Institut für Ost- und Südosteuropaforschung
Institute for East and Southeast European Studies

Arbeitsbereich Ökonomie

IOS Working Papers

No. 320 September 2012

Specialization, gravity, and European trade in final goods

Richard Frensch[*], Jan Hanousek[**], and Evžen Kočenda[***]

[*] Corresponding author: Department of Economics, University of Regensburg and Institut für Ost- und Südosteuropaforschung (IOS) Regensburg. Landshuter Straße 4, 93047 Regensburg, Germany.
E-mail: frensch@ios-regensburg.de

[**] CERGE-EI, Charles University and the Academy of Sciences, Politickych veznu 7, 11121 Prague, Czech Republic; Anglo-American University, Prague; The William Davidson Institute, Michigan; and CEPR, London. E-mail: jan.hanousek@cerge-ei.cz

[***] CERGE-EI, Charles University and the Academy of Sciences, Politickych veznu 7, 11121 Prague, Czech Republic; Anglo-American University, Prague; CESifo, Munich; IOS, Regensburg; The William Davidson Institute, Michigan; CEPR, London; and the Euro Area Business Cycle Network.
E-mail: evzen.kocenda@cerge-ei.cz

Institut für Ost- und Südosteuropaforschung
Institute for East and Southeast European Studies
Landshuter Straße 4
D-93047 Regensburg
Telefon: (09 41) 943 54-10
Telefax: (09 41) 943 54-27
E-Mail: info@ios-regensburg.de
Internet: www.ios-regensburg.de

Contents

List of Tables

List of Figures

Abstract

We suggest that bilateral gravity equations augmented by *ad hoc* measures of absolute supply-side country differences are mis-specified. Building on Haveman and Hummels (2004), we develop and test an alternative specification rooted in incomplete specialization that views bilateral gravity equations as statistical relationships constrained on countries' multilateral specialization patterns. According to our results, specialization incentives seem not to play much of a role in the average European bilateral final goods trade relationship. However, this aggregate view conceals that trade in final goods between Western and Eastern Europe is driven by countries' multilateral specialization incentives, as expressed by supply-side country differences relative to the rest of the world, fully compatible with incomplete specialization models. This indicates that many of the final goods traded between Western and Eastern Europe are still different, rather than differentiated, products.

JEL-Classification: F14, F16, L24

Keywords: international trade, gravity models, panel data, European Union

We thank Anastasiya Shamshur and Stephan Huber for their excellent research assistance. Research support from the GAČR grant No. 403/12/0080 is gratefully acknowledged. The usual disclaimer applies.

1 Introduction

While empirical gravity approaches have been used with great success since the early sixties, theoretical foundations have been somewhat slower to come.[1] As a result, bilateral gravity frameworks for analyzing gross trade flows are still often set up as eclectic combinations of determinants to test for influences beyond partner incomes and trade barriers. As our first contribution we show that *ad hoc* augmented gravity equations, specifically those augmented by absolute supply-side country differences or similarities, run into conflict with the supposed theoretical foundations, i.e., they are mis-specified. As a remedy we extend the approach of Haveman and Hummels (2004) to formulate an estimable specification of bilateral gravity on the basis of partner incomes and country-specific supply-side differences relative to the world average. Our second contribution is that we apply our framework to analyze bilateral trade patterns in capital and consumer goods among old and new European Union (EU) members. We show that, different from the average European bilateral final goods trade relationship, trade in final goods between Western and Eastern Europe is driven by countries' multilateral specialization incentives.

Our interest in trade patterns among the old and new EU members is driven by the new opportunities for specialization and trade created by the European integration process. After embarking on the uneasy path of economic transformation, the first four Central and Eastern European (CEE) countries that would become EU members signed in December 1991 the so-called "European Agreements" with the European Union.[2] Subsequently, they strove to establish a workable framework for international trade and co-operation in order to facilitate the transition process and in March 1993 they established the Central European Free Trade Area (CEFTA; Kocenda and Poghosyan, 2009). CEFTA was later enlarged by virtually all of the rest of the CEE countries and helped to remove barriers to trade among its members as well as with the EU. Many CEE countries applied for EU membership in 1995–1996 and from 1998–1999 underwent a

[1] For a recent survey of the relevant literature, see Stack (2009).

[2] The first four countries are the Czech Republic, Hungary, Poland, and Slovakia. See Table A.1 for a complete list of the CEE countries under research.

lengthy and thorough screening process towards EU accession; some CEE countries followed at later dates. The CEE countries finalized their process towards their "seal of approval" (Gray, 2009; p. 932) as full EU members and on May 1, 2004 the first round of CEE countries joined the EU followed by a second round in 2007.

EU integration has impacted international trade between old and new EU members even before actual enlargement. First, association agreements signed in the early 1990s were found to have a positive and significant impact on trade flows between the transformation and EU countries (Caporale et al., 2009; Egger and Larch, 2011). Second, despite existing economic differences among countries, the new EU members quickly became an important part of the EU-wide manufacturing and distribution web (Kaminski and Ng, 2005). In this respect Egger et al. (2008) show that the larger the difference in relative goods and factor prices of two integrating countries before integration, the larger are the potential overall gains from trade. Further, lowering the fixed cost of trade during European integration has prompted trade to increase (Frensch, 2010). These features are relevant to the composition and characteristics of EU members' trade and correlate with the empirical fact that trade in final goods (i.e. consumer and capital goods) has been increasing at a pace of about 6% a year for much of the period under research (Miroudot et al., 2009). Direct benefits resulting from the increased availability and choice of the traded final goods are likely to be complemented by less obvious advantages. Coe and Helpman (1995) theoretically show that trade can function as a channel to diffuse technology, which is also quite important in the case of final goods. Añón Higón and Stoneman (2011) provide empirical evidence for welfare growth in the economy through the benefits from innovations embodied in imported final goods.[3]

[3] Añón Higón and Stoneman (2011) show the effect of innovations via imports of final goods in five old EU countries. This indirect innovation effect is likely to materialize in the new EU countries as well and can be further paired with a direct effect caused by the innovation activities by multinationals (through FDI), who dominate the innovation process in new EU economies, as shown in Uzagalieva et al. (2012).

The set of new and old EU countries is appealing to analyze also from another theoretical perspective. The EU is a functioning free trade area. New EU members were accepted to the free trade area after their accession in 2004 and 2007, but they were already removing trade barriers before and during the accession process (Egger and Larch, 2011). Hence, we analyze a set of countries that impose no barriers on trade among themselves and for this reason the data are not contaminated by differences in tax/tariff regimes or customs rules. Further, despite a gradual catching-up process the new EU members still exhibit lower price levels for both consumer and durable goods (Égert, 2011) that along with lower labor costs may represent types of potential comparative advantages that could prove relevant for specialization and bilateral EU trade patterns during the period under research.

