2.2 Cross border outsourcing in both sectors

If a decline in trade costs stimulates outsourcing activities in both sectors, there is a number of possible diversified equilibria. Assume that relatively low-skilled labor intensive parts of production are outsourced in both sectors and use the results of the literature summarized above.[8] In the following, we denote the remaining post-outsourcing production in sector X and Y as X^1 and Y^1, respectively. Then, the following conditions for the skill intensities can be identified, which are consistent with both a diversified post-outsourcing equilibrium and an increase in international outsourcing in both sectors.[9]

Sector Y		Sector X	
$k^*_{Y^1} > \tilde{k}_Y$	and	$k^*_{X^1} > \tilde{k}_X$	with $k^*_{X^1} < \overline{H} / \overline{L}$

[8] Note that there are only two feasible technologies within both sectors: the initial (pre-outsourcing) one and the one, which uses for any given wage rate high-skilled labor more intensively due to an increase in cross border outsourcing.

[9] If cross border outsourcing is relevant only for one sector, a factor intensity reversal implied by *changing technologies* due to cross border outsourcing, i.e. $k^*_{X^1} > \tilde{k}_Y$ or $\tilde{k}_X > k^*_{Y^1}$, is inconsistent with a diversified post-outsourcing equilibrium (compare Egger and Falkinger, 2001). But, if cross border outsourcing becomes attractive in both sectors, a factor intensity reversal, if not excluded by assumption, may be consistent with a diversified post-outsourcing equilibrium. In this case, in addition to (2) the following condition is consistent with a diversified equilibrium:

Sector Y		Sector X	
$k^*_{Y^1} < \tilde{k}_Y$	and	$k^*_{X^1} > \tilde{k}_X$	with $k^*_{X^1} > \overline{H} / \overline{L} > k^*_{Y^1}$.

Moreover, note that it might pay for firms within the low-skilled labor intensive sector to make use of the pre-outsourcing technology although a more skill intensive one is available. If this is the case, the results are equivalent to those obtained if only the high-skilled intensive sector has access to outsourcing opportunities.

$$
\begin{array}{llll}
k^*_{Y^1} > \tilde{k}_Y & \text{and} & k^*_{X^1} \leq \tilde{k}_X & \\
k^*_{Y^1} \leq \tilde{k}_Y & \text{and} & k^*_{X^1} > \tilde{k}_X & k^*_{Y^1} > \overline{H}/\overline{L} > k^*_{X^1} \\
k^*_{Y^1} \leq \tilde{k}_Y & \text{and} & k^*_{X^1} \leq \tilde{k}_X & \text{with } k^*_{Y^1} > \overline{H}/\overline{L}\,.
\end{array}
\tag{2}
$$

Figure 1 represents two possible diversified post-outsourcing equilibria, which are consistent with the conditions given by the first line of (2), i.e. $k^*_{Y^1} > \tilde{k}_Y$ and $k^*_{X^1} > \tilde{k}_X$ (with $k^*_{X^1} < \overline{H}/\overline{L}$).[10] As it can be seen in Figure 1, an increase in outsourcing within both sectors does not necessarily mean that the relatively abundant factor gains (in our case that w_H/w_L increases). Rather and as pointed out by Arndt (1997), it may also imply that the abundant factor of an economy loses (in our case that w_H/w_L declines). This is indicated by a flatter isocost line tangent to X_0^2 and Y_0^1, and a steeper one tangent to X_0^1 and Y_0^1 in Figure 1.[11] But note that the abundant factor can only lose, if factor intensities within both sectors increase, i.e. if $k^*_{Y^1} > \tilde{k}_Y$ and $k^*_{X^1} > \tilde{k}_X$. Otherwise, relative wages w_H/w_L unambiguously increase.

> Figure 1 <

2.3 Theoretical summary

So far, we have analyzed the theoretical implications of cross border outsourcing within the 2x2 production model. However, the theoretical conclusions are ambiguous, so that it remains an empirical question, which of the scenarios presented are well-suited for "real-world" data and most realistic. Before we go into the details of the empirical investigation we want to summarize the theoretical priors.

1. We shall look for the evidence, whether for the EU it is accurate to assume that the high-skilled labor intensive sectors are also the net exporting ones, which is conveniently presumed in the theoretical literature.

