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Abstract

By combining and extending the previous literature, we develop and test a gravity specification that views bilateral gravity equations rooted in a Heckscher-Ohlin framework as statistical relationships constrained on countries' multilateral specialization patterns. According to our results, Heckscher-Ohlin specialization incentives do not seem 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 the incomplete specialization version of Heckscher-Ohlin. 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

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1. Introduction

While empirical gravity approaches have been used with great success since the early 1960s, the theoretical foundation for this method has been somewhat slower to arrive. Recent developments in this respect have driven bilateral gravity specifications towards "structural gravity" for explicitly assessing trade cost incidence and various trade costs along with their respective impacts on trade and its margins (for overviews, see Anderson, 2011, and Costinot and Rodríguez-Clare, 2013). To achieve this, however, structural gravity can only represent a subset of theoretical models of specialization and trade that share the property of complete specialization in equilibrium (Arkolakis et al., 2012). That selection thus excludes a very prominent class of models based on factor proportions theories of trade that need not—and in the dominant textbook representation does not—induce complete specialization of production and trade.

Incomplete-specialization versions of factor proportions theories of trade figure more prominently in a second strand of the gravity literature that tries to identify different sources of trade, connected to various theories of trade (see, e.g., Deardorff, 1998; Feenstra et al., 2001; Egger, 2002; Evenett and Keller, 2002; Haveman and Hummels, 2004; Kimura et al., 2007; and Rault et al., 2009). Clearly, this objective requires a gravity formulation more general than structural gravity, referred to by Anderson (2011) as "traditional gravity." But exactly because traditional gravity is compatible with many theories of trade, it involves a serious "model identification problem" (Evenett and Keller, 2002, p. 782). Our paper is close to this second strand of the gravity literature. However, being aware of model identification problems and often unsatisfactory attempts at their solution in previous contributions to the literature, our objective differs from the previous literature. Rather than attempting to test various theories of trade against each other using gravity, in the sense of whether or not they explain all trade better than other theories, we take the result of Evenett and Keller (2002) as our starting point, that different theories of trade explain different parts of trade. We concentrate on one important part of trade: trade in different homogeneous products resulting from the incomplete-specialization version of the Heckscher-Ohlin model.[1] In that we attempt to answer whether differences in factor proportions between pairs of countries are a more relevant source of trade for some parts of Europe rather than for others.

[1] Incidentally, this is the one source of trade that Evenett and Keller (2002) find more support for than for trade theories that involve complete specialization as arising from product differentiation or from large differences in factor endowments.

Our interest in trade patterns among old and new EU members is driven by new opportunities for specialization and trade created by the European integration process. EU integration has impacted international trade between old and new EU members even before actual enlargement. The association agreements signed in the early 1990s were found to have a positive and significant impact on trade flows between transformation and EU countries (Caporale et al., 2009; Egger and Larch, 2011). 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 the potential overall gains from trade.

European integration created new opportunities for specialization and trade among old and new EU members. 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 in specialization. One would thus expect old EU members (the EU-15) to specialize in capital-intensive final goods. Similarly, the Central and Eastern European members that joined the EU in 2004 and 2007 (the EU-10) would be expected to specialize in labor-intensive final goods. 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.

To identify this part of trade, building mainly on Deardorff (1998), Evenett and Keller (2002), and Haveman and Hummels (2004), we motivate a gravity specification that views bilateral gravity equations rooted in a Heckscher-Ohlin framework as statistical relationships constrained on countries' multilateral specialization patterns. Our bilateral gravity specification includes a time-varying country pair variable to denote the product of two countries' multilateral specialization incentives, as expressed by their respective factor-proportion differences relative to the rest of the world. As this influence is uniquely rooted in the incomplete-specialization version of the Heckscher-Ohlin model, it enables us to identify trade in different homogenous goods against all other trade, including trade in variants of differentiated goods. Based on this specification, we can show that a class of *ad hoc* gravity equations augmented by absolute supply-side country differences or similarities appears mis-specified. We then use our specification to answer whether differences in factor proportions between pairs of countries are a more relevant source of trade for some parts of Europe rather than for others, controlling for other potential sources of trade. We show that, different from the average European final goods trade relationship, trade in final goods between Western and Eastern Europe is indeed driven by the product of two countries' multilateral specialization incentives.[2] Accordingly, our third result can be read as a corollary: despite the gradual catching-up process of new EU members, many of the final goods traded between Western and Eastern Europe are still different, rather than differentiated, products.

In this respect, we are also close to a third, longstanding strand of literature outside gravity that combines sector-specific information on factor intensities with country-specific information on factor proportions, to test net trade or market-share predictions based on factor proportions theories of trade. Recent contributions to this field (Romalis, 2004, Bernard et al., 2007, and Chor, 2010) have embedded firm-based models of trade into Heckscher-Ohlin frameworks. In fact, our contribution might be seen as a gravity complement to these papers, constituting the arguably simplest way of testing for the presence of factor-proportion-driven specialization incentives in bilateral gross trade flows, because systematic deviation of factor proportions from world averages influences gross trade flows.

The rest of the paper is organized as follows. In the next section we discuss structural versus traditional gravity, highlighting the roles of trade costs and degrees of specialization on gravity specifications. In section 3, we first motivate our gravity specification with incomplete specialization. We then develop our empirical model by controlling for potentially omitted variables from outside our hypothesized approach, i.e., full trade costs and other influences on production and demand sides. Finally, we relate our gravity specification to the literature, also elaborating why we see some *ad hoc* gravity specifications as mis-specified. In section 4 we describe our data on European trade in final goods. Our estimation results are presented in section 5. Conclusions follow in section 6.

2. Trade incentives and trade costs shaping gravity

We follow Deardorff (1998), Evenett and Keller (2002), and Haveman and Hummels (2004) by making two dichotomies our point of departure for deriving bilateral gravity equations: complete *versus* incomplete specialization, and trade incentives *versus* trade costs.