Further, elaborating on the issues raised above, our results are rather striking. First, we demonstrate that a correctly specified gravity approach allowing for European final trade resulting from incomplete specialization must always formulate countries' multilateral specialization incentives, as expressed by supply-side country differences, as relative to the world average. Second, our results show that while correctly specified specialization incentives seem not to play much of a role in the average European bilateral final goods trade relationship, trade in final goods between Western and Eastern Europe is driven by supply-side country differences relative to the rest of the world. This points to the special relevance of incomplete specialization models for East-West trade across Europe—against a predominant significance of complete specialization models for the average European trade relationship. Accordingly, our third result can be read as a corollary: despite the gradual catching-up process of the new EU members, many of the final goods traded between Western and Eastern Europe are still different, rather than differentiated, products.

The rest of the paper is organized as follows. In the next section we elaborate in detail why the *ad hoc* gravity specifications are mis-specified. Section 3 develops our framework to estimate the trade and gravity specification with incomplete specialization and its application. In section 4 we describe our European data on trade in final goods. Our results are presented in section 5. Conclusions follow in section 6.

2 *Ad hoc* augmented gravity equations and complete specialization

When testing for gravity influences beyond partner incomes and trade barriers, it appears tempting to proxy supply-side country differences or similarities by absolute values of differences in per capita incomes or wages between exporter and importer countries, and then formulate prior expectations on the coefficient for per capita income differences according to alternative trade theories. On the one hand, trade driven by comparative advantages would imply a positive coefficient for the per capita income gap. On the other hand, the existence of horizontal intra-industry trade driven by new trade theories *à la* Krugman (1980) could be taken to imply a negative coefficient for the per capita income gap.[4] However, testing the influences of various trade theories against each other within one and the same gravity specification presupposes that these theories can be reduced to the same gravity specification. We argue that gravity equations augmented by *ad hoc* absolute supply-side country differences are mis-specified since they neglect the key issue of specialization. Factor proportions theories of trade are incomplete specialization models while new theories of trade provide for complete specialization.

According to Haveman and Hummels (2004), four assumptions suffice to build the simplest possible bilateral gravity structure for trade between more than two countries. These assumptions are: (i) trade is only in final goods, (ii) trade is frictionless and balanced, (iii) preferences over final goods are identical and homothetic, and (iv) each good is produced in and exported out of only one country independent from the details on the supply side that give rise to this complete specialization. Then it follows that bilateral trade is simply log-linear in both countries' incomes, and there is no scope for "augmenting" the gravity equation by adding the absolute values of differences in per capita incomes. Based on the above it also follows that augmenting this simple gravity

[4] Rault et al. (2009, p. 1551): "Concerning the sign of the difference of GDP per capita, it is positive if the Heckscher-Ohlin (H-O) assumptions are confirmed. On the contrary, according to the new trade theory, the income per capita variable between countries is expected to have a negative impact." In the same spirit, see also Egger (2002) and Kimura et al. (2007).

relationship must be grounded in violating at least one of the assumptions (i)–(iv). In the following, we therefore trace the consequences of violating these assumptions one by one.

2.1 Trade in intermediate goods

Harrigan (1995) suggests that theory predicts links between intermediate goods trade and the importer country's structure of production, expressed in terms of the capital-output ratio. However, the author finds his specified econometric model outperformed by a traditional, non-augmented gravity equation with importer country fixed effects. As shown in Frensch et al. (2012), admitting trade in intermediate goods results in generating multilateral gravity equations for individual goods export flows that are log-linear in income (as in the final goods case, see equation (1) below). With complete specialization, as in the final goods case, it is quite straightforward to decompose these multilateral gravity equations into bilateral gross trade gravity relationships, such that bilateral trade in intermediate goods with complete specialization is log-linear in both countries' incomes. Introducing trade in intermediate goods does not on its own (i.e., under the assumption of full specialization and identical homothetic technology) generate bilateral gravity equations augmented by absolute supply-side country differences.

2.2 Trade frictions

Within a monopolistic competition model, embedded in a factor proportions approach, Bergstrand (1989) succeeds in theoretically motivating the inclusion of exporter-country capital-labor ratios in a gravity equation. In his model, the production within two sectors is either capital- or labor-intensive. Trade costs are modeled as an iceberg-type loss of output, i.e., trade costs are proportional to the costs of production, and are thus also either capital-intensive or labor-intensive for the two goods. Increasing the exporting country's capital-labor ratio then lowers the opportunity cost of exporting capital-intensive products *via* decreasing trade barriers for capital-intensive goods relative to labor-intensive goods. Accordingly, the simple gravity equation can be augmented for exports of capital (labor)-intensive goods to react positively (negatively) to the exporter's capital-labor ratio. Thus, this special treatment of trade barriers implies the possibility of augmenting the simple gravity equation by supply-side country characteristics. It *does not* imply the possibility of augmenting the gravity equation by supply-side country differences between exporters and importers, though.

2.3 Heterogeneous or non-homothetic preferences

Allowing for different and/or non-homothetic preferences should be expected to result at best in motivating demand-side rather than supply-side country differences. Nevertheless, for the sake of completeness, again Bergstrand (1989) allows for non-homothetic preferences that result in the destination country's per capita income entering the gravity equation. By combining non-homothetic preferences on the demand side with modeling trade barriers in the form of iceberg costs, Bergstrand (1989) in fact succeeds in augmenting the gravity equation by both exporter and importer per capita incomes, to generate a Linder-type hypothesis such that countries with similar per capita incomes trade more with each other. However, even this combination of violating assumptions (ii) and (iii) does not suffice to generate bilateral gravity equations augmented by absolute supply-side country differences.

2.4 The extent of specialization

Accordingly, violating assumptions (i), (ii), or (iii) does not generate bilateral gravity equations augmented by absolute supply-side country differences. This means that absolute country characteristic differences can never be motivated as part of the gravity equation under complete specialization. Hence, negative coefficients for per capita income differences in augmented gross trade flow gravity equations cannot signal new trade theory—i.e., complete specialization—influences on the data. Even when complete specialization is embedded into factor proportions theory, as in Helpman and Krugman (1985), analyzing gross trade flows is simply not informative about the specific driving forces connected to new trade theories or economic geography. For that, analyzing net or intra-industry trade is necessary, as strongly suggested in Helpman (1987), one of the rare attempts to structurally test new trade complete specialization theories. As we will clarify in the next section, a gravity specification describing trade flows as log-linear in both country sizes and absolute country income differentials does not describe the data well against incomplete specialization models either, i.e., it is mis-specified.