2. In line with the literature on cross border outsourcing in one sector, the direct (own) and cross sector effects of cross border outsourcing on the skill intensities in production can be summarized as follows

[10] As in Arndt (1997a, 1997b, 1999) and without loss of generality, one may assume that excess X^1-production is used for purchasing the imports of the outsourced process. Then, isoquants X_0^1 and X_0^2 in Figure 1 represent the value of total X^1 production necessary for assembling one unit of X, including X^1 directly used in the production process and X^1 traded for imports of the outsourced fragment. The same holds true for Y^1.

[11] Note that relative wages do not necessarily alter with an increase in outsourcing activities in both sectors. This is obvious in Figure 1.

	Increase of outsourcing in	
	sector X	sector Y
Skill-intensity in sector X	+	-
Skill-intensity in sector Y	+	+/-

where "+" indicates that the skill intensity rises in response to an increase in cross border outsourcing, and "-" indicates that it declines. In the empirical part of our paper we test, whether these implications for the skill-intensities can be found for data on EU outward processing (as a narrow measure of cross border outsourcing).

3. Finally, we investigate which condition of (2) is consistent with the empirical evidence for the impact of outward processing on the skill intensities in EU manufacturing industries.

3. Empirical evidence for outward processing of EU-countries

In the empirical part we analyze data on manufacturing in the EU countries regarding the theoretical priors. We use data at the NACE 2-digit level from EUROSTAT on education levels, outward-processing, industry production, and trade. We associate low-skilled labor with employees, whose highest educational attainment is primary education and high-skilled labor with the remaining employees (secondary or tertiary education level). Corresponding wage data are not available for employment of different skill levels, which prevails any full model specification and demands for the control of unobserved influences in the estimation. We are able to provide first insights into possible implications of outward processing for EU countries.

Outward processing trade involves exports of intermediate goods both within multinational firms and at arm's length for further processing in a foreign country, which are re-imported with tariff exemption.[12] However, the major drawback of this indicator is its sensitivity with respect to changes in content requirement regulations, tariffs and other trade related regulations. Especially, this involves problems if longer time series are considered. As we focus on three years only, this should only have a minor impact on our results. Additionally, outward processing is not a comprehensive measure of a country's outsourcing activity. Unfortunately, at the present stage of research, there is no European data available for the latter. In order to isolate the effect of outward processing trade on employment, we therefore have to control for the impact of non-outward processing trade, which also comprises other outsourcing activities. For US applications, usually more direct measures from the Input-Output

[12] Trade in final and intermediate goods of the EU members with certain third countries (EU, EFTA, CEEC 10, Turkey) is now regulated in the system of Pan European Cumulation. Materials from these third countries, which are incorporated into finished products in the EU are regarded as originating materials. This easier enables traders to satisfy origin rules. However, it is also criticised for being susceptible to protectionist abuse and promoting local parts industries (see Komuro, 1997, Bhagwati et al., 1998; Kohler, 2000, gives an overview).

tables are in use. In Europe, trade with low-wage economies is sometimes used as a proxy for outsourcing (compare Greenaway et al., 1999). Supposedly, outward processing trade is a more direct and narrow measure as compared to overall trade with low-wage economies.

> Table 1 <

Table 1 provides descriptive statistics on the main variables in manufacturing of EU-countries used in the econometric analysis below. First, within EU manufacturing industries, the ratio of high-skilled to low-skilled employment amounts to about 1.8 between 1995 and 1997 and the exporting sectors (defined as net exporters) are more skill intensive than the import competing sectors (defined as net importers), which confirms the priors of the convenient Heckscher-Ohlin based theory. This difference is significant on the basis of a Kruskal-Wallis test. Second, the engagement in outward processing of import competing industries is about twice as high as in their net exporting counterparts.

> Table 2 <

Table 2 reports fixed effects panel regression results for the determinants of the relative employment of high-skilled to low-skilled labor (H/L), i.e. the skill intensity, in European manufacturing. The estimated specification reads

$$(H/L)_{ijt} = \beta_0+\beta_1 O^{x}_{ijt}+\beta_2 O^{m}_{ijt}+\beta_3 O^{X}_{ijt}+\beta_4 O^{M}_{ijt}+\beta 5(O^{x}O^{X})_{ijt}+\beta_6(O^{x}O^{M})_{ijt}+\beta_7(O^{m}O^{X})_{ijt}+\beta_8(O^{m}O^{M})_{ijt}+$$
$$\beta_9 X_{ijt}+\beta_{10} M_{ijt}+\kappa_i+\mu_j+\lambda_t+v_{ijt}. \qquad (3)$$