2.1. Trade incentives without trade costs

According to Deardorff (1998), four assumptions suffice to build the simplest bilateral gravity structure for trade within a world of more than two countries: (i) trade is only in final

[2] In this paper, the old EU (EU-15) countries are sometimes referred to as “Western Europe”. The new EU members that joined the EU in 2004 and later (EU-10) are often referred to as “Eastern Europe”. The detailed grouping is given in Appendix Table A.1.

goods, (ii) trade is balanced for each country, (iii) each good is consumed in each country according to preferences over final goods that are identical worldwide and homothetic, and (iv) all trade is frictionless. This illustrates the model identification problem mentioned in the introduction, as on the basis of these assumptions we are unable to differentiate between sources of trade, as reflected in different theories of trade, with bilateral gravity equations. As our approach in section 3 builds on Deardorff (1998), it is worth explaining his argument. For this, use nominal values to describe country *j*'s income, Y_j, and consumption and production of good k, C_j^k and X_j^k, respectively. Due to assumption (iii), $C_j^k = \lambda^k Y_j$, i.e., the consumption of good *k* in country *j* is a fixed proportion, λ^k , of income, with $\sum_k \lambda^k = 1$. As this also holds for the world as a whole, $C_{world}^k = \lambda^k Y_{world}$, each country's consumption share of good *k* corresponds to its income share in the world, s_j, and as worldwide consumption of each good equals worldwide production, each country consumes each good according to its income share, s_j, $C_j^k = (Y_j/Y_{world})\, X_{world}^k = s_j X_{world}^k$. Total production in country *j*, X_j, is described as allocated over final goods according to $X_j^k = \delta_j^k X_j$, $\sum_k \delta_j^k = 1$. Country-specific allocation parameters δ_j^k, vary according to details on the production side, to be discussed further below. Because we abstract from intermediate production in assumption (i), $X_j = Y_j$. Again, this allocation can be formulated for the world as a whole, $X_{world}^k = \delta_{world}^k Y_{world}$. The net imports of good *k* into country *j* from the world are

$$NI_{jworld}^k = C_j^k - X_j^k = s_j X_{world}^k - \delta_j^k Y_j \quad . \tag{1}$$

Consider theories of trade that yield complete specialization in equilibrium, such as Ricardo or monopolistic competition cum economies of scale based on new theories of trade (Krugman, 1980): with each good produced in only one country, a country cannot both export and import a good, i.e. net imports equal gross imports, I_{jworld}^k. Also, $X_{world}^k = X_i^k$, for some specific country *i*, such that all gross exports of good *k* into country *j* from the world are in fact from country *i*,

$$NI_{jworld}^k = I_{ji}^k = s_j X_i^k = s_j \delta_i^k Y_i \quad .$$

Summing over all goods, country *j* gross imports from country *i* equal the gross exports of *i* to *j*,

$$I_{ji} = E_{ij} = \sum_k s_j \delta_i^k Y_i = s_j \delta_i^k Y_i = \frac{Y_j \; Y_i}{Y_{world}}. \tag{2}$$

In (2) bilateral gross trade flows between i and j for complete specialization patterns are log-linear solely in both countries' incomes and world size.

It takes an additional statistical argument to get from (1) to (2) when equilibrium specialization is incomplete. When, as in a Heckscher-Ohlin framework with factor price equalization, homogenous goods are equally priced across countries, it is not possible to analytically decompose a country's worldwide trade into bilateral trade relationships: consumers are indifferent to sourcing from any country, including their own, as long as trade is costless by assumption (iv). Resolving this indifference by using Deardorff's (1998) random rationing argument, the probability of country j purchasing a unit of k produced in any country i equals country i's share in world output (including country j's output) of good k, such that

$$I_{ji}^{k} = s_j X_{world}^{k} \frac{X_i^k}{X_{world}^{k}} = s_j \delta_i^k Y_i \quad .$$

Again summing over all goods reproduces equation (2). Although there are possibilities of testing different trade theories on the basis of net trade and trade share information, given assumptions (i)–(iv), equilibrium patterns of specialization find no reflection in bilateral gross trade flows. So gravity is no help in identifying which theory of trade drives the observed bilateral trade.

2.2. Trade costs

Equation (2) is not robust to assumption (iv). Haveman and Hummels (2004) show that in the presence of infinitesimally small trade costs patterns of specialization matter for bilateral gross trade flows. I.e., the two driving forces of gravity, trade incentives and trade costs, do not act independently of each other. However, adding trade costs poses different problems for deriving bilateral gravity, depending on whether we address complete or incomplete specialization in equilibrium. How can there be incomplete specialization in a Heckscher-Ohlin framework in the presence of trade costs? Would not infinitesimal trade costs select only one supplier of each homogenous good when technologies are the same and when factor endowments are similar enough to guarantee factor price equalization? We will go into these questions in section 3 of this paper, but clearly this complication does not arise when complete equilibrium specialization is guaranteed. Consequently, Arkolakis et al. (2012) note that a class of models with CES preferences, one factor of production, linear cost functions, complete specialization, and iceberg trade costs generates isomorphic "structural gravity equations". The right-hand side of equation (2) gets multiplied by a ratio of direct trade costs between countries *i* and *j* relative to the product of the two indices of all bilateral trade costs in the system (see, e.g., equation (5) in Anderson, 2011). These indices represent (inward and outward) multilateral resistance, i.e. the intuitively appealing notion that bilateral trade barriers should always be measured relative to the world: the higher the trade barriers of a country with the world for fixed trade barriers with a specific country, the more the country will be driven to trade with this specific country.

In terms of our four assumptions, to derive structural gravity, trade only in final goods remains balanced in this class of models. Assumption (iii) is narrowed down, but most importantly assumption (iv) is substituted with assuming the presence of complete specialization in equilibrium coupled to one factor of production models.[3] Complete specialization is so important for analytically deriving gravity because it identifies places of production as sources of consumption, establishing bilateral trade relationships by definition. Bilateral gravity then becomes an accounting relationship on the production and demand sides. In consequence, however, the set of trade theories represented by structural gravity still does not cover the dominant textbook version of the incomplete specialization of factor proportions theories of trade and is thus too narrow for our purposes of identifying incomplete from complete-specialization theories of trade.

2.3. Traditional gravity

Beyond structural gravity, there is no unique definition of "the gravity equation" in the literature. We follow Arkolakis et al. (2012, p. 117) in adopting a broad definition: "a trade model satisfies a gravity equation if it predicts that in any cross section, bilateral imports can be decomposed into

$$\ln X_{ij} = A_i + B_j + \gamma \ln \tau_{ij} + \nu_{ij}\,, \tag{3}$$

where A_i is an exporter-specific term; B_j is an importer-specific term; γ is the partial elasticity of bilateral imports with respect to variable trade costs; and ν_{ij} captures country-pair–specific parameters that are distinct from variable trade costs (if any)." According to this formulation, any further deviations from assumptions (i)–(iv) in section 2.1 beyond those underlying structural gravity can be controlled for by adding country or country-pair specific effects,

[3] Deriving structural gravity is not a problem of market form: it has been shown to hold under perfect competition, Bertrand competition, monopolistic competition with homogeneous firms, and more recently under monopolistic competition with firm-level heterogeneity. See Costinot and Rodríguez-Clare (2013).

where the final clause in fact reflects the view prevailing in the literature that all deviations can be sufficiently captured by country-specific parameters.[4] Accordingly, attempts at identifying these deviations in a panel context, controlling for all other potential deviations with separate time-varying exporter and importer effects, re-opens the model identification problem.[5]

In this paper, however, we will concentrate on the "if any" clause above. We do this by identifying the interaction of countries' multilateral specialization incentives—as expressed by the product of supply-side country differences relative to the rest of the world—as a time-varying country-pair influence on gross trade flows within a gravity framework. As this influence is unique to factor-proportion influences on trade rooted in the incomplete-specialization version of the Heckscher-Ohlin model, it enables us to identify this source of trade in different homogenous goods against other trade.