3 Trade and gravity specification with incomplete specialization and its application to European trade in final goods

As already argued above, European integration created new opportunities for specialization and trade among the old and new EU members. Table A.1 in the appendix contains the list of countries. We know that an EU-incumbent country was on average capital-abundant compared to the labor-abundant average accession country (Egger et al., 2008) around the time of accession. These supply-side country differences in factor-proportions should play a role for specialization. One would expect the old EU members (EU-15) to specialize in capital-intensive final goods. Similarly, the Central and Eastern European new members that joined the EU in 2004 and 2007 (EU-10) would be expected to specialize in labor-intensive final goods, giving way to a Heckscher-Ohlin type pattern of trade. Consequently, it might be promising to analyze final goods trade flows across Europe within an incomplete specialization gravity framework compatible with factor proportions theories of trade. In fact, complete specialization will emerge as a natural special case as the absence of any specialization.[5]

3.1 Bilateral trade relationships within gravity and incomplete specialization

For a world with more than two countries, Haveman and Hummels (2004) derive country j's multilateral exports subject to the first three assumptions (i)–(iii) outlined in the previous section. Based on the homotheticity assumption and using nominal values, they describe consumption as distributed over final goods in each country according to fixed income proportions (λ) as $C_j^k = \lambda_j^k Y_j$ and $\sum_k \lambda_j^k = 1$. In the preceding expression C indicates consumption and Y is income; subscript j denotes countries, superscript k denotes products. This can also be done for the world (w) as a whole, $C_w^k = \lambda_w^k Y_w$. Further, production can be described as being allocated over the different final goods according to

[5] This is in accordance with Jakab et al. (2001) who show that the gravity equation for the CEE countries during accession period was consistent with several assumptions regarding the structure of both product and factor markets.

$X_j^k = \delta_j^k Y_j$ and $\sum_k \delta_j^k = 1$, where X indicates production. Consequently, the set of coefficients δ describes the allocation of the final goods production in each country. The production allocation can be also done for the world as a whole, $X_w^k = \delta_w^k Y_w$. The worldwide exports of good *k* of country *j* (EX_j^k) are simply given by the difference between production and consumption, $EX_j^k = X_j^k - C_j^k = \delta_j^k Y_j \; - C_j^k$. Due to homothetic preferences, each country consumes each good according to its income share in the world. As the worldwide consumption of each good equals its production, C_j^k can be rewritten as $C_j^k = (Y_j/Y_w)\, C_w^k = (Y_j/Y_w)\, X_w^k = (Y_j/Y_w)\, \delta_w^k Y_w. = (Y_j/Y_w)\, \delta_w^k Y_w$.

Summing over all goods and selecting export items with positive exports into the set K_{EXj}, Haveman and Hummels (2004) thus derive country *j*'s multilateral exports, EX_j, as log-linear in income (Y_j) and a *specialization pattern* relative to the world average ($\delta_j^k - \delta_w^k$),

$$EX_j = Y_j \sum_{k \in K_{EX_j}} (\delta_j^k - \delta_w^k). \qquad (1)$$

Analogously for imports,

$$IM_j = Y_j \sum_{k \in K_{IM_j}} (\delta_w^k - \delta_j^k).^6 \qquad (2)$$

With complete specialization, each good is exclusively supplied by one country. This means that good *k* imports of country *i* from the world are in fact the good *k* imports of country *i* from some country *j*. As country *i* uses all goods supplied by country *j*, this decomposition of multilateral trade immediately implies that bilateral trade in final goods subject to complete specialization is log-linear in both countries' incomes, as already described in section 2.

However, with incomplete specialization and costless trade it is not possible to analytically decompose (1) and (2) into bilateral trade relationships. Trade is not costless, however, and to resolve this indeterminacy one may let importers choose partners to minimize trade costs as shown in a number of relevant works (Haveman and Hummels,

[6] In principle, this method can be adapted to motivate trade in intermediate goods resulting from the horizontal or vertical fragmentation of production, see Frensch et al. (2012).

2004; Bergstrand, 1989; Eaton and Kortum, 2002; and Chor, 2010). However, at this stage we do not attempt to analytically solve the bilateral trade indeterminacy. Rather, we account for trade costs in terms of fixed effects empirically in the econometric model below. In this sense, we rather view bilateral trade equations as statistical relationships constrained on countries' multilateral specialization patterns. This reveals countries' multilateral specialization incentives as driving bilateral trade, parallel to and competing with the role of multilateral trade resistance.

In particular, bilateral trade relationships will be distributed in a statistical sense across a sample of countries, as (1) and (2) must be met on the average of all bilateral trading relationships. Further, incentives driving countries' bilateral trade under incomplete specialization must match multilateral specialization patterns in the form of deviations from the world average as described in equations (1) and (2). Specifically, specialization patterns take the form of countries' deviations from capital-labor ratios (proxied by GDP per capita) or, absent factor price equalization, deviations of wages from the world average. Hence, the bilateral trade relationships derived in (1) and (2) can be formulated in the following specification for exports:

$$\log\ EX_{ji,t} = \beta_0 + \beta_1 \log\left(Y_{j,t} \times Y_{i,t}\right) + \beta_2 \log\left(\left|w_{j,t} - w_{w,t}\right| \times \left|w_{i,t} - w_{w,t}\right|\right) + \varepsilon_{ij,t}. \quad (3)$$

Specification (3) is easy to interpret. Assuming a sample of heterogeneous countries, bilateral trade volumes ($EX_{ji,t}$) will increase with the product of trading countries' incomes ($Y_j \times Y_i$) and with the countries' degree of specialization against the world average. Specifically, bilateral trade volumes are expected to increase with the product of countries' respective supply-side differences against the world, $\left|w_j - w_w\right| \times \left|w_i - w_w\right|$. Hence, specification (3) captures the fact that bilateral trade flows will increase with relative, rather than absolute, supply-side country differences as proposed in Haveman and Hummels (2004).

