The determinants of EU processing trade

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Abstract

This paper assesses the determinants of European outward and inward processing trade. Thereby, it distinguishes between size, relative factor endowment, (other) cost factors and infrastructure variables. Using a large panel of bilateral processing trade flows of the EU12 countries at the aggregate level over the period 1988-1999, we find that infrastructure variables, relative factor endowments and other cost variables are important determinants for the EU’s outward processing trade. Costs also play a key role for the EU’s inward processing trade.
The Determinants of EU Processing Trade
Hartmut Egger and Peter Egger

1. INTRODUCTION

International outsourcing has become a key issue in the scientific and political debate on macroeconomic developments, since it makes the recent wave of globalization so different from globalization a hundred years ago. Thereby, it is usually argued that declining trade barriers and decreasing costs for service links (Jones and Kierzkowski, 1990) have led to a death of distance (Cairncross, 1997) so that “the principle of arbitrage is now applied to ever smaller slices of the value added chain” (Kohler, 2001, p. 32). Hence, firms nowadays have a strong incentive to search for alternative locations of intermediate goods production abroad and to engage in international outsourcing to low-cost countries all over the world (Arndt, 1997). This gives an intuitive explanation for the observed dynamics in North-South outsourcing. In addition, the ongoing integration process in Europe and North America has led to a reduction in the costs of intra-bloc intermediate goods transactions, thereby fostering competition between national component producers within the North.

The empirical literature has so far predominantly focused on stylized facts concerning the magnitude of international outsourcing and the possible impact of this phenomenon on wages and employment in North America and Western Europe. This has revived the debate on whether it is trade or technical progress that is responsible for the adverse labour market effects in the industrialized world (see Feenstra and Hanson, 1999; and Egger and Egger, 2003a).1

Hummels et al. (1998) and Hummels et al. (2001) illustrate that the value of imported intermediates embodied in exported goods - referred to as vertical specialization2 - accounted

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1 Treating international outsourcing and technical progress as two distinct phenomena may be misleading. Jones and Kierzkowski (2001a, p. 49) for example argue that there is a “two-way interplay between technological change and fragmentation”. Technical progress, on the one hand, leads to improved possibilities for firms to make use of the cost advantages of different countries in the production of intermediate components. On the other hand, international outsourcing encourages R&D efforts to create inputs that a number of sectors can use.

2 The terms vertical specialization and international outsourcing are used synonymously. See Hummels et al. (2001, p. 76) for a discussion.
for 30 percent of the growth in the overall export/GDP share between 1970 and 1990 and that it grew by about 40% between 1970 and 1995.

Yi (2003) simulates a Ricardian dynamic model of trade in final goods and intermediates and finds that this model performs especially well in explaining world trade growth from the late 1970s onwards. This model of vertical specialization explains about 75% of world trade growth, whereas standard models explain only 45%.

Baier and Bergstrand (2000) compute a general equilibrium model of final goods and intermediate goods trade. They show that (i) a high elasticity of substitution between goods is necessary to explain overall growth of world trade, but (ii) a low elasticity is needed to obtain reasonable estimates of the growth of outsourcing. With mixed high final goods and low intermediate goods elasticities of substitution, both overall trade growth and growth of outsourcing in a sample of capital-abundant countries are fairly well explained. In this simulation exercise, both the final and intermediate goods exports to GDP ratios increase by 73%, which is only slightly lower than the evidence reported in Feenstra (1998).

Yeats (2001) finds for a sample of OECD member countries that in 1995 parts and components accounted for more than one third of overall imports of the transport and machinery industry. Yeats provides insights into the regional dispersion of international outsourcing. He investigates three regional groups (EU12, NAFTA and EFTA) and finds that data on OECD exports of parts and components “do not indicate that there are important differences in the share of components in trade within or outside the regional blocks” (p. 114).