3. Gravity specification with incomplete specialization and an application to European trade in final goods

3.1 Trade incentives and trade costs shaping gravity with incomplete specialization

Formulating a gravity specification from a 2×2×2 framework without trade costs, Evenett and Keller (2002) find empirical support for the incomplete-specialization version of Heckscher-Ohlin. But how can there be incomplete specialization in a Heckscher-Ohlin framework in the presence of trade costs? Haveman and Hummels (2004), extending Evenett and Keller (2002) by deriving bilateral gravity in a multilateral world, resolve this puzzle by a simulation exercise. Adding infinitesimally small, but country-specific transport costs, to identical production costs determined by factor price equalization does not change prices but it rather changes the cost ordering of suppliers. Hence, there is only one minimum-cost supplier country for each good and each customer country. Nevertheless, the result gives rise to incomplete specialization in the sense of more than one country in the world producing and exporting one particular good to the rest of the world and each supplier country supplying a particular good to more than one customer country.

[4] Cf. Anderson (2011, p. 158): "gravity is about the distribution of given amounts of goods in each origin drawn by given amounts of expenditure in each destination, enabling inference about trade costs from the deviation of observed distribution from the frictionless equilibrium. The determinants of total shipments and total expenditures are irrelevant to this inference because country fixed effects are a consistent control that does not require taking a stand on any particular production or market structure model."

[5] This includes deviations from homothetic, identical demand (see Bergstrand, 1989 and Markusen, 2013), incomplete specialization models of trade in homogenous and differentiated goods (Helpman and Krugman, 1985, chapters 7 and 8), and attempts at embedding heterogenous firm models of trade into Heckscher-Ohlin frameworks (Bernard et al., 2007).

However, we should not add unequal transport costs on top of an identical equilibrium production cost. Equilibrium diversification and trade are determined by trade-offs between factor endowment and transport-cost influences, so what matters is the minimum of the total cost, i.e., the sum of production and trade costs. There can be a minimum total-cost supplier to a particular country that is not the minimum production-cost supplier, but is sufficiently close in distance to warrant the minimum transportation cost (or the other way around). There might arise situations of different suppliers having equal minimum total costs, again evoking a rationale for random rationing.

While there is no full-fledged higher-dimensional Heckscher-Ohlin theory with finite trade costs upon which to rest our gravity derivation, the previous paragraph describes how we will look at it. We combine Evenett and Keller's (2002) two-factor Heckscher-Ohlin framework with Haveman and Hummels' (2004) multi-country, multi-product description of incomplete specialization. We preserve their setup, in which factor endowments determine potential partners and infinitesimal trade costs select partners for trade in homogenous goods. We differ, however, in assumptions on geography to better match the European landscape. Rather than assuming that countries are ordered like pearls on a thread, we see many small countries encircled by other equidistant small countries. For trade, in this set-up, foreign distance does not need to matter more than distance at home. In consequence, distance effects are of a second order as compared to border effects, even within the EU context. In our homogenous-goods case, this means that potentially many countries can be suppliers to locations within one country. Assuming infinitesimally small border costs—but no other transport costs—in the derivation of incomplete-specialization forces in bilateral gravity implies that each customer country is indifferent among all potential supplier countries except itself, motivating random rationing *à la* Deardorff (1998) to decompose countries' multilateral gravity. While assuming infinitesimally small border costs is enough to make specialization incentives matter for motivating bilateral gravity, it is accounting for time-varying exporter- and importer-specific effects in the econometric specification that finally introduces the full trade-off between incomplete-specialization forces and distance in bilateral gravity equations. In testing this specification, we use sub-sampling to identify which theory of trade drives the observed bilateral trade for different trade relationships across Europe.

3.2 Bilateral gravity and incomplete specialization in the presence of infinitesimal trade costs

As trade is balanced for each country and frictionless beyond border effects, preferences are identical and homothetic, and trade is only in final goods, equation (1) from section 2 again holds. Rewriting $X^k_{world} = \delta^k_{world} Y_{world}$ yields

$$NI^k_{jworld} = s_j \delta^k_{world} Y_{world} - \delta^k_j Y_j$$

$$= Y_j \ (\delta^k_{world} - \delta^k_j). \quad (1a)$$

Summing over all goods and selecting export items with positive exports into the set S_{Ej}, Haveman and Hummels (2004) derive country *j*'s multilateral exports (E_j) as log-linear in income and a *specialization pattern* relative to the world average ($\delta^k_j - \delta^k_{world}$),

$$E_{jworld} = Y_j \sum_{k \in S_{E_j}} (\delta^k_j - \delta^k_{world}). \quad (3)$$

From section 2.1, the specialization pattern describes the difference between the value-added of final goods production in country *j* and the world average. Analogously, we derive a specification for imports:

$$I_{jworld} = Y_j \sum_{k \in S_{I_j}} (\delta^k_{world} - \delta^k_j).[6] \quad (4)$$

Were complete specialization to hold in equilibrium, it would again be easy to show that the decomposition in section 2.1 again holds such that bilateral trade depends on partner incomes and world size, and nothing else. With incomplete specialization and no further costs of trade considered, however, it is not possible to analytically decompose (3) and (4) into bilateral trade relationships for a world with more than two countries. However, bilateral trade relationships will be distributed in a statistical sense across a sample of countries, as (3) and (4) must be met on the average of all bilateral trading relationships for each country. In consequence, in a sample of heterogeneous countries, larger countries and/or countries with higher degrees of multilateral specialization can be expected to trade more with each other, provided their specializations are complementary to each other. To clarify this, we again make use of Deardorff's (1998) random choice argument, which in our context states that a country's consumers, due to small border effects, prefer their home product to foreign products, but are indifferent between foreign produced products. Hence, good *k* imports of country *i* from country *j* are given by country *i*'s worldwide imports of good *k* times country *j*'s share in worldwide exports of *k*:

[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).

$$I_{ij}^{k} = I_{iworld}^{k} \frac{E_{jworld}^{k}}{\sum_j E_{jworld}^{k}}$$

$$= Y_i\left(\delta_{world}^{k} - \delta_i^{k}\right) \frac{Y_j\left(\delta_j^{k} - \delta_w^{k}\right)}{\sum_j E_{jworld}^{k}}$$

$$= \frac{Y_j Y_i}{\sum_j E_{jworld}^{k}} \left(\delta_j^{k} - \delta_{world}^{k}\right)\left(\delta_{world}^{k} - \delta_i^{k}\right) \quad (5)$$

