Incomplete Specialization and Trade in Parts and Components

By: Richard Frensch, Jan Hanousek and Evžen Kočenda

William Davidson Institute Working Paper Number 1044
March 2013

Incomplete specialization and trade in parts and components

Richard Frensch[a]
Jan Hanousek[b]
Evžen Kočenda[c]

Abstract

Within a higher-dimensional incomplete specialization Heckscher-Ohlin framework, we first develop a gravity model that views bilateral gravity equations as statistical relationships constrained on countries' multilateral specialization patterns. Second, we test our model empirically by using a uniquely detailed and large European data set. We show that trade in the parts and components of capital goods is driven by supply-side country differences relative to the rest of the world, compatible with models of incomplete specialization and trade. We take our results as evidence of the existence of international production networks in Europe, driven by trade-offs between wages and coordination costs.

JEL-Classification: C23, F14, F23

Keywords: International trade, gravity model, offshoring, panel data, European Union

a Department of Economics, University of Regensburg and the Institute for East and Southeast European Studies (IOS) Regensburg. Landshuter Straße 4, 93047 Regensburg, Germany. Email: frensch@ios-regensburg.de.

b CERGE-EI, Charles University and the Czech Academy of Sciences, Politickych veznu 7, 11121 Prague, Czech Republic; Anglo-American University, Prague; The William Davidson Institute at the University of Michigan Business School; The Center for Organizational Dynamics, University of Pennsylvania; and CEPR, London. E-mail: jan.hanousek@cerge-ei.cz.

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

Research support from the Grant Agency of the Czech Republic grant No. 403/12/0080 is gratefully acknowledged. The usual disclaimer applies.

1. Introduction and motivation

Worldwide trade in intermediate products was already identified in the early 1960's as a key part of international trade (Balassa, 1966). Recent contributions have confirmed its increasing importance, specifically with respect to an important subset of intermediate gods: the parts and components of capital goods (Kimura et al., 2007; Grossman and Rossi-Hansberg, 2008). A number of studies (a review is in the next section) potentially linked the trade in parts and components to the existence of global supply chains and adopted a gravity framework with a variety of trade determinants to analyze the phenomenon. In this paper we contribute to this literature in two ways. First, within a higher-dimensional incomplete-specialization Heckscher-Ohlin framework we build a theory-guided gravity model with supply-side country-specific characteristics to identify driving forces for trade in parts and components. Second, we test our model empirically by using a uniquely detailed and large data set of European trade in the parts and components of capital goods. In accordance with the predictions of our model, we provide evidence that trade in the parts and components of capital goods across Europe, i.e., between East and West Europe, is driven by supply-side country differences relative to the rest of the world, compatible with models of incomplete specialization and trade. We take our results as evidence for the existence of international East-West production networks in Europe, driven by trade-offs between wages and coordination costs.

The motivation for our paper comes from the simple idea of the specialization present at the intermediate step of production. We start with the notion of fragmentation that describes the deepening of the division of labor by horizontally or vertically splitting production processes into distinct tasks. A division of labor encourages specialization and fragmentation, thus further increasing incentives towards specialization. The realization of fragmentation-induced additional gains from specialization requires breaking up the spatial concentration of production that frequently happens on an international scale. Hence, firms specialize within the global supply chain, potentially by joining into international production networks or even by offshoring individual tasks.

Apart from the potential gains, fragmentation-induced specialization implies costs of coordination beyond the level of a single firm or plant. Coordination costs typically entail costs of investment, the customization of products upon demand, communication, and two-way trading of intermediate products. One would expect firms to join the global supply chain whenever fragmentation-induced specialization gains outweigh the implied coordination costs. Hence, the international scale of production networking should increase with fragmentation, with declining coordination costs, or with the strength of international incentives to specialize.

On the country level, fragmentation-driven trade is reflected by *vertical specialization*. This happens when two or more countries provide value-added in the good's production sequence with the key aspect of using imported intermediate inputs in producing goods that are again exported, i.e., the existence of the two-way trade of intermediate inputs (Hummels et al., 2001; Kimura et al., 2007).

The most noticeable incidents of international production networks have so far been registered in East Asia (Kimura et al., 2007), as a consequence of fragmentation in the Japanese production of electrical machinery, leading to strong increases in two-way trade in parts and components of electrical machinery between Japan and its neighbors (Kimura et al., 2008).[1] When considering the evidence, one needs to keep in mind that fragmentation along with declining coordination costs represents technical progress[2] that is produced in only a few industrialized economies (Keller, 2004). Also, we observe poor-country firms specializing in tasks that tend to be routine, homogeneous, and intensive in labor, even in low-skill labor (Breda et al., 2008; Kimura, 2006; Sinn, 2005). Case study evidence points to machine building and capital-goods production as the industries experiencing the most pronounced international production networking or even offshoring.

From this description, one would expect supply-side country differences to play an effective role as in a factor-proportions setting. Specifically, across Europe one would expect firms in the Central and Eastern European (CEE) countries that entered the EU in 2004 as new members (the EU-10) to specialize in labor-intensive tasks and firms in the old EU members (the EU-15) to specialize in capital-intensive tasks within the chain of production of capital goods. This allocation of tasks would generate two-way trade in the parts and components of capital goods across Europe. This process could be expected to be the most distinct during the European

[1] These phenomena are the most salient in electrical machinery, while intrasectoral input-output relationships across borders are weak in the transport equipment sector. In addition, the basic features of international fragmentation are detected in the chemical and material sectors (Kimura et al., 2008).
[2] This is in the spirit of the notion of capital-good variety describing an economy's state of technology, as proposed in Romer (1990) and tested in Frensch and Gaucaite Wittich (2009).

convergence process and also supported by the commencement of that convergence process.[3] European trade in parts and components will form a landscape to empirically test our model.

The rest of the paper is organized as follows. Section 2 includes a review of the conceptual background for analyzing fragmentation-induced trade in the parts and components of capital goods as a subset of intermediate goods and also earlier empirical results. In section 3, we motivate a gravity-equation model for parts and components trade, based on Haveman and Hummels (2004), to refine the approach taken in Kimura et al. (2007). We formulate our estimable specification and describe our data in sections 4 and 5, respectively. Hypotheses, empirical results, and a robustness analysis are presented in section 6. Section 7 concludes.

2. Current state of the conceptual and empirical background

2.1 Overview of the relevant trade models

In theoretical models, the potential determinants of specialization within the global supply chain include both comparative advantage and product differentiation together with economies of scale. Approaches associated with new trade theory model imperfect competition on the level of intermediate goods (Egger and Falkinger, 2006; Fujita and Thisse, 2006; Hayakawa, 2007). Economic geography models (Amiti, 2005; Robert-Nicoud, 2008) aim at resolving the locations of component producers along with the trade-off between agglomeration tendencies and factor prices. Costinot et al. (2011) develop a theory of global supply chains with sequential production subject to mistakes, in which countries with lower probabilities of making mistakes specialize in later stages of production in a unique free-trade equilibrium.