Egger and Egger (2003b) consider outsourcing of EU12 member countries (1990-1997) and show that the dynamics of intra-regional (i.e., intra-EU12) production sharing and international outsourcing to the Rest of the World (ROW) are not too different. Egger and Egger (2003a) in an assessment of Austrian outsourcing to Central and Eastern European countries (CEEC) and the former Soviet Union illustrate that the development of factor costs is an important determinant of rising outsourcing. Similar to Mexico, the CEEC are at low distance from the developed markets and they are characterized by relatively low wages. The magnitude of international outsourcing is higher in the newly industrialized economies of Central and Eastern Europe than in a typical OECD economy. Egger and Egger (2002) show for a sample of 7 CEEC that in 1996 world imports of intermediate goods explain 60% of total manufacturing imports of these countries. Moreover, they emphasize that international outsourcing is not a one way phenomenon but that intermediate goods export and import shares are of the same magnitude.
A number of empirical studies have searched for stylized facts on the magnitude (and dynamics) of international outsourcing as well as on its impact on the labour markets in industrialized economies. Görg (2000) analyzes US inward processing trade in the EU and concludes that “the distribution of fragmented production around the globe will be according to countries’ comparative advantages” (p. 418). In contrast, Baldone et al. (2001) use data on textile and apparel trade to find that “there is no evidence that the choice of the processing country by EU firms is due to pre-existing comparative advantages” (p. 102). Finally, Egger and Egger (2003a) investigate the determinants of Austrian outsourcing (using a wider measure than processing trade) to the CEEC and the former Soviet Union and conclude that both declining tariffs and the size of unit labour costs in Eastern economies play an important role. Egger and Egger (2003a) show that over the period of 1990-1997 Austrian intra-industry outsourcing to Eastern economies was extremely dynamic with an average annual increase of 10.71 percent. To the best of our knowledge an analysis of the determinants of outward and inward processing trade in a large sample of bilateral relationships is so far not available.

The purpose of this paper is to investigate the determinants of EU12 bilateral processing trade, which is used as a narrow measure of international outsourcing. In Section 2 we start with a short discussion of the possible determinants of international outsourcing that are put forward in the existing theoretical literature. We group the determinants according to the type of models from which they are derived (Heckscher-Ohlin, New Trade Theory, etc.). In Section 3 we first present a few descriptive statistics on the regional dispersion and the dynamics of outward and inward processing trade of the EU12 economies. In a second step, we use data on the different determinants of international outsourcing in a fixed effects regression analysis. Finally, we account for the grouping of variables of Section 2 and compute the contribution of each group of variables to the explanation of EU outward and inward processing trade. Section 4 concludes with a summary of the most important findings.

2. THEORETICAL BACKGROUND

As mentioned above, there is a broad consensus among economists that declining tariff barriers and decreasing costs for service links are important determinants of the recent dynamics in international outsourcing. Egger and Egger (2003a) for example find that the reduction in tariff barriers is important for Austrian outsourcing to Eastern economies. In contrast, the impact of non-tariff barriers is rather ambiguous. However, changes in tariff

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3 In this study intra-industry outsourcing is measured by intermediate goods imports from Eastern economies, which are produced by industry i firms abroad and used by firms of the same industry classification at home.

4 The EU15 countries except the joining countries of 1995 (Austria, Finland and Sweden).
barriers are not accounted for in the present analysis, since we use data on outward and inward processing trade and, therefore, on international goods transactions under tariff exemption. Moreover, falling costs of service links are associated with technological improvements that are quite similar across different economies. Such changes are accounted for by time-specific fixed effects in our regression analysis below.

The theoretical research on international outsourcing has so far predominantly focused on an analysis of the possible factor price effects in traditional trade models. Following the Heckscher-Ohlin logic, firms have an incentive to outsource internationally only if countries are different with respect to their relative factor endowments (for a similar argument, see Görg, 2000, p. 409). I.e., firms outsource intermediate goods production to countries with a relative abundance of factors that are scarce at home, leading to inter-industry trade of intermediate goods.

In contrast, models in the spirit of the new trade theory point to the importance of North-North transactions and focus on intra-industry trade flows. Egger and Falkinger (2003b) stress the relevance of imperfect competition at the intermediate goods market level to explain the location of component producers and to determine the productivity of immobile factors. Irrespective of the particular framework at hand, the literature emphasizes that comparative advantages play a minor (at least not a dominant) role for trade flows between industrialized economies. Rather, it is imperfect competition or productivity gains in the case of components supply by specialized intermediate goods producers (Ethier, 1982) that motivate intra-industry trade of homogeneous or differentiated intermediate goods, respectively. In the case of differentiated goods production and monopolistic competition in the intermediate goods market, the size of (integrated) economies turns out to be an important determinant of international outsourcing. Such a result can be derived from the framework presented in Egger and Falkinger (2002, 2003b).