The incentives driving countries' bilateral trade under incomplete specialization must match the underlying Heckscher-Ohlin framework. Consider again that the worldwide exports of some good *k'* from country *j* are given by $E_{jworld}^{k'} = Y_j(\delta_j^{k'} - \delta_{world}^{k'})$. We can reduce the dimensionality of our problem by understanding this multilateral gravity equation as a bilateral gravity equation between country *j* and *world*. Then, using the argument put forward in Evenett and Keller (2002, p. 286), in a 2×2×2 Heckscher-Ohlin world, if country *j* is relatively capital rich and good *k* is capital intensive, value-added $\delta_j^{k'}$ is positively related to country *j*'s capital-labor ratio $\kappa_j = (K/L)_j$ and value-added $\delta_{world}^{k'}$ is inversely related to *world*'s capital-labor ratio $\kappa_{world} = (K/L)_{world}$. Then, the volume of trade increases with the difference between capital-labor ratios, $(\kappa_j - \kappa_{world})$, such that $E_{jworld}^{k'} \propto Y_j(\kappa_j - \kappa_{world})$. Analogously, we can write $I_{iworld}^{k'} \propto Y_i(\kappa_{world} - \kappa_i)$ for relatively labor-rich country *i* importing the capital-intensive good *k'*. Accordingly, with equation (5), for any two countries *j* and *i* that are, respectively, capital rich and labor rich relative to the world, good *k'* imports of country *i* from country *j* are

$$I_{ij}^{k'} \propto Y_i Y_j\left(\kappa_j - \kappa_w\right)\left(\kappa_w - \kappa_i\right), \quad (6)$$

as $\sum_j E_{jworld}^{k'}$ is given for each particular country. According to Ethier (1984), the Heckscher-Ohlin theorem carries through to the case of more than two goods, such that specialization patterns between *j* and *world* and *world* and *i* continue to be shaped by differences in capital-labor ratios in terms of correlations. We can therefore generalize proportionality (6) to the multi-product case, to describe the total expected imports of capital intensive goods to labor-rich *i* from capital-rich *j*,

$$E_{ji} = I_{ij} \propto Y_i Y_j\left(\kappa_j - \kappa_{world}\right)\left(\kappa_{world} - \kappa_i\right). \quad (7)$$

As country j is relatively capital-rich and i is relatively labor-rich, j exports only capital-intensive goods and i exports only labor-intensive goods such that proportionality (7) in fact holds for the total expected trade between j and i.

Deardorff (1979) shows that, in a two-country, two-factor model, trade in more than two goods still accords with the ranking of goods by factor intensity if there are unequal factor prices, as is possible here due to border costs. Accordingly, if j is capital-richer than *world*, j will export the more capital-intensive goods and its wage-rental ratio will be higher than that for *world*. Thus, the predictive power of $Y_j(\kappa_j - \kappa_{world})$ for exports in capital-intensive goods from j to *world* continues to hold for $Y_j(w_j - w_{world})$, where w_j and w_{world} represent supply-side characteristics either in the form of capital-labor or wage-rental ratios. As the analogous reasoning can be applied to labor-rich country-i imports of capital intensive goods from *world*, we can generalize proportionality (7) accordingly, such that bilateral trade is driven by countries' multilateral specialization incentives, as expressed by the product of supply-side country differences relative to the rest of the world, with or without factor price equalization,

$$E_{ji} = I_{ij} \propto Y_i Y_j (w_j - w_{world})(w_{world} - w_i). \tag{8}$$

3.3 European trade in final goods: empirical specification

As indicated in the introduction, we do not want to test how well equation (8) explains total trade. Rather, we want to test whether incomplete-specialization forces are a more or less important source of trade across different bilateral trade relationships within Europe. Although on average Western European countries are relatively capital-richer than Eastern European economies, they are not identical groupings. Consequently, we cannot for our purposes define subsamples of capital-rich versus capital-poor counties, let alone the problems with measurement. We therefore reformulate (8) in absolute values, such that for any pair in our sample of heterogeneous European countries, the basis for our econometric specification of total bilateral trade in final goods is the log-linear relationship

$$\log E_{ji} = \beta_0 + \beta_1 \log(Y_j \times Y_i) + \beta_2 \log(|w_j - w_{world}| \times |w_i - w_{world}|). \tag{9}$$

Equation (9) modifies Haveman and Hummels' (2004) approach to formulate bilateral gravity equations in the presence of incomplete specialization as statistical relationships constrained on countries' multilateral specialization patterns, with respect to both partner incomes and specialization patterns. Equation (9) is easy to interpret: assuming a sample of heterogeneous countries, bilateral trade volumes 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, $|w_j - w_{world}| \times |w_i - w_{world}|$. Hence, specification (9) captures the fact that bilateral trade flows will increase with relative, rather than absolute, supply-side country differences.

However, despite being simple and directly related to equation (8), specification (9) is incomplete. The reason is that relative supply-side country differences in (9) now predict large trade volumes also for countries that lack complementary specialization. To account for this problem, we let the data reveal specialization patterns, i.e., we select relative supply-side country differences for particular bilateral trade relationships by assigning dummy variables. Our prior expectation for specialization has already been outlined above: we expect the old EU members (EU-15) to specialize in capital-intensive goods on average, and the Eastern European new members that joined the EU in 2004 and 2007 (EU-10) are expected to specialize in labor-intensive goods on average. Hence, by letting the data speak for itself, we first assign the dummy variable *DummyEU*15/10 to equal one for trade flows between old (EU-15) and new (EU-10) EU countries, and zero otherwise. Second, we create a combined dummy variable ($DummyEU15/10_{ji} \log(|w_{j,t} - w_{world,t}| \times |w_{i,t} - w_{world,t}|)$) to detect specialization patterns between EU-15 and EU-10 countries that are *a priori* expected to be complementary on average.

Further, given the progress in the integration process between both groups of countries (EU-15 and EU-10), we expect that the pattern will show a dynamic development that represents technological progress through decreasing trade costs. Technological progress is exogenous 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 $DummyEU15/10_{ji,s} \log(|w_{j,t} - w_{world,t}| \times |w_{i,t} - w_{world,t}|)$ 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: (i) the different stages of economic transition in the CEE countries (from the early 1990s to the middle 2000s), (ii) the preparations for EU accession (1995–2004) with the relevant effects on bilateral trade and aggregate output (Egger and Larch, 2011), (iii) the post-accession period, and (iv) changes in manufacturing patterns related to FDI (Hanousek et al., 2011).