Most prominently, however, the rationalization of patterns of specialization and trade in intermediate products proceeds using traditional models of international trade, dating back to Jones and Kierzkowski (1990). These models explicitly assume the existence of the costs of coordinating international production with or without explicit reference to networks or offshoring. In particular, models of offshoring can be found to be grounded in Heckscher-Ohlin factor-proportions models of trade (Arndt, 1997; Jones and Kierzkowski, 2001; Deardorff, 2001; Egger, 2002; Egger and

[3] In an earlier stage of the integration of the EU-15 countries Chen and Novy (2011) show that during 1999–2003 cross-country trade integration was lower for those countries that joined the EU most recently and that had not abolished physical border controls.

Falkinger, 2003), in extended-factor-proportions models of both trade and FDI (Feenstra and Hanson, 1996), and in specific-factor models (Kohler, 2004). Accordingly, international incentives for the specialization of tasks are given by country differences in terms of relative factor endowments or, absent factor price equalization, in terms of factor prices. This was proposed in Grossman and Rossi-Hansberg (2008), who identify individual tasks as prone to fragmentation and potential offshoring that may be part of the production processes of quite diverse products. From the point of view of capital-rich and/or skill-rich economies, this means that any routine task in any production can potentially be offshored. Assuming that firms are able to use their own technology whenever they opt to offshore parts of production and the cost of heterogeneity of offshoring across a continuum of tasks, Grossmann and Rossi-Hansberg (2008) demonstrate that the costs of offshoring versus wage differences drive the international division of the production chain.[4]

Empirical evidence that looks at potential determinants of specialization within the international production chain is mixed. Analyzing a subset of offshore activities in terms of the U.S. inward processing trade with the EU,[5] Görg (2000, p. 418) concludes that "the distribution of fragmented production around the globe will be according to countries' comparative advantages." Exploring textile and apparel trade, however, Baldone et al. (2001, p. 102) find that "there is no evidence that the choice of the processing country by EU firms is due to pre-existing comparative advantages." Egger and Egger (2003) broaden the scope of the analysis and show that important roles for Austrian offshoring to the CEE and the former Soviet Union was played by declining tariffs and unit labor costs in the two regions. Marin (2006) presents empirical evidence for the role of institutional influences on offshoring across Europe, based on Austrian and German firms' survey data. Finally, Kimura et al. (2007) study East Asian versus European machinery parts and components trade within an augmented traditional gravity approach, where the absolute values of differences in per capita incomes between exporter and importer countries reflect

[4] This assumes that firm-level technologies open up the possibility for activities not related to offshoring to be done subject to technological differences across countries. Thus, there need not be factor-price equalization, but on the contrary, factor-price differences may exist to be exploited by offshoring activities.

[5] Inward processing imports are intermediate goods imports for further processing at home, after which goods are re-exported (as inward processing exports) under tariff exemption. Outward processing exports are intermediate goods exports to be further processed in a foreign country, after which goods are re-imported (as outward processing imports) under tariff exemption.

supply-side country differences. Finding positive coefficients for the absolute values of differences in per capita incomes for East Asian trade but negative ones for European trade, they—contrary to the previous literature—interpret their results as indicating evidence for the existence of international machinery production networks in East Asia, but not in Europe. The authors argue that European machinery parts and components trade is better explained by a horizontal product differentiation model.

2.2 Augmented traditional gravity approach

The search for evidence and determinants of activities within global supply chains employs the workhorse of the bilateral gravity framework. Models for analyzing potentially fragmentation-induced gross trade flows (processing trade, trade in parts and components, etc.) are usually set up to reflect likely determinants spelled out in competing theories with exporter and importer market sizes leading the pack. Then, supply-side country differences or similarities are supposed to catch factor-proportions influences relevant from the perspective of comparative advantages versus new trade theory or economic geography influences. The differences or similarities are usually proxied by the absolute values of differences in per capita incomes or wages between exporter and importer countries. Finally, prior expectations on the coefficient for per capita income differences are formulated to discriminate between alternative trade theories: the existence of two-way trade driven by fragmentation within international production networks *via* comparative/location advantages is taken to imply a positive coefficient for the per capita income gap. The existence of horizontal intra-industry trade driven by new trade theories *à la* Krugman (1980) would imply a negative coefficient for the per capita income gap.

Testing the influences of various trade theories against each other within the same gravity specification presupposes that these theories can be reduced to the same gravity specification. Factor proportions theories of trade are usually incomplete specialization models while new theories of trade yield a complete specialization in equilibrium. According to Haveman and Hummels (2004), due to the adding-up constraints of countries' expenditure systems, for a world with more than two countries a combination of four assumptions suffice to derive the simplest possible bilateral gravity structure. These conditions are: (i) trade is only in final goods, (ii) all 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 of the details on the supply side that give rise to this complete specialization. Under these conditions, the volume of bilateral trade is described by a log-linear equation in both countries' incomes and world income, and there is no scope for "augmenting" the gravity equation.

New or new new theories of trade are based on product differentiation and monopolistic competition and give rise to complete specialization in equilibrium. Hence, according to these theories trade cannot be represented by gravity equations augmented by adding the absolute values of differences in per capita incomes (Arkolakis et al., 2012). Under complete specialization, analyzing gross trade flows is simply not informative about the specific driving forces connected to new trade theories or economic geography. This is true even when complete specialization is embedded into factor proportions theory as in Helpman and Krugman (1985). Therefore, any scope for augmenting the simplest gravity relationship requires that assumptions (i)–(iv) are violated. As shown in section 3, admitting trade in intermediate goods does not on its own (i.e., under the assumptions of full specialization, identical homothetic technology and frictionless trade) generate bilateral gravity equations augmented by supply-side country differences. Thus, negative coefficients for per capita income differences in augmented gravity equations describing potentially fragmentation-induced gross trade flows simply cannot indicate the presence of new trade theory influences on the data that would be rooted in complete specialization. In fact, as will follow from the analysis below, a gravity specification describing trade flows in parts and components as log-linear in both country sizes and *absolute* country income differentials does not describe the data well against any theoretical model of trade, i.e., it is mis-specified.

3. A gravity model of trade in parts and components with incomplete specialization

As outlined in section 2.1, parts and components are often modeled as differentiated products. However, much of the assumed differentiation may in fact be customization on demand within production networks or offshoring relationships (Antràs and Staiger, 2012). Levchenko (2007) demonstrates the compatibility of resulting lock-in problems with a Heckscher-Ohlin factor proportions approach to trade. From this point of view, different parts and components may be viewed as *ex ante* homogenous across potential suppliers from potentially different source countries, and some parts and components may in equilibrium be produced in and be exported by more than one country. To let the data speak, we will analyze parts and components gross trade flows within an incomplete specialization Heckscher-Ohlin framework, allowing for complete specialization as a limiting case. Trade in intermediate goods will reflect the horizontal or vertical fragmentation of production.

3.1 Multilateral trade with horizontal fragmentation: Assumptions

We follow the literature by making two distinctions as a point of departure for deriving bilateral gravity equations (see especially Deardorff, 1998; Evenett and Keller, 2002; Haveman and Hummels, 2004). The distinctions are between complete versus incomplete specialization and between trade incentives versus trade costs.