With all variables already in logs. Letter "O"-variables refer to outward-processing as percent of gross production, the "X"-variable measures world exports (without re-imported intermediates) and variable M is world imports (minus outward processing) both measured as percentage of gross production as well. Finally, the specification includes fixed country (κ), industry (μ) and time effects (λ), in order to control for unobserved influences and to reduce multicollinearity across the regressors (see Hsiao, 1986, or Baltagi, 1995, for a discussion of the advantages), and v is the classical error term. We shall introduce the meaning of the various subscripts in (3): small x (m) indicates whether an outsourcing industry is a net exporter (x) or a net importer (m) in terms of (non outward processing) trade. Large X (M) indicates outward processing of the rest of a country's net exporting (net importing) industries in each year, i.e. outward processing of all net exporting (net importing) manufacturing industries except x (m). Accordingly, i is the outward processing country index, j runs over NACE 2-digit industries, and t refers to time.

In addition to the primary effects, equation (3) includes interaction terms in order to account for the fact that theory tells us that the impact of cross border outsourcing in an industry is not independent of whether the other outsourcing industries are more net exporting or more net importing ones (see the first row of (3)). We see that Model I (a restricted version of Model II) and Model II in Table 2 widely coincide in terms of parameter estimates, which underpins the robustness of our results. However, the underlying parameter restriction in Model I is significantly rejected and Model II is the more natural formulation of the problem as it also includes the primary effects of the other industries on the average industry. Therefore, our analysis below is based on Model II. Most of the coefficients in Table 2 are

significant although we wipe out large part of the variation in H/L by the inclusion of the fixed effects.[13]

The decision to account for interaction effects has an important consequence for the interpretation of the coefficients in Table 2. We are no more able to interpret the coefficients of the primary effects as the marginal effects. Fortunately, we can recover this information by differentiating (3) with respect to the variable under consideration. This leads to four marginal effects of interest:

$$\begin{aligned}
\frac{\partial E(H/L)_{ijt}}{\partial O^{x}_{ijt}} &= \beta_1 + \beta_5 O^{X}_{ijt} + \beta_6 O^{M}_{ijt} \\
\frac{\partial E(H/L)_{ijt}}{\partial O^{m}_{ijt}} &= \beta_2 + \beta_7 O^{X}_{ijt} + \beta_8 O^{M}_{ijt} \\
\frac{\partial E(H/L)_{ijt}}{\partial O^{X}_{ijt}} &= \beta_3 + \beta_5 O^{x}_{ijt} + \beta_7 O^{m}_{ijt} \\
\frac{\partial E(H/L)_{ijt}}{\partial O^{M}_{ijt}} &= \beta_4 + \beta_7 O^{x}_{ijt} + \beta_8 O^{m}_{ijt}
\end{aligned} \tag{4}$$

According to our theoretical findings, the marginal effect of a change in a net exporting industry's outward processing (O^x) on its skill intensity (H/L) is also dependent on what both the other net exporting (O^X) industries and the net importing industries (O^M) of the respective country are doing in terms of outward processing. Similarly, the marginal effects of a net importing industry (O^m), and of a country's all other net exporting (O^X) or net importing industries (O^M) depend on the other activities, which are accounted for in the interaction terms (compare (3) and (4) above). This leads to marginal effects, which are different for each observation, i.e. each manufacturing industry in a specific EU country and year. In order to give an impression of this property, Tables 3 and 4 report marginal effects of O^x_{ijt} (Table 3) and O^m_{ijt} (Table 4) for different terciles of O^X_{ijt} and O^M_{ijt}, respectively.[14]

> Table 3 and 4 <

We see that the marginal effect of an increase in a net exporter's outward processing (O^x_{ijt}) on its high-skilled to low-skilled labor ratio is negative across all presented quantiles of the distribution. In contrast, the marginal effect of a net importer's outward processing (O^m_{ijt}) on its high-skilled to low-skilled labor ratio is not unique in terms of sign: it is more likely to be negative if outward processing of a country's net exporting industries (O^X_{ijt}) is high and/or outward processing of the other import competing industries (O^M_{ijt}) is low.