Thus, bilateral trade in final goods ($E_{ji,t}$) can finally be described by the following specification:

$$\log E_{ji,t} = \beta_0 + \beta_1 \log(Y_{j,t} \times Y_{i,t}) + \beta_2 \log(|w_{j,t} - w_{world,t}| \times |w_{i,t} - w_{world,t}|) + \sum_{s=1}^{5} \gamma_s Dummy(EU15/10)_{ji,s} \log(|w_{j,t} - w_{world,t}| \times |w_{i,t} - w_{world,t}|) + \vartheta_{ji,t} + \varepsilon_{ij,t} \quad (10a)$$

where

$$\vartheta_{ji,t} = c_{ji} + k_t + \rho_{j,t} + \varphi_{i,t}. \quad (10b)$$

In specification (10a) the dummy variable *DummyEU*15/10 equals one for trade relationships between EU-15 and EU-10 countries as defined above, and zero otherwise. Then, $\varepsilon_{ij,t}$ is the error term, and $\vartheta_{ji,t}$ contains various factors influencing trade relationships described in literature; these are detailed in the specification (10b). In particular, coefficients k_t are dummies for years and they typically capture unobserved technological progress and price development. Country-pair fixed effects c_{ji} control for time-invariant trade factors. Time-varying exporter and importer effects ($\rho_{j,t}$ and $\varphi_{i,t}$) are usually included when country-pairs fixed effects c_{ji} are replaced by a parsimonious specification concerning only importers and exporters fixed effects (Anderson, 2011). Together with country-pair fixed effects they control for countries' multilateral trade resistance (Baldwin and Taglioni, 2006).

However, including all factors listed in (10b) would lead to an identification problem in the estimation stage, or at least to a weak identification of the model because of excessive number of parameters. We solve this dilemma by adopting the following specification of $\vartheta_{ji,t}$:

$$\vartheta_{ji,t} = c_{ji} + k_t. \quad (10c)$$

The reason is following. During the estimation stage (see Section 5) we also control for potential endogeneity. This is done by running dynamic panel estimation, which is conducted on the first differences of (10a). At the same time we also control for dynamic exporter and importer effects by employing the relevant auxiliary parameters during dynamic panel estimation. Consequently, (10a) is able to control for sources of trade other than the incomplete-specialization version of the Heckscher-Ohlin model, in which the product of two countries' multilateral specialization incentives is expressed by their respective factor proportions differences relative to the rest of the world. First, complete-specialization trade is identified as the limiting case for which the influence of the product of supply-side country differences relative to the rest of the world is zero.[7] Second, following Anderson (2011), all other potential sources of trade are controlled for by time-varying exporter importer effects during dynamic panel estimation (see section 5), as argued in section 2.3.

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 the presence of factor price equalization, relevant factor endowments like capital-labor ratios can be proxied by average GDP per capita. Factor price equalization may break down, as argued above. 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 trade flow 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 wage-rental ratios, assuming much lower variation in interest rates than in wages across Europe. For robustness purposes GDP per capita will be used as an alternative measure of supply-side country differences.

3.4 Relations to the literature

In the previous sections, we relied on Haveman and Hummels (2004) to extend the two-country world of Evenett and Keller (2002) to a multilateral setting. At the same time, we modified Haveman and Hummels (2004) with respect to how geography works in a multilateral Heckscher-Ohlin world, to allow for random rationing *á la* Deardorff (1998) rather than selecting one minimum cost supplier per destination country. This specified Haveman and Hummels' (2004) point that bilateral gravity equations in the presence of incomplete specialization are statistical relationships to the statement that bilateral trade is driven by countries' multilateral specialization incentives, as expressed by supply-side country differences relative to the rest of the world. Different from our argument between equations (3) and (4) and equation (7) in the previous section, Haveman and Hummels (2004)

[7] While in principle this may include the complete-specialization version of Heckscher-Ohlin, results in Debaere and Demiroglu (2003) rule this out, as factor proportions differences across Europe are simply too small.

ad hoc proxy specialization patterns by specialization incentives in terms of separate partner countries' capital-labor ratios, $\kappa_j = (K/L)_j$, relative to world averages.[8] As our specification (10a) singles out a time-varying country-pair influence unique to the incomplete-specialization version of the Heckscher-Ohlin model, it enables us to control for all other trade influences, in the form of separate time-varying exporter and importer effects during the dynamic panel estimation (see section 5), as recommended in Anderson (2011), including the specification of Haveman and Hummels (2004).

In the introduction we stated the objective of this paper in terms of testing whether differences in factor proportions between pairs of countries are a more relevant source of trade for some parts of Europe than for others, rather than attempting to test various theories of trade against each other using gravity. Other contributions to the literature have done the latter using bilateral gravity equations augmented by *ad hoc* measures of supply-side country differences, such as absolute values of differences in per capita incomes or wages between exporter and importer countries, rather than expressing supply-side country differences relative to the rest of the world. The idea of such an approach is to 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 based on factor proportions 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.[9] However, testing the influences of various trade theories against each other within one and the same gravity specification assumes that these theories can be reduced to the same gravity specification. On the basis of the sections above, we argue that gravity equations augmented by *ad hoc* absolute supply-side country differences are mis-specified since describing trade flows as log-linear in both country sizes and absolute country income differentials does not describe the data well, neither against complete- nor incomplete-specialization models of production and trade.

[8] The basis for their econometric specification of bilateral trade is log $E_{ji} = \beta_0 + \beta_1 \log(Y_j \times Y_i) + \beta_2(|\kappa_j - \kappa_{world}| + \beta_3|\kappa_i - \kappa_{world}|)$. Testing for Heckscher-Ohlin sources of specialization patterns based on this specification in a panel context and controlling for all other potential deviations with separate time-varying exporter and importer effects obviously results in the model identification problem *caveat* of section 2.3.

[9] 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).

Rather, our view of bilateral gravity equations rooted in a Heckscher-Ohlin framework as statistical relationships constrained on countries' multilateral specialization patterns can be related to the treatment of multilateral resistance in recent gravity literature (Anderson, 2011). It is in fact intuitively appealing to measure both trade incentives rooted in supply-side country differences as trade as well as bilateral trade barriers relative to the world.

Finally, as noted in the introduction, our contribution is also close to papers outside gravity that combine sector-specific information on factor intensities with country-specific information on factor proportions. Especially, our contribution may be seen as a gravity complement to Romalis (2004), who combines Krugman (1980) with the two-country, two-factor, and many goods model in Dornbusch et al. (1980) into a many-country, many-goods and two-factor model with finite border costs, with the prediction that countries capture larger market shares in industries that use their abundant factor more intensively. In terms of tackling the multidimensionality problems of Heckscher-Ohlin trade, Romalis (2004) also reduces the problem by assuming only two types of countries, northern and southern, and then accounting for the separate roles of border costs and product differentiation in generating his results: border costs without product differentiation define countries' total trade, but in terms of bilateral trade only delimit country pairs that may trade with each other, very much like our equation (7) implies the result that there is zero trade among capital-rich or among labor-rich countries.