A full theoretical derivation of bilateral gravity in the presence of trade costs is so far limited to complete specialization cases. In our incomplete specialization Heckscher-Ohlin framework, we first have to answer how equilibrium can arise in the presence of trade costs in a Heckscher-Ohlin world economy comprised of $j = 1,\ldots,J$ countries with equal technologies, two factors of production (capital K and labor L), one final good, and many homogenous intermediate goods $k = 1,\ldots,N$. With zero trade costs, destination-country customers are indifferent from where they source a particular homogenous good between all supplier countries, including their own country, resulting in random rationing *à la* Deardorff (1998). When trade costs vary by distance, one would expect that adding trade costs eliminates all but one supplier of this particular good to this particular country. However, any of the other suppliers may still be the minimum total cost supplier to other countries, given variations in distance between countries. So even if bilateral trade becomes completely specialized in the presence of trade costs, worldwide production does not need to be. General equilibrium specialization and trade is the outcome of total cost minimization as the sum of production and trade costs. In equilibrium there may be a minimum total cost supplier to a particular country that is not the minimum production cost supplier but is close in distance or the other way around. Also, we might have situations of equal minimum total cost suppliers, evoking a rationale for random rationing. Without specifying the technology of overcoming trade barriers, equilibrium diversification and trade are determined by a trade-off between factor endowment and trade cost influences.

While there is no higher dimensional Heckscher-Ohlin theory with trade costs upon which to rest our gravity derivation, this is how we look at it. Specifically, we put a multi-country, multi-product, two-factor Heckscher-Ohlin framework into an intermediate goods trade extension of Haveman and Hummels' (2004) description of incomplete specialization as our starting point. We argue that what we add in terms of trade cost structure upon the seamless world fits European realities: all countries are small and encircled by other equidistant small countries. Assuming an infinitesimally small border effect but no trade or any other service link costs implies that each customer country is indifferent among all potential supplier countries except itself,[6] motivating random rationing *à la* Deardorff (1998) to decompose countries' multilateral gravity. Finally, adding specific effects in the econometric specification introduces the trade-off between incomplete-specialization forces and service-link costs into bilateral-gravity equations that is behind much of the theoretical motivation for the fragmentation-induced trade cited in section 2. In accordance with the above we make the following assumptions.

Assumption 1 – technology. Production is horizontally fragmented in the spirit of Grossman and Rossi-Hansberg (2008), where firm-specific production technologies are available in all countries. Hence, N tasks are carried out, using two factors of production (capital K and labor L), each of which results in a tradable intermediate good—a part or component. One final good is assembled from these N parts or components. All production is subject to homothetic derived demands.

Assumption 2 – trade costs. We assume an infinitesimally small border effect, but no trade or any other coordination costs.

Assumption 3 – trade balance. Imports of country i from country j (IM_{ij}) are equal to the exports of country j to country i (EX_{ji}), $IM_{ij} = EX_{ji}$.

3.2 Multilateral gravity and incomplete specialization in the presence of trade costs

According to Assumption 1, all production is subject to homothetic derived demands, such that all variables can be studied in nominal terms: C is consumption or use, X

[6] In terms of our empirical work (Section 5), this ensures that distance-related coordination costs are of second order compared to border effects.

production, Y income, EX exports, and IM imports. Subscripts denote countries, superscripts goods. Given the existence of N intermediate goods and neglecting primary inputs, parameters δ_j^k denote the allocation of value-added Z to the production of a part or component k in each country j over two stages of production. Then,

$$Z_j^k = X_j^k = \delta_j^k Y_j \qquad \text{for } k = 1,..., N \tag{1}$$

and

$$Z_j^{N+1} = X_j^{N+1} - \sum_{k=1}^N C_j^k = \delta_j^{N+1} Y_j, \text{ with } \sum_{k=1}^N \delta_j^k + \delta_j^{N+1} = 1 \tag{2}$$

such that

$$\sum_{k=1}^N Z_j^k + Z_j^{N+1} = Y_j \ . \tag{3}$$

With Assumption 1 (homotheticity in production), parameters ϕ represent the productivity of parts and components, and describe the distribution of derived demands in nominal terms,

$$C_j^k = \phi_j^k X_j^{N+1} \qquad \text{for } k = 1, ..., N. \tag{4}$$

With (2) and (3), the value-added in producing the final good can be written as

$$Z_j^{N+1} = \delta_j^{N+1} Y_j = X_j^{N+1} - \sum_{k=1}^N C_j^k \, X_j^{N+1} - X_j^{N+1} \sum_{k=1}^N \phi_j^k$$
$$= X_j^{N+1}\left(1 - \sum_{k=1}^N \phi_j^k\right) \tag{5}$$

such that

$$X_j^{N+1} = \frac{\delta_j^{N+1} Y_j}{1-\sum_{k=1}^N \phi_j^k} \ . \tag{6}$$

Equation (6) describes the output of the final good in country j. Demand is given by spending the total income on the final good, $C_j^{N+1} = Y_j$. Accordingly, the net exports of the final good are described by

$$NE_j^{N+1} = X_j^{N+1} - C_j^{N+1} = \frac{\delta_j^{N+1} Y_j}{1-\sum_{k=1}^N \phi_j^k} - Y_j = \left(\frac{\delta_j^{N+1}}{1-\sum_{k=1}^N \phi_j^k} - 1\right) Y_j. \tag{7}$$

For parts and components, output is given in (1) and used in (4), which also holds for the world as a whole, $C_w^k = \phi_w^k X_w^{N+1}$. With final goods output as described in (6) we obtain

$$\frac{C_j^k}{C_w^k} = \frac{\phi_j^k}{\phi_w^k} \frac{\delta_j^{N+1} Y_j}{\delta_w^{N+1} Y_w} \frac{1-\sum_{k=1}^N \phi_w^k}{1-\sum_{k=1}^N \phi_j^k} \text{, for k = 1,...,}N. \tag{8}$$

Expression (8) can be simplified using two characteristics of world trade. First, the world version of (7) implies that $1 - \sum_{k=1}^N \phi_w^k = \delta_w^{N+1}$, as world trade in final goods must always be balanced. Second, world output of any good is always equal to world use, such that

$$C_j^k = \frac{\phi_j^k}{\phi_w^k}\frac{\delta_j^{N+1}Y_j}{Y_w}\frac{}{1-\sum_k \phi_j^k}X_w^k$$
$$= \frac{\phi_j^k}{\phi_w^k}\frac{\delta_j^{N+1}Y_j}{Y_w}\frac{}{1-\sum_k \phi_j^k}\delta_w^k Y_w$$
$$= \frac{\phi_j^k}{\phi_w^k}\frac{\delta_j^{N+1}}{1-\sum_k \phi_j^k}\delta_w^k Y_j. \tag{9}$$

Country *j*'s net exports or imports of part or component *k* are described by

$$NE_j^k = X_j^k - C_j^k, \qquad \text{for } k = 1, \ldots, N. \tag{10}$$

Hence,

$$NE_j^k = \delta_j^k Y_j - \frac{\phi_j^k}{\phi_w^k}\frac{\delta_j^{N+1}}{1-\sum_k \phi_j^k}\delta_w^k Y_j = \left(\delta_j^k - \frac{\phi_j^k}{\phi_w^k}\frac{\delta_j^{N+1}}{1-\sum_k \phi_j^k}\delta_w^k\right)Y_j\,. \tag{11}$$

As we are only interested in parts and components trade, we may simplify (11) by assuming balanced final goods trade for each single country,[7] such that

$$NE_j^k = (\delta_j^k - \frac{\phi_j^k}{\phi_w^k}\delta_w^k)Y_j, \quad \text{for } k = 1, \ldots, N. \tag{12}$$

On the basis of (12), countries export a specific part or component if they devote a greater share of the value-added to producing this good than the rest of the world ($\delta_j^k > \delta_w^k$), or if their part or component is more productive in terms of final output than the rest of the world ($\phi_j^k < \phi_w^k$). With Assumption 1 (firm-specific technologies are identically available everywhere in the world), we can further simplify (12) to

$$NE_j^k = (\delta_j^k - \delta_w^k)Y_j, \qquad \text{for } k = 1, \ldots, N. \tag{13}$$

Summing over all goods *k*, the net exports of the parts and components of country *j* to the world are

$$NE_j \;= Y_j \textstyle\sum_{k=1}^{n}(\delta_j^k - \delta_w^k)\;. \tag{14}$$

[7] Empirically, assuming balanced trade does not usually make a significant difference; see Helpman (1987).