Moreover, it is well known from models of the new economic geography type that the size of the local market becomes crucial for the location decision of firms. Indeed, if transport costs are not too low, the advantage of being close to the (bigger) market may dominate any competition effects so that lowering barriers to trade and factor mobility result in a core-periphery pattern. Hence, this literature points to the relevance of differences in the market size (where market size is endogenously determined by the amount of mobile factors located in an economy) for the pattern of goods trade. Of course, the focus of these models so far has

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6 For the impact of market size on trade and fragmentation, see also Burda and Dluhosch (2002).
predominantly been on final goods trade. See among others Krugman (1991) and Ludema and Wooton (2000). However, it is straightforward that core-periphery patterns should also have an impact on international outsourcing activities (see, e.g., Krugman and Venables, 1995; and Baldwin et al., 2003, chapter 8). Moreover, Grossman and Helpman (2004) emphasize the role of market thickness when studying the determinants of the location of sub-contracted activity.\(^7\)

We conclude that according to the models of the new trade theory both overall market (endowment) size and differences in the size of markets should be important determinants of intermediate goods trade, whereas differences in the relative factor endowments may eventually be of second-order importance.

A third set of possible determinants of vertical fragmentation and international outsourcing are put forward by studies with a politico-economic focus. In such models, it is argued that infrastructure variables have an important impact on the location choice of firms. Egger and Falkinger (2003b) investigate the impact of public infrastructure provision on the location of intermediate goods producers and the pattern of international outsourcing in a free trade agreement. As a result they find that higher public infrastructure investment attracts firms and makes a country less dependent on intermediate goods production abroad. The opposite outcome is obtained in the partner country, where international outsourcing to the “high” public infrastructure country is intensive.\(^8\)

Finally, international outsourcing decisions may also be affected by institutional settings\(^9\) as well as by differences in the tax rates on profits and earnings. Of course, these types of variables may exert effects on the location choice of intermediate goods producers which are comparable to the ones associated with public infrastructure provision.

Deardorff (2001b) has recently analyzed the relationship between international outsourcing and financial crises by modelling the latter as a “loss of confidence in a currency” (p. 21). This suggests real exchange rate dynamics as a possible determinant of international outsourcing decisions. For instance, the results in Swenson (2000) point to a significant negative impact of dollar depreciation (i.e., a rise in the perceived price of foreign inputs) on outward processing of US firms.

\(^7\) Egger and Egger (2004) investigate the role of asymmetries in country sizes in a Hotelling model with trade in final and intermediate goods.

\(^8\) Carr et al. (2002) remark that low infrastructure quality make the poorest countries unprofitable locations for production.

\(^9\) We do not have data on the different institutional settings in all countries used in our empirical analysis below. Therefore, we will use information on the exporter-to-importer relative price level of processing trade to account for institutional differences.
Summing up, theoretical models motivate the use of four groups of variables as possible determinants of international outsourcing, namely:

(i) Overall market size and differences in the size of markets (new trade theory).
(ii) Differences in relative factor endowments (Heckscher-Ohlin).
(iii) Other cost determinants such as relative prices, real exchange rates and taxes (currency crises and politico-economic models).
(iv) Infrastructure variables (politico-economic models).

We use these four groups of determinants as possible explanatory variables for EU outward and inward processing trade. Though our empirical analysis is not a rigorous test of the different theoretical models analyzed above, it gives first insights into the relevance of the different groups of variables for processing trade in a large sample of country pairs.

3. DATA AND ESTIMATION RESULTS

We use data on bilateral outward\textsuperscript{10} (OPX, OPM) and inward\textsuperscript{11} (IPX, IPM) exports and imports of the EU12 economies available from EUROSTAT at the 8-digit combined nomenclature level. We aggregate the data to obtain bilateral nominal processing trade figures for each EU12 economy in ECU at an annual basis (1988-1999).

Figures 1a-1d illustrate the cumulative growth of overall EU12 outward and inward processing trade between 1988 and 1999. For the purpose of tractability, Figures 1a-1d display only developments of EU processing trade with (other) Western European economies (solid black line), CEEC (dashed line) as well as the development of total (average) EU processing trade (gray line). Obviously the development of aggregate bilateral processing trade is rather dynamic. The average annual growth rate of outward processing exports (imports) over this period amounts to about 8.4% (10.2%), whereas it is only about 2.3% (4.2%) for inward processing exports (and imports).\textsuperscript{12}

\textsuperscript{10} Outward processing exports (OPX) consist of intermediate goods exports – both within multinational firms and at arm’s length transactions – for further processing in a foreign country, after which the goods are re-imported under tariff exemption. The latter trade flow is measured as outward processing imports (OPM).

\textsuperscript{11} Inward processing imports (IPM) consist of intermediate goods imports from a foreign economy for further processing at home, after which the goods are re-exported under tariff exemption. The latter trade flow is measured as inward processing exports (IPX).