4. Data

Final goods exports from country *j* to *i*, (E_{ji}), from 1992 to 2008 are obtained from the UN COMTRADE database. The definition of final goods follows the BEC categorization of UN Statistics.[10] 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. For our analysis we use bilateral trade data for the set of countries listed in Appendix Table A.1. We consider all bilateral trades in which at least one (either exporter or importer, or both) is an EU country (EU-15 or EU-10). Thus, for each year we observe hundreds of bilateral trade data points. Specifically we observe a total of 29 × 28 = 812 bilateral trade relationships in

[10] 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.

Europe alone, a part of which are between Western (EU-15) and Eastern (EU-10) European economies.

For our first and key trade flow measure we employ 1-digit-level aggregate trade flows. Then we use all 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 as in Frensch (2010). Hence, our second measure, trade along the extensive margin, represents the variety of final goods exported from country j to country i. It is defined as a count measure over 1,147 final goods (702 capital goods, 445 consumer goods) out of all 5,368 of the SITC Rev.3 categories. Our third measure, along the intensive margin, represents the depth of the trade in the final goods exported from country j to country i. The intensive margin is defined as the average volumes of the exported final goods categories.

Exporter (Y_j) and importer GDP (Y_i) at current prices are obtained from *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, respectively). 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 *World Development Indicators*. To construct relative supply-side country differences, $|w_j - w_{world}| \times |w_i - w_{world}|$, world GDP per capita at current prices and world average wage (w_{world}) 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 A.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 in our estimation as they account for differences in country sizes; more discussion is offered in section 6. Time-specific effects in specification (10a) and (10c) 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 U.S.-dollar-denominated data are converted to euros.

As outlined in the introduction, our interest in trade patterns among old and new EU members is driven by the new opportunities for specialization and trade created by European integration. Although new EU members were accepted in 2004 and 2007, they had already removed 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.

5. Estimation

We estimate specification (10a) and (10c) on unbalanced panel data with a mean length of time dimension of about 10 years.[11] 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.[12]

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 (ABBB) technique. The test confirms the endogeneity of the explanatory variables. Therefore, we proceed with instrumentation.

Technically, we estimate the theoretically motivated specification (10a) 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 (10a) 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 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 in absolute values or scaled per capita values, would create problems even in a panel setting. The reason is that, by construction, the unobserved panel-level effects are correlated with potentially endogenous independent variables that cause standard estimators to be

[11] 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.

[12] 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).

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). Finally, the ABBB technique, as employed, accounts for time-varying exporter and importer behavior and it does so more efficiently than panel OLS with time-varying effects.[13]

Since bilateral trade volume will increase with the product of trading countries' incomes, we expect that $\beta_1 > 0$. As equations (3) and (4) 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 of 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 $w_i > w_{world}$, then there is no reason to assume the majority of country pairs to be complementarily specialized. In this case, the higher extent of countries' respective supply-side differences against the world ($|w_j - w_{world}| \times |w_i - w_{world}|$) 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 combined dummy variable ($DummyEU15/10_{ji} \log(|w_{j,t} - w_{world,t}| \times |w_{i,t} - w_{world,t}|)$) for a specific period (s) selects 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 incomplete-specialization incentives playing any role, in which case $\beta_2 = \gamma_s = 0$.

As already argued above, complete specialization is in principle compatible with both monopolistic competition models of trade and Heckscher-Ohlin. Evenett and Keller (2002) discriminate between the two on the basis of the presence of intra-industry trade, assuming that all observed intra-industry trade is solely accounted for by monopolistic competition models of trade. We have reservations about this identification, given the literature pointing to Heckscher-Ohlin forces yielding different forms of intra-industry trade (see, e.g., Davis, 1995). Since Debaere and Demiroglu (2003) find evidence of similar factor endowments among many countries of our sample, we rather argue that these endowments potentially enable them to produce the same set of goods. On this basis, we will identify our limiting

[13] The ABBB technique is a dynamic panel estimation that is a structural form estimation and controls for endogeneity. The way the estimation method is constructed assumes that the country fixed effects are not necessarily constant over time. The time-varying effects of exporter-importer country pairs are already controlled for by the technical implementation. Note that these parameters are considered auxiliary and they are not estimated by the main model.

case of $\beta_2 = \gamma_s = 0$ as complete specialization based on monopolistic competition models of trade, indicating trade in differentiated rather than different products.

6. Empirical results

We introduce our benchmark results for trade flows in final goods from, to, and across Europe based on specification (10a) in Tables 1 and 2. Each table contains estimates for a specific variable employed to measure supply-side country differences based on weighted world averages. Table 1 shows the estimates when supply-side country differences are proxied by wages, while Table 2 shows estimates when GDP per capita is employed. Statistically significant and large coefficients β_1 for both measures demonstrate that larger countries indeed trade more final goods with each other.

The average specialization effect of relative supply-side country differences on final goods trade flows is captured by coefficients β_2. No matter what measure of the relative supply-side country differences is used, coefficients β_2 are negative and relatively small (-0.096 in Table 1 and -0.078 in Table 2). 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 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.

The average pattern, captured by coefficients β_2, however, does not fully reveal the role of specialization incentives in old and new EU members. This becomes evident when we compare the coefficients β_2 with the always significantly positive and larger coefficients γ_s. The sum of the coefficient pairs β_2 and γ_s is computed for each period separately: $\beta_2 + \gamma_1$ for the first period 1992–1995, $\beta_2 + \gamma_2$ for the second period 1996–1998, etc. For each period the sum of the coefficient pairs β_2 and γ_s is positive and statistically significant. This fact indicates that relative supply-side country differences *do* drive final goods trade between the original EU-15 and ten new EU countries (EU-10), rather than within each of the two country groups or across the average of all European trade relationships. Specifically, when measuring relative supply-side country differences by wages (Table 1), final goods trade flows between old and new EU members react with an elasticity between 4 and about 7%. Measuring relative supply-side country differences by per capita GDP (Table 2) lowers both elasticities to a range between 0% and 5%. In both cases elasticities rise gradually during the first three periods (1992–2001) and subsequently decrease during last two periods (2002–

2008). This pattern might be credited to the fact that already in the early years of the economic transformation, and still before accession, would-be new EU members rapidly reoriented their international trade relationships towards EU countries. Increasing coefficients provide evidence that both old and would-be new EU countries have reaped the benefits of the relatively large supply-side country differences. At a later stage, shortly before and following accession, new EU members progressed in their economic convergence process and their differences with respect to the old EU members began to decrease. This process is reflected in declining coefficients during 2002–2008. However, despite the variation in the sum of the coefficient pairs β_2 and γ_s in different periods, we show that bilateral trade flows between old and new EU members appear to be driven by incomplete-specialization motives.