Selecting export items into set K_{EXj}, country j's multilateral parts and components exports are

$$EX_j = Y_j \sum_{k \in K_{EX_j}} (\delta_j^k - \delta_w^k). \quad (15)$$

Analogously imports are defined as,

$$IM_j = Y_j \sum_{k \in K_{IM_j}} (\delta_w^k - \delta_j^k). \quad (16)$$

By extending the descriptions of trade only in final goods in Haveman and Hummels (2004) to trade in parts and components in this way, equations (15) and (16) yield our first result.

Result 1. A country's multilateral exports (imports) of parts and components, generated by horizontal fragmentation, are log-linear in country income Y and a *specialization pattern.* A country's specialization pattern is described as its deviation from the rest of the world in terms of the average value-added share of producing the parts and components in its export and import baskets, i.e., by $\sum_{k \in K_{EX_j}} (\delta_j^k - \delta_w^k)$ and $\sum_{k \in K_{IM_j}} (\delta_w^k - \delta_j^k)$, respectively.

Exports and imports exhibit unitary elasticities with respect to the country income provided specialization patterns are uncorrelated with income.

As an intermediate step we proceed with the simple version of bilateral trade in parts and components with complete specialization, when each part or component is exclusively supplied by one country. Hence, 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 the parts and components supplied by country j, this decomposition of multilateral trade straightforwardly implies bilateral trade in parts and components with complete specialization as log-linear in both countries' incomes.[8]

3.3 Bilateral trade under incomplete specialization

[8] This is shown in Haveman and Hummels (2004) for trade in final goods. Chaney (2008) demonstrates that bilateral gravity continues to hold under conditions of complete specialization, even when not every good produced is traded.

In contrast to the simple complete specialization case, with incomplete specialization and no further cost of trade considered, it is not possible to strictly analytically decompose (15) and (16) into bilateral trade relationships. However, (15) and (16) together imply the two following results that represent conditions subject to which bilateral parts and components trade relationships will be distributed in a statistical sense in a sample of countries.

Result 2. For bilateral trade to occur, countries' specialization patterns as described in (15) and (16) must be complementary. Hence, there must be at least one k that is both exported by country j and imported by country i.

Result 3. Equations (15) and (16) describe countries' multilateral trade, i.e., the expected values of bilateral relationships. Thus, (15) and (16) can be expected to be met on the average in all bilateral trading relationships.

Results 2 and 3 together already allow for qualitative predictions for bilateral trade relationships. First, larger countries trade more on average. Using Result 1, in a sample of heterogeneous countries, larger countries can indeed be expected to trade more with each other. Hence, the bilateral parts and components trade volume will increase with the product of trading countries' incomes ($Y_j \times Y_i$). Second, countries that are more specialized against the world average trade more on average. Thus, in a sample of heterogeneous countries, countries that are more specialized *vis-à-vis* the world can be expected to trade more parts and components with each other provided that their specialization is complementary.

Combining our Result 1 with previous results from the literature allows us to derive the most important result of this section in the form of a bilateral-gravity framework constrained on countries' multilateral specialization patterns reflecting factor endowments or factor prices.

Result 4. With incomplete specialization, bilateral trade in parts and components is log-linear in both countries' incomes and their specific supply-side differences with respect to the world. Formally,

$$EX_{ji} \propto Y_j Y_i (w_j - w_w)(w_w - w_i), \tag{17}$$

where w_j, w_i, and w_w represent countries' and world-average supply-side characteristics either in the form of capital-labor or wage-rental ratios.

The remainder of this section derives Result 4, by combining Result 1 with the previous literature to analyze the interaction between factor endowments/prices and border effects within a gravity framework viewing bilateral trade equations as statistical relationships constrained on countries' multilateral specialization patterns. In particular, we make use of Deardorff's (1998) random choice argument, which in our context states that a country's customers, due to small border effects, prefer their home part or component to foreign ones, but are indifferent between foreign-produced parts or components. Hence, good *k* imports of country *i* from country *j* are given by country *i*'s worldwide imports of *k* times country *j*'s share in worldwide exports of *k*. Formally,

$$IM_{ij}^{k} = IM_{i}^{k}\frac{EX_{j}^{k}}{\sum_{j} EX_{j}^{k}}. \quad (18)$$

Incentives driving countries' bilateral trade under incomplete specialization must match our underlying Heckscher-Ohlin framework. Following the derivation of Result 1, consider again that worldwide exports of part or component *k* out of country *j* are given by $EX_j^k = Y_j(\delta_j^k - \delta_w^k)$. We now interpret this multilateral gravity equation between country *j* and world *w* as a bilateral gravity equation between two countries *j* and *w*. 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 part or component *k* is capital intensive, value-added δ_j^k is positively related to country *j*'s capital-labor ratio $\kappa_j = (K/L)_j$, and δ_w^k is inversely related to *w*'s capital-labor ratio, $\kappa_w = (K/L)_w$. Hence, the volume of trade increases in the difference between capital-labor ratios, $(\kappa_j - \kappa_w)$, such that

$$EX_j^k \propto Y_j(\kappa_j - \kappa_w). \quad (19)$$

Analogously, we can write $IM_i^k \propto Y_i(\kappa_w - \kappa_i)$ for relatively labor-rich country *i* exporting the labor-intensive part or component and importing the capital-intensive *k*. Accordingly, for any two countries *j* and *i*, capital-rich and labor-rich relative to the world *w*, respectively,

$$IM_{ij}^{k} \propto Y_i Y_j (\kappa_j - \kappa_w)(\kappa_w - \kappa_i) \quad (20)$$

as $\sum_j EX_j^k$ is given for each particular country.