\textsuperscript{12} Note that changes in outward processing imports are much more dynamic than changes in outward processing exports. This may be due to an increase in foreign processing activities (induced by a death of distance) or due to increasing costs abroad.
We see that, by and large, Western European outward processing trade is relatively dynamic. Further, there is above average growth outward processing trade with the CEEC after the fall of the iron curtain, which enabled multinationals to set up production plants there.\(^{13}\) Outward processing exports to (imports from) the CEEC increased by about 12.4% (17.1%) per annum within this period. Finally, the growth rates of processing trade with the CEEC seem to develop anti-cyclical to some extent. This might indicate that EU firms perceive intermediate goods supply in CEEC markets as a strong substitute for EU supply, so that differences in exchange rate movements or factor costs affect processing trade in these directions. Similar findings are obtained for EU12 processing trade with Asia, not displayed in Figures 1a-1d. Figures 1c and 1d suggest that the pattern of inward processing trade differs from that one of outward processing trade. Accordingly, we would expect determinants such as market size and exchange rates to have a differential impact on outward and inward processing trade flows.

> Figure 2 <

Figure 2 displays the development of processing trade shares in percent of total EU trade. It can be seen that, over the sample period, especially outward processing exports have risen in percent of total trade. The other concepts of processing trade were declining in importance in the second half of the 1990s to return basically to their share in the late 1980s. One reason for this development could be seen in the declining need for tariff exemption in the case of outward processing in a world with already low and still declining trade barriers.

> Figures 3a-4d <

In Figures 3a-4d, we plot the country bloc share of outward and inward processing trade for the first and the last year in our sample (1988 and 1999). Thereby, we treat South America and Africa as one single bloc, and North America, Australia and Oceania as another one. As easily can be seen from Figures 3a-3d, it is mostly the low-wage, adjacent and relatively infrastructure abundant CEEC, where the shares of outward processing trade have grown. Regarding inward processing trade, the share of North America and Asia has grown mostly at the expense of inward processing from Western European economies. Below, we assess the determinants of this development by means of regression analysis.

The explanatory variables are grouped according to our theoretical considerations in Section 2. Hence, we use information on: size variables (overall bilateral size: SGDP, relative bilateral

\(^{13}\) The impact of a reduction in tariffs, e.g., due to the implementation of the Europe agreements, on outward processing trade is less clear-cut, because outward processing trade is partially exempted from border duties (see Baldone et al., 2001).
size: SIMI), relative factor endowments (absolute difference in GDP per capita\textsuperscript{14}: RLFAC1; absolute difference in secondary school enrolment: RLFAC2), other cost variables (relative prices: RP,\textsuperscript{15} relative real effective exchange rate: REXCH, taxes on profits and earnings in the partner country: TAXM), and variables reflecting the infrastructure endowment of the partner country (size of road network: ROADM, size of telephone network: PHONEM, size of electricity supply: ELECTRM). In the Appendix, we present a detailed list of the covered reporting and partner countries. Table 1 provides details on the construction, the sources and the labels of the variables in use.\textsuperscript{16}

To estimate the impact of each of these groups of variables, we specify the following regression model:

\[
Y_{ijt} = \beta_0 + \beta_1 \text{SGDP}_{ijt} + \beta_2 \text{SIMI}_{ijt} + \beta_3 \text{RLFAC1}_{ijt} + \beta_4 \text{RP}_{ijt} + \beta_5 \text{REXCH}_{ijt} + \beta_6 \text{TAXM}_{jt} + \beta_7 \text{ROADM}_{jt} + \beta_8 \text{PHONEM}_{jt} + \beta_9 \text{ELECTRM}_{jt} + \mu_{ij} + \lambda_t + \epsilon_{ijt},
\]

and, alternatively, a model where we use RLFAC1 and RLFAC2 together:

\[
Y_{ijt} = \gamma_0 + \gamma_1 \text{SGDP}_{ijt} + \gamma_2 \text{SIMI}_{ijt} + \gamma_3 \text{RLFAC1}_{ijt} + \gamma_4 \text{RLFAC2}_{ijt} + \gamma_5 \text{RP}_{ijt} + \gamma_6 \text{REXCH}_{ijt} + \gamma_7 \text{TAXM}_{jt} + \gamma_8 \text{ROADM}_{jt} + \gamma_9 \text{PHONEM}_{jt} + \gamma_{10} \text{ELECTRM}_{jt} + \mu_{ij} + \lambda_t + \epsilon_{ijt},
\]