This information can also be derived for the marginal effects of the other outward processing variables of interest (O^X_{ijt} and O^M_{ijt}) and expressed by the average marginal effect across the sample together

[13] Interestingly, most of the variation is explained by country rather than industry effects. This implicitly means that if a country is relatively well endowed with H, then all industries use relatively more H. In contrast, the variation between industries in the average country is less pronounced.

[14] Similarly, one could generate tables for the effects of O^X and O^M. However, since they are negative throughout the sample, we do not present them in order to save space.

with the standard error (see Table 5).[15] In order to derive empirical results, which are as close as possible to the theoretical hypotheses, we report two different marginal effects of each O^X_{ijt} and O^M_{ijt} depending on whether an industry is either net exporting or net importing.[16]

> Table 5 <

Regarding the theoretical results for the marginal effect of a change in outward processing on the equilibrium values of the skill intensities in both the net exporting and the net importing sector, we come up with the following conclusions from our empirical results in Table 5. First, there is coincidence between theory and evidence for outward processing in EU manufacturing, that a change in net exporter outward processing might lead to a negative effect on H/L in both the net exporting and the net importing industries. This coincidence can be seen from the negative sign of the marginal effects (A), (C), and (D) in Table 5.[17] In contrast to the theoretical priors, we also find a negative marginal effect of a positive change in net importer outward processing on H/L in both the net exporting and the net importing industries. This is obvious from the negative sign of (B), (E), and (F) in Table 5. However, this evidence is not that strong as for net exporters, since the own effect of an increase in a net importer's outsourcing (O^m) is not negative throughout the sample. See the positive maximum for (B) in Table 5 and remember the terciles with a positive marginal effect from Table 4 and the fact that Table 5 only presents means of the coefficients and standard errors for the whole sample of observations. We will see that this ambiguity of the effect of O^m together with the cumulative properties of the effects, which are not comprehensively captured by the marginal effects alone, turns out to be strong enough to account for a positive overall effect of an increase in outward processing in both the net exporting and the net importing EU manufacturing industries.

In order to provide additional insights in the overall effects of an increase in outward processing on H/L in European manufacturing, we undertake a simulation analysis. Given our estimation results, we can turn to the following experiment of thought. Other things being equal, assume that only the share of outward processing in 1997 were changed to its 1995 value (or 1996 if 1995 is not available). In other words, we assume that "world" in 1995 (or 1996) were just as 1997 except in terms of outward processing as percent of gross production. We can then compare the increase in H/L according to "real world" data and according to our model prediction for the "artificial world" counterfactual. "Real world" and "artificial world" (indicated by stars) data are presented in Table 6.

> Table 6 <

Between 1995 and 1997, outward processing in EU manufacturing grew by about 6.3 percent p.a. (see column 2 in Table 6). It was about three times more dynamic in the net importing industries than in the

[15] The standard error of this marginal effect is calculated from the variances and the covariances of the terms in the marginal effect. See Greene (1997, p. 391f.) for more details on this problem.

[16] Regarding (4), these four effects can be defined as $C = \beta_3+\beta_5 O^x_{ijt}$, $D = \beta_3+\beta_7 O^m_{ijt}$, $E = \beta_4+\beta_8 O^m_{ijt}$, $F = \beta_4+\beta_6 O^x_{ijt}$, compare Table 5.

[17] There is only a small quantile of the distribution, where this marginal effect is positive. See the relatively small but positive maximum coefficient of (A) in Table 5.

net exporting ones. Within the same period, the skill intensity rose by about 1.8 percent p.a. in manufacturing as a whole, being more pronounced in the net exporting industries (2.3 percent; see column 3 in Table 6).

For the average EU industry, we see that outward processing alone accounts for less than one percent in absolute value of the average annual change in H/L between 1995 and 1997 (column 4 in Table 6). For the net importing industries, the predicted change is about five times higher as compared to their net exporting counterparts. This is due to the outward processing activities, which were about three times more dynamic than in net exporting industries. Regarding our theoretical conclusions from above, this is no contradiction to the theoretical hypotheses. The more intensively outward processing increases in the net importing industries with respect to the net exporting ones, the more likely an increase in the relative skill intensity (H/L) in both the net exporting and the net importing industry is. Concerning the set of possible diversified post-outsourcing equilibria identified in section 2.3 with both exporting and import competing industries engaged in cross border outsourcing, the empirical evidence is consistent with the conditions described by line 1 in (2) i.e. $k_{Y^1} > k_Y$ and $k_{X^1} > k_X$. Moreover, a factor intensity reversal induced by outsourcing opportunities cannot be supported for European economies.