According to Ethier (1985), the Heckscher-Ohlin theorem carries through to the case of more than two goods, such that specialization patterns between countries *j* and *w* and countries *w* and *i* continue to be shaped by differences in capital-labor ratios, at least in terms of correlations. Deardorff (1979) shows that, in a two-country, two-factor model, trade in more than two goods accords with the ranking of goods by factor intensity if there are unequal factor prices, as long as there is no connection between trade in final goods and intermediate goods. Different factor prices should be the rule in our context due to infinitesimally small home country effects. As we have derived Result 1 on trade in parts and components without reference to trade in final goods, country *j* will export the more capital intensive parts and components if country *j* is capital-richer than country *w* and if its wage-rental ratio is higher than that in country *w*. Thus, the predictive power of $Y_j(\kappa_j - \kappa_w)$ for exports from country *j* to country *w* continues to hold. We can, however, generalize that for exports from capital-rich country *j* to country *w* in fact $Y_j(w_j - w_w)$ has predictive power, where w_j and w_w represent supply-side differences either in the form of capital-labor or wage-rental ratios. The analogous reasoning can be applied to labor-rich country *i* imports from *w*, so we can generalize proportionality (15) to the multi-product case, to describe total imports to labor-rich *i* from capital-rich *j*, with or without factor price equalization. Finally, according to Assumption 3 ($IM_{ij} = EX_{ji}$), equation (17), as stated in Result 4, indeed holds.

4. Empirical specification

4.1 General outline

Combining our results from the previous section now allows us to specify a testable bilateral gravity equation. For any pair in a sample of heterogeneous countries we reformulate Result 4 in terms of absolute values. Hence, (17) directly translates into a log-linear relationship:

$$\log EX_{ji} = \beta_0 + \beta_1 \log(Y_j \times Y_i) + \beta_2 \log(|w_j - w_w| \times |w_i - w_w|). \quad (21)$$

Specification (21) is a substantial two-fold extension of Haveman and Hummels' (2004) approach towards formulating bilateral gravity equations in the presence of incomplete specialization as statistical relationships.[9] First, we extend their approach to trade in intermediate goods; second, we succeed in identifying a particular form of the influence of Heckscher-Ohlin sources of specialization patterns on bilateral gravity equations for trade in parts and components. Equation (21) is easy to interpret. Assuming a sample of heterogeneous countries, bilateral trade volumes (EX_{ji}) 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, $|w_j - w_w| \times |w_i - w_w|$. Hence, specification (21) captures the fact that bilateral trade flows will increase with relative, rather than absolute, supply-side country differences.

However, the problem with the above formulation is the potential absence of complementary specialization in Result 3 above: relative supply-side country differences $|w_j - w_w| \times |w_i - w_w|$ predict large trade volumes also for countries that lack complementary specialization. We solve this problem by introducing dummy variables to account for bilateral parts and components trade relationships between countries that are expected to be characterized by complementary specialization. This assignment should be done based on *a priori* information about the values of the supply-side country differences, e.g., on the basis of $w_j > w_w$ and $w_i < w_w$. Since our empirical analysis is performed on European trade data, we introduce a dummy variable *DummyEU*15/10 that equals one for trade relationships between an EU-15 (old) and an EU-10 (new) country and zero otherwise. Specifically, within a panel of data on EU-25 countries, bilateral trade in parts and components ($EX(PC)_{ji,t}$) can be described, so far without accounting for trade barriers, by the following specification:

$$\log EX(PC)_{ji,t} = \beta_0 + \beta_1 \log(Y_{j,t} \times Y_{i,t}) + \beta_2 \log\left(|w_{j,t} - w_{w,t}| \times |w_{i,t} - w_{w,t}|\right) + \\ +\beta_3 Dummy(EU15/10)_{ji} \log\left(|w_{j,t} - w_{w,t}| \times |w_{i,t} - w_{w,t}|\right). \qquad (22)$$

[9] Haveman and Hummels' (2004) basis for their econometric specification of bilateral trade is $\log EX_{ji} = \beta_0 + \beta_1 \log(Y_j \times Y_i) + \beta_2 \log(|w_j - w_w| + \beta_3 |w_i - w_w|)$. I.e., larger countries can be expected to trade more with each other, controlling for their specialization patterns, which they *ad hoc* proxy by specialization sources in terms of partner countries' capital-labor ratios, relative to world averages.

4.2 Trade barriers and gravity specification for bilateral trade in parts and components with incomplete specialization

Traditional gravity approaches explicitly cope with different trade barriers, i.e., distance (to proxy transport costs), geographic contiguity, cultural proximity, and the like. However, the relevant discussion on using gravity frameworks (Cheng and Wall, 2005; Baldwin and Taglioni, 2006) recommends making use of the panel structure of available trade data. The specific purpose is to incorporate trade barriers under time-invariant country-pair-specific as well as country-pair-invariant time-specific omitted variables to be controlled for by appropriate fixed effects. In terms of trade barriers, this procedure has the advantage over traditional procedures of also controlling for countries' multilateral trade resistance (see Anderson and van Wincoop, 2003). Hence, the procedure has the intuitively appealing notion that bilateral trade barriers should always be measured relative to the world, in a similar fashion as trade incentives in the form of supply-side country differences described above. An implication is that, given fixed trade barriers between countries *j* and *i*, then the higher the trade barriers of a country *j* with respect to the world, the more the country *j* will be driven to trade with country *i*.

The estimable specification is rooted in our model described in section 3 and accounts for the issues raised in section 4.1. It takes the following simple form of a gravity model:

$$\log\ EX(PC)_{ji,t} = \beta_0 + \beta_1 \log\left(Y_{j,t} \times Y_{i,t}\right) + \beta_2 \log\left(\left|w_{j,t} - w_{w,t}\right| \times \left|w_{i,t} - w_{w,t}\right|\right) + \\ + \sum_{s=1}^{5} \gamma_s Dummy(EU15/10)_{ji,s} \log\left(\left|w_{j,t} - w_{w,t}\right| \times \left|w_{i,t} - w_{w,t}\right|\right) + c_{ji} + k_t + \\ \varepsilon_{ij,t}. \tag{23}$$

Exogenous (to our model), technical progress through decreasing coordination costs and ongoing fragmentation can be represented by time effects. Nevertheless, our motivation of fragmentation and the trade it induces does not imply a high degree of substitutability but rather complementarity between technical progress and the possibility of using supply-side country differences. Hence, we model this by interacting the combined variable $DummyEU15/10_{ji} \log\left(\left|w_{j,t} - w_{w,t}\right| \times\right.$

$|w_{i,t} - w_{w,t}|)$ with time-period effects. For this purpose, we divide the sample period (1992–2008) into five sub-periods of (almost) equal length.[10]

4.3 Estimation strategy

Specification (23) is estimated on unbalanced panel data with a mean time length of about 10 years. We proxy capital-labor ratios by GDP per capita and wage-rental ratios by wages, assuming much lower variation in interest rates than in wages across Europe.[11] In specification (23) we use time-invariant asymmetric country-pair-specific effects (c_{ij}) to capture the fixed effects between exporting and importing countries that do not change over time. In general, researchers prefer using a pairwise fixed effects model because the individual effects could be correlated with the explanatory variables; this potential correlation of the fixed effects and right-hand-side variables can lead to inconsistent estimates, especially in a dynamic setting. Moreover, a pairwise fixed-effects model absorbs all time-invariant regressors that characterize the relationship between an exporter and importer. Further, pairwise fixed effects estimation has an advantage by eliminating potential omitted variable bias. Finally, by using a pairwise fixed-effects model we are able to account for the multilateral trade resistance issue broadly discussed in the literature.[12]

In order to obtain consistent estimates we employ a dynamic panel-data model following the approaches of Arellano and Bond (1991), Arellano and Bover (1995), Blundell and Bond (1998), and Blundell et al. (2000). The estimator is implemented in STATA 12 as an *xtdpd* command and it uses moment conditions in which the lagged levels of the dependent and predetermined variables serve as instruments for the differenced equation. 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.