where \(Y_{ijt}\) stands for bilateral processing trade of country i with country j in year t (either OPX\(_{ijt}\), OPM\(_{ijt}\), IPX\(_{ijt}\) or IPM\(_{ijt}\)). If imperfect competition and economies of scale are important at the intermediate goods level, we would expect (large) positive parameters \(\beta_1\) (\(\gamma_1\)) and \(\beta_2\) (\(\gamma_2\)). However, both SGDP and SIMI should be of minor importance as compared to RLFAC1 and RLFAC2, if traditional (Heckscher-Ohlin based) trade theory provides a key explanation for processing trade. Other cost motives not directly associated with factor rewards are reflected by the relative price of the good in the exporting economy as compared to the importing one (\(\beta_4\), \(\gamma_5\)), the real exchange rate of the partner countries (\(\beta_5\), \(\gamma_6\)) and the taxes on profits and earnings in the partner country (\(\beta_6\), \(\gamma_7\)). Finally, studies with a politico-economic focus as well as models of multinational firms underpin the impact of infrastructure variables for transportation and firm set-up costs and, hence, on the decision of firm location, thereby predicting a high (positive) value of parameters \(\beta_7\)–\(\beta_9\) (\(\gamma_8\)–\(\gamma_{10}\)). To guard against

\textsuperscript{14} The idea that GDP per capita is an appropriate measure for relative factor endowment goes back to Kaldor (1963). It is noteworthy that the change in GDP per capita also captures a country’s change in technology. Differences in relative factor endowments and technology levels are captured by the fixed country pair effects.

\textsuperscript{15} Similar to processing trade volume figures, we obtain the exporter-to-importer relative unit values of processing trade, where appropriate weighting gives aggregate price ratios at the bilateral level (RP).

\textsuperscript{16} The similarity of country size index à la Helpman (1987) is defined as: \(\text{SIMI}_{ijt} = \log\left(1 - \left(\frac{\text{GDP}_i}{\text{GDP}_t} + \frac{\text{GDP}_j}{\text{GDP}_t}\right)^2 - \left(\frac{\text{GDP}_i}{\text{GDP}_t} + \frac{\text{GDP}_j}{\text{GDP}_t}\right)^2\right)\), where indices i and j refer to exporter and importer countries, respectively, t denotes time, and GDP is a country’s real GDP.
omitted time-invariant variables, we account for fixed bilateral effects ($\mu_{ij}$), which capture the
influence of geographical location (distance, common borders, island) and cultural
characteristics (common language, colonial relationships), and for fixed time effects ($\lambda_t$) to
control for general technological change and, in particular, for the decrease in the costs of
service links and the multilateral decline in trade costs.\footnote{Time-specific fixed effects have a
significant impact. However, the results are not displayed in Table 2.}

Table 2 summarizes our findings from four regressions, which correspond to the four different
dependent variables at hand: OPX (Model I), OPM (Model II), IPX (Model III), and IPM
(Model IV), respectively. It is noteworthy that only heteroskedasticity consistent standard
errors and test statistics are reported. Further, extreme outliers in the upper and lower three
centiles of the distribution of residuals have been excluded. Concerning the model
characteristics, the overall fit is well, and we explain between 76\% and 86\% of the variation
in processing trade data. According to the F-tests, an omission of the fixed country pair effects
would render us with biased parameters. Also, a potentially more efficient approach with
exporter and importer country effects is significantly rejected against the chosen one with
country pair effects. Except for model IV, we would obtain biased parameters, if we treated
the country pair effects as random rather than fixed. About twice as many observations are
available for outward processing than for inward processing trade.

Regarding the impact of the covariates, we find that country size has basically only an
insignificant effect on processing trade, whereas cost motives and relative factor endowments
are important in almost all regressions. The insignificant negative impact of similarity in
country size in most of the regressions could be interpreted as weakly indicating the presence
of vertical multinationals (see Carr et al., 2001, or Markusen, 2002). Interestingly, outward
processing trade of the EU12 economies takes mostly place in countries that are labour-
abundant. This is indicated by the positive impact of RLFAC1 in Table 2. Infrastructure
variables in the partner countries are of relevance for outward processing trade, but their
impact is also not negligible for inward processing trade. However, for the judgement about
the relative importance of groups of variables as compared to each other it is insufficient to
look only at the significance of single parameters. Therefore, we undertake a covariance
analysis, where we compute the contribution of each bloc of variables to the estimated sum of
squares of all covariates together.