3.2 European trade in final goods

Despite being simple and directly related to the specialization patterns described in (1) and (2), specification (3) is incomplete. The reason is that relative supply-side country differences in (3) predict large trade volumes also for countries that lack complementary specialization. To account for this potential problem, we deviate from Haveman and Hummels (2004) and actually employ two conditions according to which bilateral trade relationships are distributed in a statistical sense across a sample of countries: First, equations (1) and (2) describe countries' multilateral trade, i.e., (1) and (2) must be met on the average of all bilateral trading relationships. Second, for bilateral trade to occur, countries' specialization patterns as described in (1) and (2) must be complementary: there must be at least one good that is both exported by country *j* and imported by country *i*. To let the data reveal specialization patterns, we select relative supply-side country differences for particular bilateral trade relationships. This is done by assigning dummy variables to bilateral trade relationships between countries expected to be characterized by complementary specialization from *a priori* known information, e.g., on the basis of $w_j > w_w$ and $w_i < w_w$.[7]

Our prior expectation on specialization has already been outlined above: we expect the old EU members (EU-15) to specialize in capital-intensive goods, the Central and Eastern European new members that joined the EU in 2004 and 2007 (EU-10) would be expected to specialize in labor-intensive goods. Hence, we could assign a dummy variable to conveniently detect specialization patterns between old (EU-15) and new (EU-10) EU countries, ($DummyEU15/10_{ji,s} \log(|w_{j,t} - w_{w,t}| \times |w_{i,t} - w_{w,t}|)$).

Further, given the progress in the integration process between both groups of countries we expect that the pattern will show a dynamic development that represents technological progress through decreasing trade costs. Technological progress is exogenous

[7] An alternative is to introduce simple absolute supply-side country differences, $|w_j - w_i|$. Doing so in a log-linear fashion within a gravity framework implies substitutability between countries' complementary specialization and their relative supply-side country differences, $|w_j - w_w| \times |w_i - w_w|$. However, this would actually again amount to mis-specifying the gravity model against our two conditions governing the statistical distribution of bilateral trade relationships.

to our model and can be represented by time effects. Our motivation of trade implies complementarity between technological progress and the possibility of using supply-side country differences. Hence, we model this by interacting the combined variable $DummyEU15/10_{ji,s} \log(|w_{j,t} - w_{w,t}| \times |w_{i,t} - w_{w,t}|)$ with time-period effects and for this purpose we divide the sample period (1992–2008) into five sub-periods (s) of (almost) equal length. The division of the time span into several periods reflects the different stages of economic transition in the CEE countries (from the early 1990s until the middle 2000s), preparations for EU accession (1995–2004) with the relevant effects on their bilateral trade and aggregate output (Egger and Larch, 2011), and changes in manufacturing patterns related to FDI (Hanousek et al., 2011).

Thus, within a panel of EU-25 countries, bilateral trade in final goods ($EX_{ji,t}$) can be described by the following specification:

$$\log\ EX_{ji,t} = \beta_0 + \beta_1 \log(Y_{j,t} \times Y_{i,t}) + \beta_2 \log(|w_{j,t} - w_{w,t}| \times |w_{i,t} - w_{w,t}|) +$$

$$+ \sum_{s=1}^{5} \gamma_s Dummy(EU15/10)_{ji,s} \log(|w_{j,t} - w_{w,t}| \times |w_{i,t} - w_{w,t}|) \ + \ c_{ji} + k_t + \varepsilon_{ij,t}. \quad (4)$$

In specification (4) the dummy variable *DummyEU*15/10 equals one for trade relationships between EU-15 and EU-10 countries, and zero otherwise. All trade barriers are subsumed under time-invariant country-pair-specific as well as country-pair-invariant time-specific omitted variables, to be controlled for by appropriate fixed effects (Baldwin and Taglioni, 2006), with the advantage of also controlling for countries' multilateral trade resistance (Anderson and van Wincoop, 2003).

The theoretical background behind our specification rests in incomplete specialization models such as Heckscher-Ohlin and, therefore, incentives for incomplete specialization and trade are supply-side country differences in factor endowments, relative to the world average. In terms of theory, factor price equalization may break down. Further, in terms of empirical work, using GDP per capita might create a problem at the estimation stage due to potential correlation with the dependent variable. Hence, we employ in our benchmark regression data on wages in pairs of exporting (w_j) and importing (w_i) European countries to capture supply-side country differences. In the presence of factor price equalization, relevant factor endowments like capital-labor ratios can also be proxied by average GDP per capita. For robustness purposes GDP per capita is used as an alternative measure of the supply-side country differences.

4 Data

Final goods exports from country j to i, (EX_{ji}), from 1992 to 2008 are from the BACI database drawn from UN COMTRADE (see Gaulier and Zignago, 2010). All our trade data are reported according to the Standard International Trade Classification, Revision 3 (SITC, Rev.3). Data are used at all aggregation levels: 1-digit-level aggregate trade flows and 3,114 entries at the 4- and 5-digit levels to distinguish and count SITC categories for the definition of extensive versus intensive margins of trade flows. The definition of final goods follows the BEC categorization of UN Statistics.[8] Y_j and Y_i are exporter and importer GDP at current prices, respectively, obtained from the *World Development Indicators* (accessed via the DCI database). Our direct measure for forming relative supply-side country differences are wages, measured as annual wage averages in the manufacturing sector of the exporting or importing country (w_j and w_i). The data were obtained from LABORSTA (International Labour Office statistical databases (http://laborsta.ilo.org/). As an alternative measure of the supply-side country differences we employ exporter and importer GDP per capita at current prices obtained from the *World Development Indicators*. To construct relative supply-side country differences, $|w_j - w_w| \times |w_i - w_w|$, world GDP per capita at current prices and world average wage (w_w) are measured as mean GDP per capita in the world and the mean wage in the world, respectively. The world is defined by our full reporting sample of countries described in Appendix Table 1. Following Debaere (2003) we also construct weighted averages of world GDP per capita and wages, in which population sizes (p_i), obtained from the *World Development Indicators*, serve as weights. The weighted averages are used as a robustness check to account for differences in country sizes; more discussion is offered in section 6. Time-specific effects in specification (4) also control for each year's data using a different *numéraire* since GDP and trade values are all current (Baldwin and Taglioni, 2006), where the original US dollar-denominated data are converted to euros.

[8] United Nations Statistics Division, Methods and Classifications: Classification by Broad Economic Categories, defined in terms of SITC, Rev.3 (BEC Rev.3).
Available online at http://unstats.un.org/unsd/class/family/family2.asp?Cl=10

5 Estimation

We use two types of final goods—capital and consumer goods—to estimate specification (4) on unbalanced panel data with a mean length of time dimension of about 10 years.[9] In order to obtain consistent estimates we employ a dynamic panel-data model following Arellano and Bond (1991), Arellano and Bover (1995), Blundell and Bond (1998), and Blundell, Bond, and Windmeijer (2000). The estimator is implemented in STATA 12 as the command *xtdpd* and it uses moment conditions in which lagged levels of the dependent and predetermined variables serve as instruments for the differenced equation.[10]

We begin our estimation by performing a Hausman-type specification test to assess the potential endogeneity of the explanatory variables by comparing a standard fixed effects model with the Arellano-Bond-Bover-Blundell technique. The test confirms the endogeneity of the explanatory variables. Therefore, we proceed with instrumentation.