We complement our results by a robustness check and perform a statistical comparison of the coefficients derived from the estimated specification (10a) where wages and GDP per capita serve as a measure for supply-side country differences. We compare the coefficients presented in Table 1 (wages) and Table 2 (GDP per capita). In Figure 1 we present the plots of the confidence intervals of the above coefficients. Dark and blank bars depict wages-based and GDP-based coefficients, respectively. The shapes of the dark bars exhibit wider intervals due to the greater variability of wages. There is a clear overlap of the confidence intervals of coefficients β_1 and β_2. For the coefficients associated with multiples of countries' incomes (β_1), this finding comes as no surprise since the identical measures are used in estimation. The overlap of the confidence intervals of coefficients associated with the average specialization effect (β_2) means that the results are in a statistical sense robust to either of the two measures of supply-side country differences. However, there is no overlap for coefficients associated with complementary specialization effects (γ_s). Coefficients are lower when per capita GDP is used and this proxy underestimates the effect of the supply-side country differences in measuring complementary specialization effects. Hence, the robustness check supports the choice of wages as adequate measure of the supply-side country differences.

In the next step we further enrich our results by decomposing our analysis of the trade in final goods into its two key components: capital and consumer goods. The results are presented in two tables in the Appendix: Table A.2 (capital goods) and Table A.3 (consumer goods). In each table we present estimates when supply-side country differences are proxied by wages.[14] Our findings are in line with those of the aggregate final goods: trade increases with countries' incomes (large and positive coefficients β_1), the average incomplete-specialization effect of relative supply-side country differences does not seem to contribute to trade (small, negative coefficients β_2), and relative supply-side country differences (sum of β_2 and γ_s) are drivers of trade in capital and consumer goods between the old and new members of the EU. However, we find distinctive differences in the effects of both types of final good. The effect of the countries' incomes (β_1) is by about one-fifth stronger for capital goods. The average incomplete-specialization effect (β_2) is more balanced for both goods. The key differences are found in the effect of specialization patterns in trade between the EU-15 and EU-10. Technical progress in terms of declining trade costs, as captured by the sub-period dummies' coefficients (γ_s), appears to positively influence both types of final-good trade for EU-15/EU-10 pairs. The dynamics of this influence is different, though. In case of capital goods, coefficients γ_s increase over time until the EU accession and then decrease. For consumer goods, coefficients γ_s gradually decrease during the whole period under research. Consistently larger sums of the coefficient pairs β_2 and γ_s in Table A.3 show that the role for incomplete-specialization incentives across Europe is more robust for consumer goods than for capital goods (Table A.2). Specifically, capital goods trade flows between Eastern and Western Europe react with an elasticity growing from about 2 to about 6% (Table A.2). Consumer goods trade flows (Table A.3) exhibit a much stronger reaction: elasticity begins at about 16% and gradually declines to about 7%. 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 clear for consumer goods trade.

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, the traded final goods are differentiated products, as 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, and this is even more true for consumer than for capital goods.

[14] 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.

Based on the highly disaggregated nature of our original trade data, we extend our analysis by decomposing trade in final goods along the two margins defined in section 4. The *extensive* margin denotes the number of exported goods and represents the variety of trade, while the *intensive* margin refers to the average volumes per exported good and represents the depth of trade. We report the results for trade in final goods in specifically marked columns in Tables 1 and 2 and also separately for capital goods (Table A.2) and consumer goods (Table A.3). First, coefficients associated with market size (β_1) are about 50% larger for the intensive margin than for the extensive margin, no matter whether we look at final goods as a whole or decomposed. This finding reveals that trade in final 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 final-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. Also, the effects on the two margins of trade depend on the type of final good. For capital goods, the intensive margin reactions negligibly increase over time while the extensive margin response becomes consistently larger for our first three sub-periods until 2001, but then decreases during 2002–2008 (Table A.2). In this sense, the results for capital goods are similar to those obtained for final goods as a whole (Tables 1 and 2). For consumer goods, the extensive margin reaction declines slowly over the whole period under research while the intensive margin response drops during first two periods and then remains at the same level (Table A.3).

On the basis of the significance of Heckscher-Ohlin forces we analyze the trade margins of homogenous, rather than differentiated, products. Hence, our trade margin results may have a structural, quasi-Rybczynski explanation already noted in Romalis (2004), along the lines of Ventura (1997). If Eastern European countries were to repeat the experience of other previously rapidly growing small open economies, their capital accumulation would not simply induce more capital intensive production of the same goods, with a consequent reduction in marginal products. Rather, trade would enable them to shift production to capital-intensive industries without an effect on factor prices. Together with this, we should see a decline in the strength of the extensive margin responses to Heckscher-Ohlin forces that are based on these countries' initially being capital-poorer than Western Europe, which is indeed what we observe.

7. Conclusions

In this study, we combine and extend the previous literature, especially Deardorff (1998), Evenett and Keller (2002), and Haveman and Hummels (2004). We develop a gravity specification that views bilateral gravity equations rooted in a Heckscher-Ohlin framework as statistical relationships constrained on countries' multilateral specialization patterns. Heckscher-Ohlin multilateral specialization incentives are expressed by supply-side country differences relative to the rest of the world. On the basis of this specification, we argue that gravity equations augmented by *ad hoc* measures of supply-side country differences are mis-specified, due to theoretically unmotivated attempts to allow for both complete- and incomplete-specialization influences on trade within the same gravity framework. 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 trade relationships, negligibly small specialization coefficients indicate that specialization incentives do not play much of a role in final-good 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, which is 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 products rather than differentiated products, despite the gradual catching-up process of the new EU members.

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Table 1. Final goods estimation

(w=wages as supply-side country differences; population weighted averages)

Explanatory variables			Trade Flows	Extensive Margin	Intensive Margin
log Y_j Y_i		β_1	0.769*** (0.007)	0.320*** (0.003)	0.448*** (0.006)
log ($\|w_j - w_w\| \times \|w_i - w_w\|$)		β_2	-0.096*** (0.011)	-0.069*** (0.005)	-0.028*** (0.010)
log ($\|w_j - w_w\| \times \|w_i - w_w\|$) for EU-15 and EU-10 pairs	1992-1995	γ_1	0.164*** (0.007)	0.130*** (0.003)	0.034*** (0.006)
	1996-1998	γ_2	0.169*** (0.006)	0.136*** (0.003)	0.033*** (0.006)
	1999-2001	γ_3	0.178*** (0.006)	0.146*** (0.002)	0.032*** (0.005)
	2002-2004	γ_4	0.161*** (0.006)	0.135*** (0.002)	0.025*** (0.005)
	2005-2008	γ_5	0.135*** (0.006)	0.105*** (0.003)	0.030*** (0.006)
Number of observations				23308	

Note: Table contains results for country-pair fixed effects estimation using dynamic panel technique (Arellano-Bond-Bover-Blundel). Standard errors are shown in parentheses. ***, **, and * denote statistical significance on 1%, 5% and 10%, respectively.