We find that a country’s relative price position and cost situation (measured by other cost
variables) are most important to explain processing trade, irrespective of whether outward or
inward processing trade is considered. About 49%-58% of bilateral outward processing trade and roughly 60%-61% of inward processing trade are explained by the variables belonging to this group. For outward processing trade, the infrastructure endowment of the partner country is extremely relevant, explaining about 20%-24% of this type of trade. Infrastructure is also important for inward processing trade, accounting for up to 20% of the variation in the data. Inward processing trade in the EU is likely relatively high-skilled labour intensive. Since the EU is relatively well endowed with both high-skilled labour and physical capital, transport costs and set-up costs (associated with infrastructure quality) in the outsourcing destinations seem relatively important for outward processing, but sheer scale economies (and imperfect competition) are less important. Finally and in contrast to inward processing trade, the EU’s outward processing trade to a relatively large extent is determined in line with standard Heckscher-Ohlin arguments. This result complements the finding in Görg (2000) for bilateral outward processing trade flows between the US and the EU that the “empirical analysis of US inward processing trade in EU countries gives support to the prediction [...] that the distribution of fragmented production around the globe will be according to countries’ comparative advantages”.

> Table 3 <
The results for the model that includes both RLFAC1 and RLFAC2 are summarized in Table 3. The use of secondary school enrolment ratios in RLFAC2 leads to a loss in observations. Accordingly, a difference to the results in Table 2 can arise due to both differences in sample coverage and the use of two relative endowment difference variables. However, the majority of the conclusions drawn from Table 2 are robust to this change in the specification. Only the size parameters in the outward and inward processing import equations are now significant, and the associated point estimates of SGDP and SIMI point to a significant importance of vertical multinationals for processing trade.

4. CONCLUSIONS
Since the late 1990s, EU processing trade has developed rather dynamically. Looking at aggregate bilateral processing trade figures of the EU12 economies, we observe for instance that outward processing imports from other EU12 members grew at a geometric average of 6% per annum between 1988 and 1999 whereas those from Central and Eastern Europe rose by more than 17% per annum. This paper addresses the question of which determinants are most important for this development. Thereby, we distinguish between four groups of covariates in our panel econometric study: size, relative factor endowments, other cost factors,
and infrastructure variables. Implicitly, this enables us to address the question of which type of outsourcing model is most eager to cope with the stylized facts (Heckscher-Ohlin based models, economies of scale type approaches, or frameworks which underpin the importance of politico-economic variables such as infrastructure expenditures).

By and large, we find that other cost factors than pure factor costs such as the source to partner country real effective exchange rate ratio or the partner country's level of taxes on profits and earnings are key determinants of EU12 outward and inward processing trade. For outward processing trade, infrastructure variables such as the road and telephone networks or the electricity supply in the partner country are also very important, whereas market size seems to be more or less irrelevant. For the EU countries' inward processing trade, the cost factors seem even more important. We interpret this finding as an indication for the EU's specialization in high-quality and capital-intensive production stages, where small changes in economic size or comparative advantage are less relevant.

APPENDIX: COUNTRY COVERAGE

Superscript o) means that only outward processing data are available, superscript i) indicates that only inward processing data are reported.

Reporter country coverage

Austria, Denmark, Finland, France, Germany, Greece o), Ireland, Italy, Netherlands, Portugal o), Spain o), Sweden o), United Kingdom.

Partner country coverage

Western European: Austria, Cyprus, Denmark i), Finland, France, Germany, Greece o), Iceland, Ireland, Italy, Malta, Netherlands, Norway, Portugal, Spain i), Sweden, Switzerland, United Kingdom. Central and Eastern European: Bulgaria, Croatia, Czech Republic, Georgia o), Hungary, Moldova o), Poland, Romania, Russia, Slovak Republic, Ukraine. African: Algeria o), Congo (Dem. Republic) i), Ghana o), Ivory Coast, Morocco, South Africa, Tunisia. Central and North American: Canada, Costa Rica, Dominican Republic o), USA. South American: Chile, Colombia, Ecuador, Uruguay o), Venezuela. Asian: Bahrain i), China, Iran, Israel, Japan, Malaysia, Pakistan, Philippines, Singapore. Australian and Ozeanian: Australia, New Zealand.