Technically, we estimate the theoretically motivated specification (4) in a panel setting with fixed effects plus instrumental variables to overcome problems of omitting variable bias and to control for time-invariant endogeneity and selection bias. This is done because some of the right-hand-side variables are correlated with the dependent variable. Specifically, given that specification (4) is rooted in models of incomplete specialization and trade, such as Heckscher-Ohlin, existing wage differences may be subject to factor price equalization tendencies by the very offshoring trade they induce. We follow Arellano and Bond (1991) and apply the simplest possible remedy in choosing the second lags of the explanatory variables as instruments. Further, let us note that GDP by standard identities contains corrections for international trade flows and therefore using a GDP measure, either absolute values or scaled per capita values, would create problems even in a panel setting. The reason is that, by construction, the unob-

---

[9] One drawback to using panel data lies in the potential non-stationarity of trade and income data, likely implying biased estimates with fixed effects models. However, since the mean time length of our panel is about 10 years, the unit root is not a real issue.

[10] As we do not encounter any zero trade flows, there is no need for a two-step procedure, such as in Helpman et al. (2008).

served panel-level effects are correlated with potentially endogenous independent variables that cause standard estimators to be inconsistent. Our estimation approach controls for the potential endogeneity of explanatory variables and performs well even with low-order moving average correlations in error terms or predetermined variables as in Blundell and Bond (1998).

Since bilateral trade volume will increase with the product of trading countries' incomes, we expect that $\beta_1 > 0$. As equations (1) and (2) describe the expected values of bilateral trade relationships, we may even expect β_1 to equal one, provided the extent of specialization is uncorrelated with income. We cannot form an unambiguous *a priori* expectation on β_2 without further information on the sample of countries. If the sample is heterogeneous in terms of complementary specialization, we expect $\beta_2 > 0$. On the other hand, if the sample is sufficiently homogenous, with say all $w_i > w_w$, then there is no reason to assume the majority of country pairs to be complementarily specialized. In this case higher $|w_j - w_w| \times |w_i - w_w|$ will even generate less trade, as both countries together move away from the world average and we may expect $\beta_2 < 0$. Finally, if the dummies *Dummy*EU15/10 select from the data country pairs exhibiting complementary specialization we expect $\gamma_s > 0$. Of course, for the limiting case of complete specialization, we would not find specialization incentives to play any role, in which case $\beta_2 = \gamma_s = 0$.

6 Empirical results

We introduce our benchmark results for capital and consumer trade flows across Europe based on specification (4) in Tables 1 and 2. Each table contains estimates for a specific variable to represent supply-side country differences based on simple world means, for wages in Table 1 and GDP per capita in Table 2. Statistically significant coefficients β_1 demonstrate that larger European countries indeed trade more final goods with each other. However, estimated trade flow elasticities with respect to income are substantially lower than one, suggesting that the extent of specialization is negatively correlated with income, and more so for consumer than for capital goods. Technical progress in terms of declining trade costs, as captured by the sub-period dummies, appears to positively influence both types of final goods trade for EU-15/EU-10 pairs as coefficients γ_s are increasing slowly over time; there is only one exception of a lower coefficient in the final sub-period.

Table 1 Capital goods and consumer goods flows, w=wages (simple world averages)

		Capital goods	Consumer goods
log Y_j Y_i		0.704^{***} (0.023)	0.537^{***} (0.024)
log ($\lvert w_j - w_w\rvert \times \lvert w_i - w_w\rvert$)		-0.057^{***} (0.019)	0.063^{***} (0.022)
log ($\lvert w_j - w_w\rvert \times \lvert w_i - w_w\rvert$) for EU-15 / EU-10 pairs	1992–1995	0.122^{***} (0.033)	0.210^{***} (0.038)
	1996–1998	0.139^{***} (0.033)	0.210^{***} (0.038)
	1999–2001	0.178^{***} (0.033)	0.209^{***} (0.037)
	2002–2004	0.200^{***} (0.031)	0.231^{***} (0.035)
	2005–2008	0.192^{***} (0.031)	0.246^{***} (0.034)
N		27,681	26,969

The specialization effect on final goods trade flows of relative supply-side country differences is captured by coefficients γ_s. When relative supply-side country differences are measured by wages (Table 1), β_2 is negative and very small for capital goods trade flows and positive but very small for consumer goods. When relative supply-side country differences are measured by GDP per capita (Table 2), β_2 is insignificant for both types of final goods trade. This finding confirms that specialization incentives compatible with theories of incomplete specialization and trade do not play much of a role for final goods trade in our sample of European countries. Rather, the average European bilateral trade relationship in final goods appears to be represented by a simple gravity specification, "as if" driven by factors compatible with complete specialization theories (such as economies of scale and product differentiation).

Table 2 Capital and consumer goods flows, w=GDP per capita (simple world averages)

		Capital goods	Consumer goods
log Y_j Y_i		0.706^{***} (0.019)	0.582^{***} (0.020)
log ($\lvert w_j - w_w\rvert \times \lvert w_i - w_w\rvert$)		–0.014 (0.027)	0.042 (0.028)
	1992–1995	0.119^{***} (0.022)	0.136^{***} (0.024)
	1996–1998	0.130^{***} (0.022)	0.139^{***} (0.024)
log ($\lvert w_j - w_w\rvert \times \lvert w_i - w_w\rvert$) for EU-15 / EU-10 pairs	1999–2001	0.144^{***} (0.022)	0.139^{***} (0.024)
	2002–2004	0.152^{***} (0.022)	0.150^{***} (0.023)
	2005–2008	0.141^{***} (0.021)	0.155^{***} (0.023)
N		33,451	32,390

This average pattern, however, conceals a significant role for specialization incentives across Europe, as becomes evident when we compare the coefficient β_2 with always significantly positive and much larger coefficients γ_s. The sum of the coefficient pairs β_2 and γ_s ($\beta_2 + \gamma_1$ for the first period 1992–1995, $\beta_2 + \gamma_2$ for the second period 1996–1998, etc.) shows that relative supply-side country differences drive capital goods trade between the original EU-15 and the ten accession countries (EU-10), rather than within each of the two country groups or across the average of all bilateral European trade relationships. Specifically, when measuring relative supply-side country differences by wages (Table 1), capital goods trade flows between Eastern and Western Europe react with an elasticity growing from about 6% to some 14%. Consumer goods trade flows (Table 2) react about twice as elastically. Measuring relative supply-side country differences by per capita GDP (Table 2) lowers both elasticities to a range between 12% and 15% when not accounting for the insignificant coefficient β_2. Consequently, bilateral capital goods trade flows between old and new EU members appear to be driven by incomplete specialization motives, and this is even more evidenced for consumer goods trade.