[10] Navaretti and Venables (2004), among others, show that fragmentation is a necessary condition for countries starting to engage in production-process vertical division of labor to utilize the advantage of location differences.

[11] Amiti and Davis (2011) analyze the impact of trade liberalization on wages by accounting for firm-level heterogeneity in trade behavior as well as the large and growing importance of trade in intermediate products.

[12] For details on the use of relative price differences dealing with multilateral trade resistance in gravity-type specifications see Anderson and Van Wincoop (2003). Feenstra (2004) shows that including country-pair dummies generates about the same effect as using relative price differences.

As the test confirms the endogeneity of explanatory variables we proceed with instrumentation. We estimate the theoretically motivated specification (23) in a panel setting with fixed effects plus instrument variables a) to overcome the problems of omitting-variables bias and b) 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, 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 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).

5. Data

Bilateral trade in parts and components $EX(PC)_{ji}$ describes the exports of parts and components from country j to country i over the period 1992–2008. The data were compiled from the United Nations COMTRADE database. The definition of the parts and components of capital goods follows the BEC categorization of the UN Statistics. Our data cover 24 EU countries, which leads to 552 (23 x 24) importer-exporter country pairs.[13] Our data do not contain zero-trade flows; hence, we do not need to apply the two-stage estimation procedure suggested in Helpman et al. (2008). The details on the data and variables used are provided in Tables 1 and B.1.

In our estimation we employ three different measures of bilateral trade in parts and components. First, we measure the trade flows of how much country j exports to country i, which is identical to how much country i imports from country j. Then, following Frensch (2010), we measure bilateral trade along the extensive and intensive margins. Hence, our second measure, trade along the extensive margin, represents the *variety* of parts and components of capital goods exported from country j to country i at time t. It is defined as a count measure over some 300 parts and components out of all 3,114 of the SITC Rev.3 categories. Our third measure, along

[13] Belgium and Luxembourg are treated as one country. Cyprus and Malta are not included due to limited data.

the intensive margin, represents the *intensity* of parts and components exported from country j to country i at time t. The intensive margin is defined as the average volumes of exported parts and components categories.

Further, Y_j and Y_i are exporter and importer GDP at current prices, respectively. Similarly we employ exporter and importer GDP per capita at current prices as an alternative measure of supply-side country differences. Both GDP-related data were obtained from the World Development Indicators (accessed via the DCI database). Our primary measure of supply-side country differences is wages in exporting (w_j) and importing (w_i) countries and they are measured as the annual wage average in the manufacturing sector of exporting (importing) country j (i) at a specific year t. For each country an average wage in the manufacturing sector in the local currency was converted into USD. The data were obtained from LABORSTA (International Labor Office statistical databases, http://laborsta.ilo.org/).

World GDP per capita at current prices and world average wage (w_w) is measured as the mean GDP per capita in the world and the mean wage in the world, respectively; the world is defined by our full reporting sample described in Appendix Table A.1. Analogous to a simple mean we also construct the weighted averages of world GDP per capita and wages in which population sizes (p_i) serve as weights. Population data were obtained from World Development Indicators. With these variables we construct relative supply-side country differences in GDP per capita and wages, $|w_j - w_w| \times |w_i - w_w|$. Given that specification (23) is rooted in factor-proportion models of incomplete specialization and trade, existing wage differences may be subject to factor price equalization tendencies by the very trade they induce.[14] As factor-price differences may not be strictly exogenous, we follow Arellano and Bond (1991) and apply the simplest possible remedy in choosing the second lags of the explanatory variables as instruments.

The time-specific effects in (23) also control for each year's data using a different *numéraire* since GDP and trade values are all current (Baldwin and Taglioni, 2006), where original USD-denominated data are converted to euros.

6. Empirical Results

6.1 A priori *expectations and benchmark results*

[14] Most of the fragmentation-induced offshoring literature is in fact on these labor market effects; see, e.g., Geishecker and Görg (2008).

Our key results are based on estimates from specification (23) that are explicitly rooted in incomplete specialization. Hence, we can form *a priori* expectations on some coefficients and formulate testable hypotheses. First, we state Hypothesis 1.

Hypothesis 1: The bilateral parts and components trade volume will increase with the product of trading countries' incomes; formally we test whether $\beta_1 > 0$.

As equations (15) and (16) 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.

Second, we state Hypothesis 2.

Hypothesis 2: The volume of trade is related to the extent of supply-side country differences relative to the world.

However, we cannot form an *a priori* expectation about the value of β_2 without further information on the sample of countries. If the sample is heterogeneous in terms of complementary specialization, we expect $\beta_2 > 0$. 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 deviations of both countries' specialization incentives from world averages, i.e., higher $|w_j - w_w| \times |w_i - w_w|$, will generate less parts and components trade, such that $\beta_2 < 0$.

Third, if a complementary specialization can be derived from the data then the dummy variable *Dummy*EU15/10 in specification (23) would capture the "right" country pairs with complementary specialization. For that case, we state Hypothesis 3.

Hypothesis 3: The volume of trade will increase with the extent of truly complementary specialization between countries; formally we test whether $\gamma_s > 0$.

Since the interactive term $DummyEU15/10_{ji} \log\left(|w_{j,t} - w_{w,t}| \times |w_{i,t} - w_{w,t}|\right)$ is estimated separately for five sub-periods over the period 1992–2008, we obtain five coefficients γ_s. This set of coefficients enables us to capture the dynamic effects.

Finally, we state Hypothesis 4.

Hypothesis 4: The volume of trade will increase with the degree of specialization between the new and old EU countries.

Hypothesis 4 is assessed via the net effect of the relative supply-side country differences that is captured by the sum of the coefficients ($\beta_2 + \gamma_s$). A positive value of the sum favors the above idea of intra-European specialization. For the natural limiting case of complete specialization, we would not find specialization patterns to play any role, in which case $\beta_2 = \gamma_s = 0$. In fact, complete specialization is in principle compatible with both (new) new theories of trade, based on monopolistic competition models of trade as well as Heckscher-Ohlin with trade costs or for substantial differences in endowments. However, Debaere and Demiroglu (2003) find evidence of similar factor endowments among large parts of our country sample, to potentially enable them to produce the same set of goods. Heckscher-Ohlin-based simulation results in Haveman and Hummels (2004) with infinitesimally small trade costs changing the ordering of minimum cost suppliers without changing prices give 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. On this basis, we will identify our limiting case of $\beta_2 = \gamma_s = 0$ as complete specialization based on monopolistic competition models of trade, indicating trade in variants of differentiated products rather than in different homogenous products.

We introduce our benchmark results based on specification (23) in the first columns of Table 2 and 3 (flows), where we present the estimated coefficients for the dependent variables of bilateral parts and components trade introduced in section 4.3. Each table contains estimates for a specific variable described earlier that represents supply-side country differences: wages (Table 2) and GDP per capita to proxy capital-labor ratios (Table 3). The results for both types of variables are not materially different. The key fact is that our results provide evidence for trade in parts and components of capital goods due to the existence of multinational production networks across Europe, and inform about the driving forces identified already in the first section.