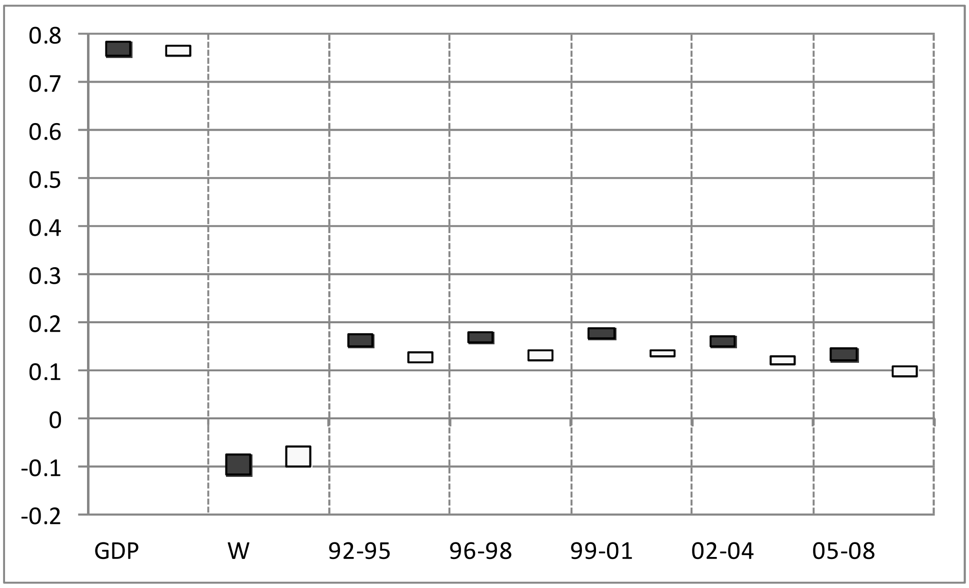
Table 2. Final goods estimation

(w=GDP per capita supply-side country differences; population weighted averages)

Explanatory variables			Trade Flows	Extensive Margin	Intensive Margin
log $Y_j\ Y_i$		β_1	0.766*** (0.006)	0.316*** (0.003)	0.450*** (0.006)
log ($\lvert w_j - w_w \rvert \times \lvert w_i - w_w \rvert$)		β_2	-0.078*** (0.011)	-0.064*** (0.004)	-0.014 (0.010)
log ($\lvert w_j - w_w \rvert \times \lvert w_i - w_w \rvert$) for EU-15 and EU-10 pairs	1992-1995	γ_1	0.127*** (0.005)	0.103*** (0.002)	0.024*** (0.005)
	1996-1998	γ_2	0.131*** (0.005)	0.110*** (0.002)	0.021*** (0.004)
	1999-2001	γ_3	0.136*** (0.004)	0.116*** (0.002)	0.019*** (0.004)
	2002-2004	γ_4	0.121*** (0.004)	0.109*** (0.002)	0.012*** (0.004)
	2005-2008	γ_5	0.098*** (0.005)	0.087*** (0.002)	0.012*** (0.004)
Number of observations			27755		

Note: Table contains results for country-pair fixed effects estimation using dynamic panel technique (Arellano-Bond-Bover-Blundel). Standard errors are shown in parentheses. ***, **, and * denote statistical significance on 1%, 5% and 10%, respectively.

Figure 1. Comparison of confidence intervals for coefficients in specification (10)



Note: Dark and blank bars refer to wages-based and GDP p.c.- based coefficients, respectively. Confidence intervals are labeled in the following way: *GDP* denotes the coefficient of the log Y_j Y_i (β_1) and *W* denotes coefficient of the log ($|w_j - w_w| \times |w_i - w_w|$) where *w* stands for wages (β_2). Remaining confidence intervals refer to coefficients of the log ($|w_j - w_w| \times |w_i - w_w|$) for the EU-15/10 dummy (γ_1- γ_5), computed over specified time periods; i.e. from 1992–1995 to 2005–2008.

Appendix

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 A2. Capital goods estimation
(w=wages supply-side country differences, population weighted averages)

Explanatory variables			Trade Flows	Extensive Margin	Intensive Margin
log Y_j Y_i		β_1	0.802*** (0.008)	0.327*** (0.003)	0.475*** (0.008)
log $(\|w_j - w_w\| \times \|w_i - w_w\|)$		β_2	-0.111*** (0.014)	-0.065*** (0.005)	-0.046*** (0.012)
log $(\|w_j - w_w\| \times \|w_i - w_w\|)$ for EU-15 and EU-10 pairs	1992-1995	γ_1	0.140*** (0.009)	0.106*** (0.003)	0.034*** (0.008)
	1996-1998	γ_2	0.154*** (0.008)	0.115*** (0.003)	0.038*** (0.007)
	1999-2001	γ_3	0.176*** (0.007)	0.128*** (0.003)	0.048*** (0.007)
	2002-2004	γ_4	0.161*** (0.007)	0.116*** (0.003)	0.044*** (0.007)
	2005-2008	γ_5	0.129*** (0.008)	0.082*** (0.003)	0.048*** (0.007)
Number of observations			22914		

Note: Table contains results for country-pair fixed effects estimation using dynamic panel technique (Arellano-Bond-Bover-Blundel). Standard errors are shown in parentheses. ***, **, and * denote statistical significance on 1%, 5% and 10%, respectively.

Table A3. Consumer goods estimation
(w=wages supply-side country differences; population weighted averages)

Explanatory variables			Trade Flows	Extensive Margin	Intensive Margin
log Y_j Y_i		β_1	0.677*** (0.007)	0.272*** (0.003)	0.405*** (0.006)
log ($\lvert w_j - w_w\rvert \times \lvert w_i - w_w\rvert$)		β_2	-0.091*** (0.011)	-0.080*** (0.006)	-0.010 (0.010)
log ($\lvert w_j - w_w\rvert \times \lvert w_i - w_w\rvert$) for EU-15 and EU-10 pairs	1992-1995	γ_1	0.250*** (0.007)	0.169*** (0.004)	0.081*** (0.007)
	1996-1998	γ_2	0.242*** (0.007)	0.167*** (0.003)	0.075*** (0.006)
	1999-2001	γ_3	0.222*** (0.006)	0.164*** (0.003)	0.058*** (0.005)
	2002-2004	γ_4	0.201*** (0.006)	0.151*** (0.003)	0.051*** (0.005)
	2005-2008	γ_5	0.186*** (0.006)	0.129*** (0.003)	0.056*** (0.006)
Number of observations				22544	

Note: Table contains results for country-pair fixed effects estimation using dynamic panel technique (Arellano-Bond-Bover-Blundel). Standard errors are shown in parentheses. ***, **, and * denote statistical significance on 1%, 5% and 10%, respectively.

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