Comparing the "real world" change in H/L with the isolated effect of outward processing only (labeled as H^*/L^* in Table 6) we realize that outward processing alone accounts for about 4 percent of the observed change in the average EU manufacturing industry and for about 18 percent of the change in the average net importing industry. For five out of twenty European manufacturing industries, we can explain more than 10 percent of the observed factor intensity dynamics by outward processing only. Since outsourcing and skills are measured differently, it is difficult to compare our results for the EU with those of Feenstra and Hanson (1999) for the US. Feenstra and Hanson (1999) find an overall effect of narrow outsourcing on the non-production-to-production workers' wage ratio of about 0.29 percent per annum, which is about 40 percent of its actual increase. We find an increase in the skill intensity in both the net exporting and the import competing sector being more pronounced in the latter one. However and in accordance with our theoretical discussion (compare Figure 1), it is not possible to derive a clear prediction about the resulting effect on the relative wages. Concerning our empirical approach, there are three important differences as compared to Feenstra and Hanson (1999). First, our measure of outsourcing is probably narrower as compared to the one used by Feenstra and Hanson (1999). Second, we base our hypotheses on a two sector model and try to account for the impact of narrow outsourcing in other sectors on H/L, which means to account for the (short-run) general equilibrium effects.[18] According to our results, the impact of outward processing on H/L would be considerably higher when ignoring these inter-sectoral effects. Third and in contrast to Feenstra and Hanson (1999), our framework does not allow to explicitly account for country specific terms of trade effects. Rather, our estimates are relevant for the "typical" EU member country.

[18] Our fixed effects regressions do not allow for a long-run evaluation of inter-sectoral impacts of outsourcing. In general, this is difficult to tackle with econometric tools.

4. Conclusions

The theory on cross-border outsourcing of the last decades primarily has been done on the basis of a general equilibrium analysis within the 2x2 Heckscher-Ohlin framework. We follow this line and concentrate on diversified pre- and post-outsourcing equilibria only, so that any industry produces at least part of its output at home. Our analysis extends previous research in the following way:

1. We underpin the importance of whether cross border outsourcing is undertaken by an exporting or import competing industry for the expected effects on both skill-intensities and relative wages between workers of different skills. In addition, we provide a comprehensive discussion of all possible post-outsourcing equilibria also for a situation in which both sectors are engaged in cross border outsourcing.

2. We present an empirical analysis on outward processing (as a narrow measure of cross border outsourcing) in EU manufacturing industries over the period 1995-1997 on the basis of our theoretical results and search for the coincidence between theory and evidence.

At the descriptive level, we find that the high-skilled to low-skilled labor ratio, i.e. the skill intensity, is higher in the exporting industries than in their import competing counterparts. Outward processing is more pronounced in import competing industries. In the regression analysis we find that the marginal own and cross industry effects of outward processing in net exporting and net importing industries widely confirm the theoretical hypotheses. On the one hand, we expect that outward processing in an import competing industry has a positive impact on the skill intensity in both the exporting and the import competing sector. This is weakly in contrast to our empirical findings, where the effect of outward processing in the net importing industries is not uniquely positive throughout the sample. On the other hand, we find a significantly negative effect of outward processing in net exporting industries. This is in accordance with theory, which supports either a positive or a negative effect on the skill intensity in the exporting sector (H/L) and a negative effect on the skill intensity in the net importing sector.

In EU manufacturing, outward processing has grown at relatively rapid pace of more than 6 percent p.a., which is markedly more pronounced in the net importing industries (11 percent p.a.). The growth in the employment ratio between high-skilled and low-skilled labor amounted to about 1.8 percent p.a. being most pronounced for the net exporting industries (2.3 percent p.a.). We find that outward processing alone can explain about 4 percent of the observed change in overall EU manufacturing and about 18 percent of the change in the import competing industries. For a couple of NACE two-digit industries, extra-EU outward processing accounts for about and more than 20 percent of the observed change.