First, the statistically significant coefficients β_1 demonstrate that larger countries trade more with each other. Second, the negative coefficients β_2 confirm that our sample of European countries on average in fact features a rather homogeneous specialization pattern in the international production chain as compared to the world average. This seems to confirm the results in Kimura et al. (2007) in that European trade in parts and components is based on monopolistic competition models of trade, indicating trade in variants of differentiated products rather than in different homogenous products. However, this average pattern does not reveal the 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 sums 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.) show that relative supply-side country differences do drive trade in parts and components across Europe. This trade is compatible with models of incomplete specialization and trade, but only between the original EU-15 and the ten accession countries (EU-10), rather than within each of the two country groups. Specifically, when measuring relative supply-side country differences by wages (Table 2), parts and components trade flows between East and West Europe react with an elasticity growing from about 8% ($\beta_2 + \gamma_1$) to some 15% ($\beta_2 + \gamma_4$). When population-weighted averages are used (Table 4) the trade flows react with even larger elasticity growth from about 15% ($\beta_2 + \gamma_1$) to about 21% ($\beta_2 + \gamma_4$). Measuring relative supply-side country differences by per capita GDP (Table 3) brings elasticities to a range between 9% and 13%, or 13–16% for results accounting for population weights (Table 5). Consequently, bilateral trade flows in parts and components between old and new EU members appear to be driven by incomplete specialization motives.

Third, technical progress in terms of declining coordination costs and ongoing fragmentation—as captured by the sub-period dummies—appears to positively influence trade in parts and components: with the exception of the final sub-period, for EU-15/EU-10 pairs, coefficients γ_s are increasing slowly over time. The slight decrease of the γ_5 coefficient in the final 2005–2008 sub-period might indicate that EU-10 countries catch up with the EU-15 so that supply-side country differences between both groups, relative to the world, become less pronounced. This may well be affected by the technological progress in the EU-10 countries that is closely linked to foreign direct investment and multinationals (Uzagalieva et al., 2012). As foreign-owned subsidiaries become a part of the innovation systems and the industrial structure of the EU-10 countries, they promote overall technological growth in the region that further contributes to catch-up with the EU-15.

Finally, as part of robustness checks (see section 6.2), we plot the confidence intervals of the coefficients estimated from specification (23) in Figure 1. Black and white bars depict simple and weighted means, respectively. Based on the coefficients' values (vertical axis) and their confidence intervals it is clearly evident that sum of the coefficients associated with development of the specialization ($\beta_2 + \gamma_s$) is for all five considered periods statistically greater than zero. This property of the coefficients directly implies that specialization patterns of the EU-15 and EU-10 countries were complementary during the period under research.

6.2 Robustness

Tables 2 and 3 already confirm that the relative supply-side country differences that generate trade in parts and components across Europe do not depend on the measurement of these differences, either as wages or as GDP per capita.

As already discussed in Debaere (2003), measuring world averages in relative supply-side country differences matters a lot. So far, world average wages and GDP per capita have been measured as simple averages in the world defined by our full reporting sample described in Appendix Table A.1. Tables 4 and 5 display the results of a modified world average measurement. We now employ an average that is weighted by countries' populations, as comparable work force data are unavailable on the scale of our full sample. The results are not materially different from those reported in Tables 2 and 3. Hence, our results are also robust to this change in measurement.

Finally, we complement our robustness results by a statistical comparison of the coefficients derived from the estimated specification (23) where wages serve as a measure for supply-side country differences. These are coefficients presented in Table 2 (simple averages) and Table 4 (weighted averages). In Figure 1 we present the plots of the confidence intervals of the above coefficients. Black and white bars depict simple and weighted means, respectively. The shapes of the white bars reflect the lower dispersion due to weighting. The three graphs in Figure 1 show that there is ample overlap of the confidence intervals of coefficients. Hence, our results are in a statistical sense robust to the world average measurement in terms of simple or weighted averages.

6.3 Trade margins and conjectures on links to the offshoring literature

The results of the previous section provide evidence that the East-West part of the European trade in parts and components is driven by trade-offs between location advantages and coordination costs, relative to the rest of the world. As Kimura et al. (2007) do for East Asia, we take this as evidence for the existence of supply chains in the form of international production networks across Europe. While this in itself does not constitute evidence for outright offshoring of labor-intensive tasks from West

European to East European firms, we may conclude from the literature cited in section 2.1 that this is what happens regularly. Accordingly, in this section we will interpret trade in parts and components between East and West Europe as being offshore related.

Based on the highly disaggregated nature of our original trade data (see Appendix A for data details) we decompose the influences on parts and components trade along the two margins of trade, i.e., along *extensive* (number of exported goods) versus *intensive* (average volumes per exported good) import margins. This reveals that trade in parts and components across Europe is predominantly realized along the intensive margin in response to market size increases, but along the extensive margin in response to stronger relative supply-side country differences, i.e., more offshore-related trade between the EU-15 and the EU-10 in response to stronger relative supply-side country differences may have resulted predominantly from the offshoring of new activities rather than extending the scale of already-offshore activities.

The above results have important implications in terms of wages. According to Bergin et al. (2011), recent new offshoring from the EU-15 to the EU-10 may, *ceteris paribus*, have increased employment volatility in the new EU. The margin distinction, however, may also be of relevance for wages in the home country. Estimating Mincer-type wage equations augmented by offshoring treatment effects to firm-level data, Geishecker and Görg (2008) demonstrate that offshoring low-skill tasks decreases the wages of German low-skill employees. Comparing wage and employment effects across countries features significant differences in this respect, which may be motivated by different labor market institutions, as suggested in Geishecker et al. (2008).

Our results may be related to an alternative explanation for the internationally varying labor-market effects of offshoring, however. Empirical work on the labor-market effects of offshoring has so far been mainly guided by the theoretical framework of Feenstra and Hanson (1996), in which offshoring is costless or uniformly costly across discrete sets of tasks, predicting the effects indeed identified in Geishecker and Görg (2008). More recent theoretical work, however, generalizes Feenstra and Hanson (1996) by introducing task-specific trade costs that potentially limit the offshoring of a continuum of tasks (Grossman and Rossi-Hansberg, 2008). More offshoring of low-skill tasks, made possible by decreasing coordination costs over all tasks, then *ceteris paribus* implies a positive productivity effect in the source country, which appears strongest in those firms that have already offshored the most, and which therefore carries the highest potential benefits for the skill groups hit hardest by offshoring. The labor market effects that disadvantage the skill groups hit hardest by offshoring, as already identified in Feenstra and Hanson (1996), are thus counterbalanced and may even be dominated under certain conditions. Firms that have already offshored most tasks are increasingly likely to strengthen already-existing relationships rather than create new offshoring relationships. In our trade terminology, existing offshoring relationships, in turn, get strengthened along the intensive margin, as opposed to strengthening along the extensive margin by new relationships. One might therefore suspect the unambiguous results of Geishecker and Görg (2008) to hold for offshoring relationships that get predominantly strengthened along the extensive margin, rather than along the intensive margin. With the caveat of our using disaggregated macro rather than micro data, this, in turn, seems to be the case for the offshoring relationship between the EU-15 and the EU-10, i.e., the "old" and the "new" EU members. In the spirit of the Grosssman Rossi-Hansberg (2008) approach, this would suggest the conjecture that recent waves of offshoring activities from "old" to "new" EU members might have hurt (low-skill) workers in the old EU, perhaps more so than old EU offshoring elsewhere.