Finally, we perform several robustness checks to verify the validity of our results. As discussed in Debaere (2003), measuring world averages in relative supply-side country differences matters a lot. Therefore, in Tables 3 and 4 we employ the world wage and per capita GDP averages weighted by countries' populations, as comparable work force data are unavailable on the scale of our full sample. The results in Tables 3 and 4 are not materially different from those reported in Tables 1 and 2. Hence, our results are quite robust to this change in measurement.

We also complement our robustness results by a statistical comparison of the coefficients derived from the estimated specification (4) where wages serve as a measure for supply-side country differences, i.e., we compare the coefficients presented in Table 1 (simple averages) and Table 3 (weighted averages). In Figure 1 we present the plots of the confidence intervals of the above coefficients. Dark and blank bars depict simple and weighted means, respectively. The shapes of the blank bars reflect the lower dispersion due to weighting. The two graphs in Figure 1 show that there is an ample overlap of the confidence intervals of coefficients. Hence, our results are in a statistical sense robust to our world average measurement in terms of simple or weighted averages.

Table 3 Capital and consumer goods flows, w=wages (population-weighted world averages)

		Capital goods	Consumer goods
log Y_j Y_i		0.701*** (0.008)	0.533*** (0.006)
log ($\|w_j - w_w\| \times \|w_i - w_w\|$)		–0.028** (0.014)	0.054*** (0.011)
log ($\|w_j - w_w\| \times \|w_i - w_w\|$) for EU-15 / EU-10 pairs	1992–1995	0.133*** (0.010)	0.203*** (0.008)
	1996–1998	0.149*** (0.009)	0.201*** (0.008)
	1999–2001	0.190*** (0.009)	0.202*** (0.007)
	2002–2004	0.207*** (0.009)	0.228*** (0.007)
	2005–2008	0.196*** (0.010)	0.245*** (0.008)
N		27,681	26,969

Table 4 Capital and consumer goods flows, w=GDP per capita (population-weighted world averages)

		Capital goods	Consumer goods
log Y_j Y_i		0.702*** (0.007)	0.595*** (0.005)
log ($\|w_j - w_w\| \times \|w_i - w_w\|$)		–0.002 (0.012)	0.020** (0.010)
log ($\|w_j - w_w\| \times \|w_i - w_w\|$) for EU-15 / EU-10 pairs	1992–1995	0.121*** (0.007)	0.139*** (0.005)
	1996–1998	0.132*** (0.006)	0.142*** (0.005)
	1999–2001	0.145*** (0.006)	0.140*** (0.005)
	2002–2004	0.153*** (0.006)	0.152*** (0.005)
	2005–2008	0.144*** (0.006)	0.160*** (0.005)
N		33,451	32,390

In the above account we have shown that European trade in final goods on average appears as if driven by forces compatible with complete specialization models. The driving factors of complete specialization models are economies of scale and product differentiation. Hence, we may conclude that for the average European trade relationship, traded final goods are differentiated products, as is expected for trade relationships between similar countries. However, given the special relevance of incomplete specialization models for East-West trade across Europe, many of the final goods traded between Western and Eastern Europe are different products rather than differentiated products.

Further, we can extend our results by decomposing trade in final goods along its two margins, based on the highly disaggregated nature of our original trade data. The *extensive* margin denotes the number of exported goods, while the *intensive* margin refers to average volumes per exported good. We report results for trade in capital goods in the Appendix Table A.2. First, coefficients associated with market size (β_1) are about 60% larger for the intensive margin than for the extensive margin. This reveals that trade in capital goods across Europe is predominantly realized along the intensive margin with respect to the size of the economy. Second, when we inspect the sum of coefficient pairs β_2 and γ_s, these are consistently larger along the extensive rather than the intensive margin. Accordingly, more capital goods trade for EU-15/EU-10 country pairs in response to relative supply-side country differences in wages is mostly realized along the extensive margin. The difference in the effects on the two margins of trade becomes consistently larger for our first four sub-periods until 2004, but decreases during 2005–7. We identify the same pattern for consumer goods as well.[11]

The relevant empirical literature, quoted in section 1, emphasizes that European integration results in more trade between new and old EU members. We accentuate these findings. Our trade flow results indicate that final goods traded between Western and Eastern Europe are different, not differentiated, products. Our margin results corroborate that more trade between new and old Europe in response to supply-side country differences is realized in an increased number of different products rather than more trade in established products.

[11] We perform the analysis also in terms of GDP per capita as relative supply-side country differences. The results are qualitatively the same. We do not report detailed results due to space, but they are readily available upon request.

7 Conclusions

Gravity equations employed to analyze gross trade flows are frequently augmented by *ad hoc* measures of supply-side country differences. We first argue that gravity formulations of this sort are mis-specified, due to theoretically unmotivated attempts to allow for both complete and incomplete specialization influences on trade within the same gravity framework. Building on Haveman and Hummels (2004), we then suggest an alternative specification rooted in incomplete specialization; complete specialization emerges as a natural special case in terms of the absence of speciliazation. This view reveals countries' multilateral specialization incentives as driving bilateral trade, corresponding to and competing with the role of multilateral trade resistance. We then apply our framework to analyze European trade in final goods.

Our results show that trade in final goods between Western and Eastern Europe is driven by countries' multilateral specialization incentives that are expressed by supply-side country differences relative to the rest of the world. In addition, more trade between new and old Europe in response to supply-side country differences is realized in an increased number of different products rather than more trade in established products. At the same time, for the majority of European bilateral trade relationships, insignificant or comparatively very small specialization coefficients indicate that specialization incentives do not play much of a role in final goods trade. Hence, European trade in final goods in our data on average appears as if driven by forces compatible with complete specialization models. As the driving factors of complete specialization models are economies of scale and product differentiation, we may conclude in a corollary that for the average European trade relationship, traded final goods are differentiated products, as expected in trade relationships between similar countries. However, given the special relevance of incomplete specialization models for East-West trade across Europe, many of the final goods traded between Western and Eastern Europe are still different, rather than differentiated, products, despite the gradual catching-up process of the new EU members.

References

Anderson, James E., and Eric van Wincoop, Gravity with gravitas: a solution to the border puzzle. *American Economic Review 93*, 1, 2003, pp. 170–192.

Añón Higón, Dolores, Paul Stoneman, Trade in final goods and the impact of innovation. *Economics Letters*, 110, 2011, pp. 197–199.

Arellano, Manuel, and Stephen R. Bond, Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies 58*, 2, 1991, pp. 277–297.

Arellano, M., and O. Bover. Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics 68*, 1995: 29–51.