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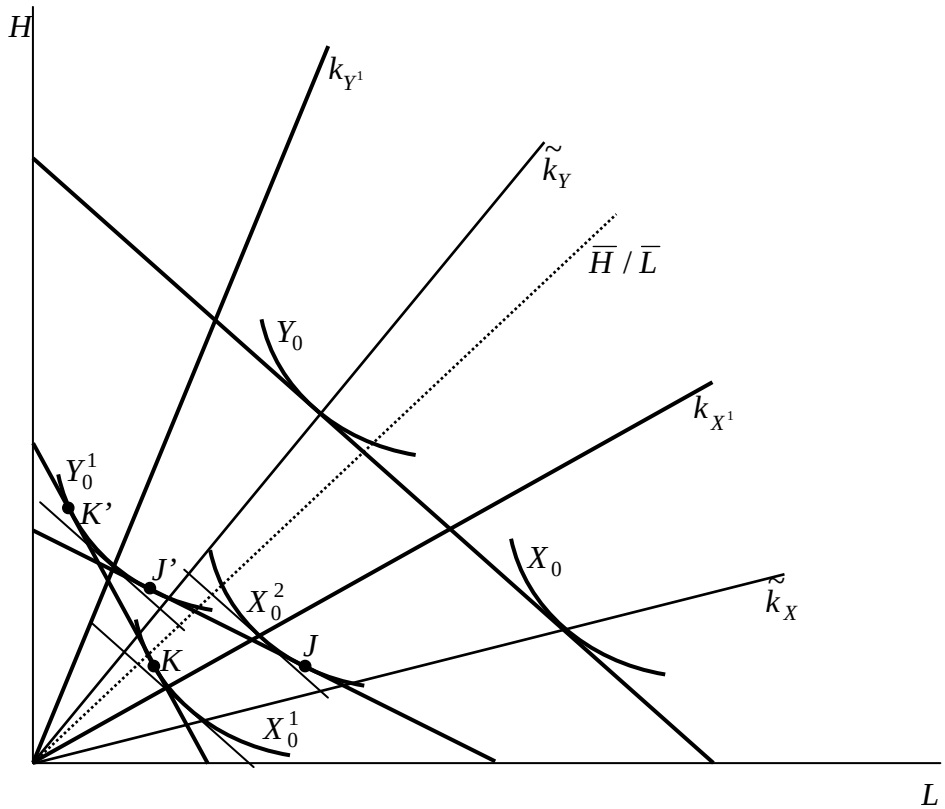

Figure 1: Cross border outsourcing in both sectors with $k_{Y^1}^* > \tilde{k}_Y$ and $k_{X^1}^* > \tilde{k}_X$

Table 1: Descriptive Statistics for EU Countries (1995-1997)

	EU industries	Net exporting industries	Net importing industries
High-skilled-to-low-skilled employment ratio (H/L)	1,795	1,856	1,705
Outward processing[1)]	0,249	0,174	0,358
World exports[1)]	43,714	46,768	39,165
World imports[1)]	40,455	31,535	53,738

1) As percent of gross production. - 2) (H/L) between net exporting and net importing industries is significantly different according to a Kruskal-Wallis test with a (χ^2) test statistic of 6.480 and a p-value of 0.011.

Table 2: Panel Regression Results for Relative Employment of High-skilled to Low-skilled Workers (H/L) in Manufacturing of EU Countries

Independent Variables[1)]	Model I	Model II
Constant (1)	-0,041	0,284 **)
	(0,160)	(0,152)
Outward processing of:		
Net exporting industry (2)	-0,022 **)	-0,022 *)
	(0,011)	(0,012)
Net importing industry (3)	-0,007	-0,008
	(0,012)	(0,012)
A country's other net exporter outward processing (4)[2)]	-	-0,057
	-	(0,060)
A country's other net importer outward processing (5)[2)]	-	-0,236 **)
	-	(0,051)
Exporter interaction term I (6): (2)*(4)	0,009 **)	0,007
	(0,004)	(0,007)
Exporter interaction term II (7): (2)*(5)	0,003	-0,010 **)
	(0,003)	(0,005)
Importer interaction term I (8): (3)*(4)	0,015 **)	0,013 **)
	(0,004)	(0,007)
Importer interaction term II (9): (3)*(5)	0,002	-0,011 **)
	(0,003)	(0,005)
Export openness (10)[3)]	-0,102 **)	-0,086 *)
	(0,057)	(0,056)
Import openness (11)[3)]	0,126 **)	0,103 **)
	(0,041)	(0,040)
Observations	515	515
Adjusted R^2	0,86	0,87
F-tests:		
Time effects (2, 476)	2,17	3,38 **)
Exporter effects (11, 476)	144,03 **)	151,87 **)
Industry effects (20, 476)	48,31 **)	48,71 **)

1) Standard errors are reported in parentheses.- 2) This defined as the difference in outward processing between all net exporting industries and all net importing industries and all net importing industries in one year of the respective sending country. - 3) Outward processing trade has been substracted.
*) significant at 10 percent. **) significant at 5 percent.