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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
<th>Source of raw data</th>
</tr>
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<tbody>
<tr>
<td>OPX</td>
<td>Log of outward processing exports of EU countries</td>
<td>COMEXT - EUROSTAT</td>
</tr>
<tr>
<td>OPM</td>
<td>Log of outward processing imports of EU countries</td>
<td>COMEXT - EUROSTAT</td>
</tr>
<tr>
<td>IPX</td>
<td>Log of inward processing exports of EU countries</td>
<td>COMEXT - EUROSTAT</td>
</tr>
<tr>
<td>IPM</td>
<td>Log of inward processing imports of EU countries</td>
<td>COMEXT - EUROSTAT</td>
</tr>
<tr>
<td>SGDP</td>
<td>Log of exporter plus importer real GDP</td>
<td>World Development Indicators - World Bank</td>
</tr>
<tr>
<td>SIMI</td>
<td>Log of similarity index in size (Helpman, 1987)</td>
<td>World Development Indicators - World Bank</td>
</tr>
<tr>
<td>RLFAC1</td>
<td>Absolute difference in log of real GDP per capita</td>
<td>World Development Indicators - World Bank</td>
</tr>
<tr>
<td>RLFAC2</td>
<td>Absolute difference in secondary school enrolment ratio</td>
<td>World Development Indicators - World Bank</td>
</tr>
<tr>
<td>RP</td>
<td>Reporter to partner unit value ratio (weighted averages)</td>
<td>COMEXT - EUROSTAT</td>
</tr>
<tr>
<td>REXCH</td>
<td>Reporter to partner real effective exchange rate ratio</td>
<td>World Development Indicators - World Bank</td>
</tr>
<tr>
<td>TAXM</td>
<td>Log of partner tax rates on profits and earnings</td>
<td>World Development Indicators - World Bank</td>
</tr>
<tr>
<td>ROADM</td>
<td>Log of road network of partner in kilometres</td>
<td>World Development Indicators - World Bank</td>
</tr>
<tr>
<td>PHONEM</td>
<td>Log of telephone mainlines per 1000 people in partner</td>
<td>World Development Indicators - World Bank</td>
</tr>
<tr>
<td>ELECTRM</td>
<td>Log of electricity production of partner in kwh</td>
<td>World Development Indicators - World Bank</td>
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Table 2 - The Determinants of EU Outward and Inward Processing Trade

<table>
<thead>
<tr>
<th>Explanatory variables:</th>
<th>Dependent is OPT exports</th>
<th>Dependent is OPT imports</th>
<th>Dependent is IPT exports</th>
<th>Dependent is IPT imports</th>
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<td></td>
<td>β</td>
<td>Std.</td>
<td>β</td>
<td>Std.</td>
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<tr>
<td><strong>Size:</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Sum of exporter and importer GDP (SGDP)</td>
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<td>0.759</td>
<td>1.208</td>
<td>0.781</td>
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<tr>
<td>Similarity in size (SIMI)</td>
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<td>0.742</td>
<td>-1.074</td>
<td>0.751</td>
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<tr>
<td><strong>Endowments:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absolute difference in GDP per capita (RLFAC1)</td>
<td>1.857</td>
<td>0.692 ***</td>
<td>0.976</td>
<td>0.703</td>
</tr>
<tr>
<td>Reporter to partner price ratio (RP)</td>
<td>0.041</td>
<td>0.031</td>
<td>-0.019</td>
<td>0.031</td>
</tr>
<tr>
<td>Reporter to partner real effective exchange rate ratio (REXCH)</td>
<td>0.634</td>
<td>0.289 **</td>
<td>0.740</td>
<td>0.292 **</td>
</tr>
<tr>
<td>Partner tax rates on profits and earnings (TAXM)</td>
<td>-0.518</td>
<td>0.172 ***</td>
<td>-0.550</td>
<td>0.175 ***</td>
</tr>
<tr>
<td><strong>Infrastructure variables:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road network of partner country in kilometres (ROADM)</td>
<td>0.138</td>
<td>0.304</td>
<td>0.094</td>
<td>0.309</td>
</tr>
<tr>
<td>Telephone mainlines per 1000 people in partner country (PHONEM)</td>
<td>0.546</td>
<td>0.216 **</td>
<td>0.184</td>
<td>0.219</td>
</tr>
<tr>
<td>Electricity production in kwh in partner country (ELECTRM)</td>
<td>0.531</td>
<td>0.486</td>
<td>1.119</td>
<td>0.495 **</td>
</tr>
<tr>
<td>Observations</td>
<td>1564</td>
<td></td>
<td>1563</td>
<td></td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.864</td>
<td></td>
<td>0.848</td>
<td></td>
</tr>
<tr>
<td>Country pair effects: F-test</td>
<td>22.675</td>
<td>0.000 ***</td>
<td>20.669</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>Country effects versus country pair effects: F-test</td>
<td>7.110</td>
<td>0.000 ***</td>
<td>12.650</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>Hausman test: $\chi^2$-test</td>
<td>36.760</td>
<td>0.000 ***</td>
<td>30.140</td>
<td>0.000 ***</td>
</tr>
<tr>
<td><strong>Variance contribution in % of covariates:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>4.4</td>
<td>0.237</td>
<td>15.3</td>
<td>0.136</td>
</tr>
<tr>
<td>Endowments</td>
<td>22.5</td>
<td>0.007 ***</td>
<td>6.7</td>
<td>0.165</td>
</tr>
<tr>
<td>Other cost variables</td>
<td>48.7</td>
<td>0.031 **</td>
<td>57.6</td>
<td>0.017 **</td>
</tr>
<tr>
<td>Infrastructure variables</td>
<td>24.4</td>
<td>0.068 *</td>
<td>20.4</td>
<td>0.081 *</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>0.044 **</td>
<td>100.0</td>
<td>0.058 **</td>
</tr>
</tbody>
</table>