Baldwin, Richard E., and Daria Taglioni, Gravity for dummies and dummies for gravity equations. NBER working paper 12516, Cambridge, Mass., 2006.

Bergstrand, Jeffrey H., The generalised gravity equation, monopolistic competition, and the factor-proportions theory in international trade. *Review of Economics and Statistics 71*, 1, 1989, pp. 143–153.

Blundell, Richard, and Stephen R. Bond, Initial condition and moment restrictions in dynamic panel data models. *Journal of Econometrics 87*, 1, 1998, pp. 115–143.

Blundell, R., S. Bond, and F. Windmeijer. Estimation in dynamic panel data models: Improving on the performance of the standard GMM estimator. In *Nonstationary Panels, Cointegrating Panels and Dynamic Panels*, ed. B. H. Baltagi, 53–92. New York: Elsevier, 2000.

Caporale, Guglielmo Maria, Christophe Rault, Robert Sova, and Anamaria Sova, On the bilateral trade effects of free trade agreements between the EU-15 and the CEEC-4 countries. *Review of World Economics*, *145*(2), 2009, pp. 189–206

Chor, Davin, Unpacking sources of comparative advantage: a quantitative approach. *Journal of International Economics 82*, 2010, pp. 152–167.

Coe, D.T., Helpman, E., International R&D spillovers. *European Economic Review 39*, 5, 1995, pp. 859–887.

Debaere, Peter, Relative factor abundance and trade. *Journal of Political Economy 111*, 3, 2003, pp. 589–610.

Eaton, Jonathan, and Samuel Kortum, Technology, geography, and trade. *Econometrica 70*, 5, 2002, pp. 1741–1779.

Egger, Peter, An econometric view on the estimation of gravity models and the calculation of trade potentials. *The World Economy 25*, 2, 2002, pp. 297–312.

Egger, Peter and Larch, Mario, An assessment of the Europe agreements' effects on bilateral trade, GDP, and welfare. *European Economic Review* 55, 2, 2011, pp. 263–279. February.

Egger, Peter, Mario Larch, Michael Pfaffermayr, and Janette Walde, The EU's attitude towards Eastern Enlargement in space. *Journal of Comparative Economics 36*(1), 2008, pp. 142–156.

Égert, Balázs, Catching-up and inflation in Europe: Balassa–Samuelson, Engel's Law and other culprits. *Economic Systems*, *35*(2), 2011, pp. 208–229.

Frensch, Richard, Trade Liberalisation and Import Margins. *Emerging Markets Finance & Trade 46*, 3, May–June 2010, pp. 4–22.

Frensch, Richard, Jan Hanousek, and Evzen Kocenda, Incomplete Specialization and Offshoring across Europe, CESifo working paper 3809, May 2012.

Gaulier and Zignago,. BACI: International Trade Database at the Product-level. The 1994–2007 version. CEPII working paper 2010-23, 2010.

Gray, Julia, International Organization as a Seal of Approval: European Union Accession and Investor Risk. *American Journal of Political Science 53*(4), 2009, pp. 931–949.

Harrigan, James, The volume of trade in differentiated intermediate goods: theory and evidence. *Review of Economics and Statistics 77*, 1, 1995, pp. 283–293.

Hanousek, Jan, Kočenda, Evzen, Maurel, Mathilde, Direct and indirect effects of FDI in emerging European markets: Survey and Meta-analysis. *Economic Systems 35*(3), 2011, pp. 301-322.

Haveman, Jon, and David Hummels, Alternative hypotheses and the volume of trade: the gravity equation and the extent of specialization. *Canadian Journal of Economics 37*, 1, 2004, pp. 199–218.

Helpman, Elhanan, Imperfect competition and international trade: evidence from fourteen industrial countries. *Journal of the Japanese and International Economies 1*, 1, 1987, pp. 62–81.

Helpman, Elhanan and Paul R. Krugman, *Market Structure and Foreign Trade*. MIT Press, Cambridge, Mass., 1985.

Helpman, Elhanan, Marc Melitz, and Yona Rubinstein, Estimating trade flows: trading partners and trading volumes. *Quarterly Journal of Economics 123*, 2, 2008, pp. 441–487.

Jakab, Zoltán M., Kovács, Mihály A., and Oszlay, András, How Far Has Trade Integration Advanced?: An Analysis of the Actual and Potential Trade of Three Central and Eastern European Countries. *Journal of Comparative Economics 29*(2), 2001, pp. 276–292.

Kaminski, B. and Ng, F., Production disintegration and integration of Central Europe into global markets. *International Review of Economics and Finance 14*(3), 2005, pp. 377–390.

Kimura, Fukunari, Yuya Takahashi, and Kazunobu Hayakawa, Fragmentation and Parts and Components Trade: Comparison between East Asia and Europe. *North American Journal of Economics and Finance 18*, 2007, S. 23–40.

Kočenda, Evzen, Poghosyan, Tigran, Macroeconomic Sources of Foreign Exchange Risk in New EU Members. *Journal of Banking and Finance 33*(11), 2009, pp. 2164–2173.

Krugman, Paul R., Scale economies, product differentiation, and the pattern of trade. *American Economic Review 70*, 5, 1980, pp. 950–59.

Miroudot, Sébastien, Rainer Lanz and Alexandros Ragoussis, Trade in intermediate goods and services. OECD Trade Policy Working Paper No. 93, 2009.

Rault, Christophe, Robert Sova, and Ana Maria Sova, Modelling international trade flows between CEEC and OECD countries. *Applied Economics Letters 16*, 2009, pp. 1547–1554.

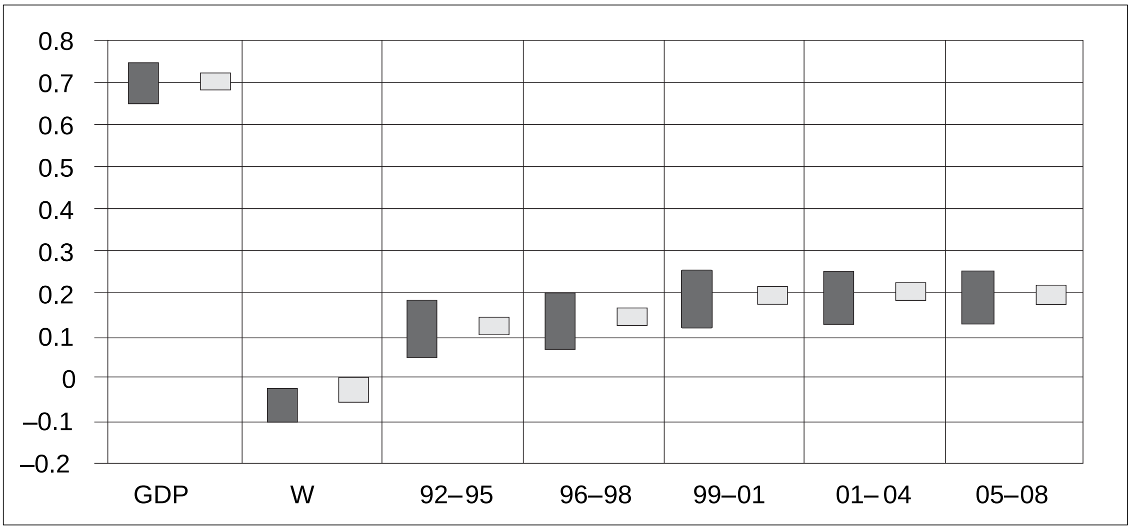
Stack, Marie M., Regional integration and trade: controlling for various degrees of heterogeneity in the gravity model. *The World Economy 32*, 5, May 2009, pp. 772–789.