Table 3: Marginal Effects of a Change in a Net Exporter's Outward Processing (OP) for Different Levels

	OP of other net exporting industries		
OP of net importing industries	Low	Medium	High
Low	-0,028	-0,020	-0,020
Medium	-0,044	-0,036	-0,036
High	-0,046	-0,046	-0,037

Table 4: Marginal Effects of a Change in a Net Importer's Outward Processing (OP) for Different Levels

	OP of net exporting industries		
OP of other net importing industries	Low	Medium	High
Low	0,001	0,027	0,028
Medium	-0,014	0,013	0,013
High	-0,015	-0,015	0,012

Table 5: Marginal Effects of Outward Processing (OP) Variables on H/L

	Coefficients		
Average marginal effect of:	Mean	Minimum	Maximum
OP of net exporting industries (A)	-0,030 **)	-0,058	0,008
	(0,014)		
OP of net importing industries (B)	-0,021 **)	-0,056	0,030
	(0,009)		
OP of other net exporting industries on net exporters (C)	-0,116 **)	-0,164	-0,075
(net exporter own effect)	*(0,044)*		
OP of other net exporting industries on net importers (D)	-0,160 **)	-0,275	-0,066
(net exporter cross effect)	*(0,044)*		
OP of other net importing industries on net importers (E)	-0,149 **)	-0,228	-0,052
(net importer own effect)	*(0,040)*		
OP of other net importing industries on net exporters (F)	-0,152 **)	-0,210	-0,085
(net importer cross effect)	*(0,040)*		

Standard errors in parentheses. - **) significant at 5 percent.

Table 6: Average Annual Change in H/L for EU Industries (1995-1997)

Industry[1)]	Observed annual change		Annual change attributable to OP	
	OP	H/L	H^*/L^*	as percent of observed
Food products and beverages (15)	-3,30	-2,03	-0,18	9,01
Manufacture of textiles (17)	26,02	-0,72	-0,10	13,60
Manufacture of wearing apparel; dressing and dyeing of fur (18)	-5,23	15,48	-0,03	NA
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear (19)	-0,01	1,58	0,00	NA
Manufacture of wood and of products of wood and cork, except furniture; Manuf. of articles of straw and plainting materials (20)	-10,37	6,56	0,21	3,23
Manufacture of pulp, paper and paper products (21)	-11,30	4,52	1,45	31,98
Publishing, printing and reproduction of recorded media (22)	-0,25	0,61	-0,45	NA
Manufacture of chemical and chemical products (24)	16,51	-4,12	0,22	NA
Manufacture of rubber and plastic products (25)	-14,72	4,13	-0,50	NA
Manufacture of other non-metallic mineral products (26)	11,11	4,98	0,16	3,28
Manufacture of basic metals (27)	26,85	11,69	0,25	2,18
Manufacture of fabricated metal products, except machinery and equipment (28)	21,61	-1,40	-0,02	1,55
Manufacture of machinery and equipment n. e. c. (29)	8,94	1,59	0,30	19,06
Manufacture of office machinery and computers (30)	-4,66	5,32	-0,19	NA
Manufacture of electrical machinery and apparatus n. e. c. (31)	5,27	2,88	-0,28	NA
Manufacture of radio, television and communication equipment and apparatus (32)	2,02	13,07	-0,13	NA
Manufacture of medical, precision and optical instruments, watches and clocks (33)	-1,39	-11,13	0,31	NA
Manufacture of motor vehicles, trailers and semi-trailers (34)	-14,48	0,88	0,15	16,58
Manufacture of other transport equipment (35)	17,85	7,87	0,16	1,99
Manufacture of furniture; manufacturing n. e. c. (36)	40,16	-0,90	-0,71	79,23
All EU industries	6,32	1,79	0,07	3,75
All net exporting EU industries	3,42	2,31	0,03	1,16
All net importing EU industries	11,57	0,85	0,16	18,35

1) NACE 2-digit industries (Revision 1 code in parentheses); NA = not available, because change in H^*/L^* has opposite sign of H/L.