a) After outward processing trade. - b) For inward processing trade, drawback system. *** significant at 1%; ** significant at 5%; * significant at 10%.
Table 3 - The Determinants of EU Outward and Inward Processing Trade (GDP per Capita and Secondary School enrolment is Used in RLFAC)

<table>
<thead>
<tr>
<th>Explanatory variables:</th>
<th>Dependent is OPT exports$^a$</th>
<th>Dependent is OPT imports$^a$</th>
<th>Dependent is IPT exports$^b$</th>
<th>Dependent is IPT imports$^b$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model V</td>
<td>Model VI</td>
<td>Model VII</td>
<td>Model VIII</td>
</tr>
<tr>
<td>Size:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum of exporter and importer GDP (SGDP)</td>
<td>0.226 0.881</td>
<td>1.714 0.933 *</td>
<td>-0.093 1.267</td>
<td>2.348 1.254 *</td>
</tr>
<tr>
<td>Similarity in size (SIMI)</td>
<td>-1.103 0.762</td>
<td>-1.718 0.785 **</td>
<td>-0.644 1.341</td>
<td>-0.863 1.313</td>
</tr>
<tr>
<td>Endowments:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absolute difference in log GDP per capita (RLFAC1)</td>
<td>2.061 0.756 ***</td>
<td>1.024 0.781</td>
<td>-1.728 1.110</td>
<td>-0.558 1.093</td>
</tr>
<tr>
<td>Absolute difference in share of secondary school enrolment (RLFAC2)</td>
<td>0.006 0.004</td>
<td>0.004 0.004</td>
<td>-0.003 0.006</td>
<td>0.009 0.006</td>
</tr>
<tr>
<td>Other cost variables:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reporter to partner price ratio (RP)</td>
<td>0.080 0.032 **</td>
<td>-0.010 0.033</td>
<td>0.166 0.042 ***</td>
<td>0.100 0.042 **</td>
</tr>
<tr>
<td>Reporter to partner real effective exchange rate ratio (RECH)</td>
<td>0.671 0.320 **</td>
<td>0.789 0.329 **</td>
<td>1.154 0.640 *</td>
<td>0.375 0.628</td>
</tr>
<tr>
<td>Partner tax rates on profits and earnings (TAXM)</td>
<td>-0.457 0.189 **</td>
<td>-0.380 0.196 *</td>
<td>-0.062 0.296</td>
<td>-0.037 0.291</td>
</tr>
<tr>
<td>Infrastructure variables:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road network of partner country in kilometres (ROADM)</td>
<td>-0.105 0.323</td>
<td>-0.011 0.333</td>
<td>1.122 0.523 **</td>
<td>-0.308 0.514</td>
</tr>
<tr>
<td>Telephone mainlines per 1000 people in partner country (PHONEM)</td>
<td>0.624 0.236 ***</td>
<td>0.231 0.244</td>
<td>0.377 0.408</td>
<td>0.245 0.396</td>
</tr>
<tr>
<td>Electricity production in kwh in partner country (ELECTRM)</td>
<td>1.249 0.527 **</td>
<td>2.060 0.543 ***</td>
<td>2.026 0.914 **</td>
<td>0.574 0.895</td>
</tr>
<tr>
<td>Observations</td>
<td>1316</td>
<td>1320</td>
<td>649</td>
<td>648</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.876</td>
<td>0.857</td>
<td>0.847</td>
<td>0.804</td>
</tr>
<tr>
<td>Country pair effects: F-test</td>
<td>21.974 0.000 ***</td>
<td>19.729 0.000 ***</td>
<td>11.335 0.000 ***</td>
<td>9.773 0.000 ***</td>
</tr>
<tr>
<td>Hausman test: $\chi^2$-test</td>
<td>88.860 0.000 ***</td>
<td>44.500 0.000 ***</td>
<td>34.380 0.000 ***</td>
<td>14.600 0.147</td>
</tr>
</tbody>
</table>

a) After outward processing trade. - b) For inward processing trade, drawback system. *** significant at 1%; ** significant at 5%; * significant at 10%.
Figure 2 - Development of EU Processing Trade in Percent of Total Trade