Uzagalieva, A., Kočenda, E., and Menezes, A., 2012. Technological Innovation in New European Union Markets. Forthcoming in *Emerging Markets Finance and Trade*.

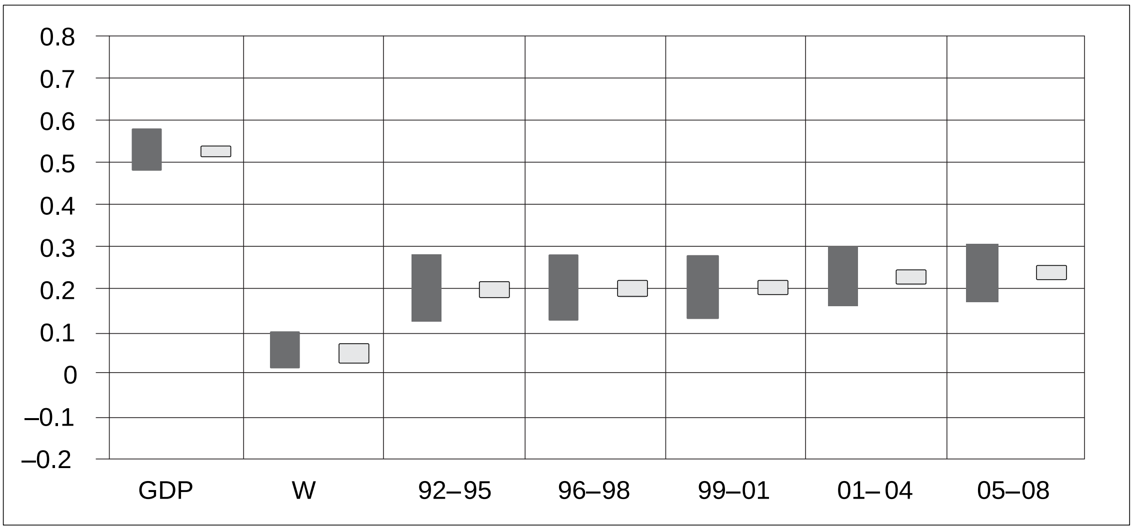
Appendix

Figure 1 Comparison of confidence intervals for coefficients in specification (4)

A. Capital Goods



B. Consumer Goods



Note: Confidence intervals are labeled in the following way: *GDP* denotes the coefficient of the log $Y_j\, Y_i$ and *W* denotes coefficient of the log $(|w_j - w_w| \times |w_i - w_w|)$ where w stands for wages. Remaining confidence intervals refer to coefficients of the log $(|w_j - w_w| \times |w_i - w_w|)$ for the EU-15/10 dummy, computed over specified time periods, i.e. 1992–1995 to 2005–2008.

Table A.1 Import-reporting countries and trade data availability

1	Austria (1992–2008)	9	France (1992–2008)	17	*Latvia* (1995–2008)
2	Belgium and Luxembourg (1992–2008)	10	United Kingdom (1992–2008)	18	Netherlands (1992–2007)
3	*Bulgaria* (1996–2008)	11	Germany (1992–2008)	19	*Poland* (1992–2008)
4	*Czech Republic* (1993–2008)	12	Greece (1992–2008)	20	Portugal (1992–2008)
5	Denmark (1992–2008)	13	*Hungary* (1992–2008)	21	*Romania* (1992–2008)
6	Spain (1992–2008)	14	Ireland (1992–2008)	22	*Slovakia* (1993–2008)
7	*Estonia* (1995–2008)	15	Italy (1992–2008)	23	*Slovenia* (1995–2008)
8	Finland (1992–2008)	16	*Lithuania* (1995–2008)	24	Sweden (1992–2008)

Notes: Belgium and Luxembourg are treated as one country. EU-15 countries are underlined, EU-10 are in *italics*. Each reporting country's import data are given for all reporter countries for the indicated time period. Reporter countries plus Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Belarus, Canada, Switzerland, Cyprus, Georgia, Iceland, Kazakhstan, Kyrgyzstan, Moldova, Macedonia, Malta, Norway, Russia, Tajikistan, Turkmenistan, Turkey, Ukraine, Uzbekistan, the U.S., China, Hong Kong, Japan, South Korea, Taiwan, and Thailand (54 countries in all, on average accounting for above 90 per cent of reported imports) constitute the "world" for the computation of our world averages.

Table A.2 Capital goods margins (simple and population-weighted world averages)

w=Wages	Period	Capital goods			
		Simple average		Weighted average	
		Extensive Margin	Intensive Margin	Extensive Margin	Intensive Margin
log Y_j Y_i		0.272*** (0.013)	0.433*** (0.013)	0.262*** (0.003)	0.438*** (0.007)
log ($\|w_j - w_w\| \times \|w_i - w_w\|$)		–0.039*** (0.011)	–0.018 (0.012)	0.001 (0.005)	–0.030** (0.012)
log ($\|w_j - w_w\| \times \|w_i - w_w\|$) for EU-15 / EU-10 pairs	1992–1995	0.086*** (0.021)	0.036** (0.018)	0.093*** (0.004)	0.040*** (0.009)
	1996–1998	0.099*** (0.020)	0.040** (0.018)	0.105*** (0.004)	0.045*** (0.008)
	1999–2001	0.125*** (0.020)	0.053*** (0.017)	0.132*** (0.003)	0.058*** (0.008)
	2002–2004	0.139*** (0.019)	0.061*** (0.017)	0.142*** (0.003)	0.066*** (0.008)
	2005–2007	0.116*** (0.019)	0.076*** (0.017)	0.115*** (0.004)	0.081*** (0.008)
N		27681	27681	27681	27681