7. Conclusions

This study started by stating that analyzing gross trade flows in parts and components with gravity equations augmented by *ad hoc* measures of supply-side country differences appear to be mis-specified, due to theoretically unmotivated attempts to allow for both complete and incomplete specialization influences on parts and components trade within the same gravity framework. We develop an appropriate gravity framework, rooted in the incomplete-specialization version from Heckscher-Ohlin, that views bilateral parts and components trade gravity equations as statistical relationships constrained on countries' multilateral specialization patterns and allows this trade to increase with fragmentation, declining coordination costs, and multilateral incentives to specialization, and also to decline with trade resistance. Complete specialization emerges as a natural limiting case with specialization patterns playing no role.

We apply this framework to a truly Europe-wide sample of countries, while fully accounting for potential tendencies towards factor price equalization via trade.

We find no evidence for the average bilateral European parts and components trade relationship to be driven by countries' multilateral specialization incentives, as expressed by relative (to the rest of the world) supply-side country differences. However, we do find this evidence for parts and components trade relationships between EU-15 and EU-10 countries, together with a positive influence for technical progress in terms of declining coordination costs and ongoing fragmentation and a negative impact of multilateral trade resistance. Analogous to Kimura et al. (2007)'s conclusion on East Asia, we take this as evidence for the existence of international production networks across Europe, driven by trade-offs between wages and coordination costs.

In particular, the results do not contradict Grossman and Rossi-Hansberg (2008), where firms' decisions about offshoring and trade in parts and components are embedded in an environment of incomplete factor price equalization, firm-level technologies, and the cost heterogeneity of offshoring across a continuum of tasks, and are thus compatible with the view that offshoring need not hurt (low-skill) workers, as long as offshoring relationships get strengthened along the intensive margin as opposed to the extensive margin. In as much as international production networks across Europe are shaped by the outright offshoring of labor-intensive tasks from West to East, our results, however, suggest that exactly this strengthening along the extensive margin by creating new relationships might have been happening recently when extending offshoring from the EU-15 to the EU-10.

Extensions of this paper may better reflect the influence of declining coordination costs, so far proxied by sub-period fixed effects. More realistic attempts should aim at measuring trade liberalization or institutional variation especially with respect to the labor market (Geishecker et al., 2008).

References

Amiti, Mary, Location of vertically linked industries: agglomeration versus comparative advantage. *European Economic Review 49,* 4, 2005, pp. 809–832.

Amiti, Mary, and Donald R. Davis. Trade, Firms, and Wages: Theory and Evidence. *Review of Economic Studies*, 2012,) 79(1): 1-36.

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.

Antràs, Pol and Robert W. Staiger, Offshoring and the role of trade agreements. *American Economic Review 102*, 7 (2012), pp. 3140–3183.

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.

Arkolakis, Costas, Arnaud Costinot, and Andrés Rodríguez-Clare, New trade models, Same old gains? *American Economic Review 102,* 1, 2012, pp. 94–130.

Arndt, Sven W., Globalization und the open economy. *North American Journal of Economics and Finance 8*, 1, 1997, pp. 71–79.

Balassa, Bela (1966). Tariff Reductions and Trade in Manufacturers among the Industrial Countries. American Economic Review, 56(3), 466-473.

Baldone, S., F. Sdogati, and L. Tajoli, Pattern and determinants of international fragmentation of production: evidence from outward processing trade between the EU and Central and Eastern European Countries. *Weltwirtschaftliches Archiv 137*, 1, 2001, pp. 80–104

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

Bergin, Paul R., Robert C. Feenstraa, and Gordon H. Hanson, Volatility due to offshoring: Theory and evidence. *Journal of International Economics 85,* 2, 2011, pp. 163–173

Blundell, Richard, and StephenR. 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.

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.

Breda, Emanuele, Rita Cappariello und Roberta Zizza, Vertical specialization in Europe: evidence from the import content of exports. Working Paper 682, Bank of Italy, August 2008.

Chaney, Thomas, Distorted gravity: the intensive and extensive margins of international trade. *American Economic Review 98*, 4, 2008, pp. 1707–1721.

Chen, N., Novy, D., 2011. Gravity, trade integration, and heterogeneity across industries. *Journal of International Economics 85,* 2, pp. 206–221.

Cheng, I-H., and H.J. Wall, Controlling for country heterogeneity in gravity models of trade and integration. *Federal Reserve Bank of St. Louis Review 87,* 1, 2005, pp. 49–63.

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

Costinot, Arnaud, Jonathan Vogel, and Su Wang, An elementary theory of global supply chains. NBER Working Paper No. 16936, Cambridge, Mass., April 2011.

Deardorff, Alan V., Weak links in the chain of comparative advantage. *Journal of International Economics 9*, 1979, pp. 197–209.

Deardorff, Alan V., Determinants of bilateral trade: Does gravity work in a neoclassical world? In: Frankel, Jeffrey (ed.), *The Regionalization of the World Economy*, Chicago, University of Chicago Press, 1998, pp. 7–32.

Deardorff, Alan V., Fragmentation in simple trade models. *North American Journal of Economics and Finance 12*, 2001, pp. 121–137.

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

Debare, Peter, and Ufuk Demiroglu , On the similarity of country endowments. *Journal of Intenational Economics 39*, 2003, pp. 101–136.

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

Egger, Hartmut, International outsourcing in a two-sector Heckscher-Ohlin model. *Journal of Economic Integration 17*, 2002, pp. 687–709.

Egger, Hartmut, and Peter Egger, Outsourcing and skill-specific employment in a small economy: Austria after the fall of the iron curtain. *Oxford Economic Papers 55*, 4, 2003, pp. 625–43.

Egger, Hartmut, and Peter Egger, The determinants of EU processing trade. *World Economy 28*, 2, 2005, pp. 147–168.

Egger, Hartmut, and Josef Falkinger, 2003. The distributional effects of international outsourcing in a 2 x 2 production model, The North American Journal of Economics and Finance, 14(2), 189-206.

Egger, Hartmut, and Josef Falkinger, 2006. The role of public infrastructure and subsidies for firm location and international outsourcing. European Economic Review, 50(8), 1993-2015.

Ethier, Wilfred J., Higher dimensional issues in trade theory. In: Jones, Ronald W. and Peter B. Kenen (eds.), *Handbook of lnternational Economics*, vol. I, Amsterdam and New York, Elsevier, 1984, pp. 131–184.

Evenett, Simon J. and Wolfgang Keller, On theories explaining the success of the gravity equation. *Journal of Political Economy 110*, 2, April 2002, pp. 281–316.

Feenstra, Robert C., and Gordon H. Hanson, Foreign direct investment, outsourcing and relative wages. In: Robert C. Feenstra, Gene M. Grossman, and D. A. Irwin (eds.), *The Political Economy of Trade Policy: Papers in Honor of Jagdish Bhagwati*, MIT Press, Cambridge, Mass., 1996, pp. 89–127.

Fidrmuc, Jarko, Gravity models in integrated panels. *Empirical Economics 37*, 2, 2009, pp. 435–446.

Frensch, Richard, Trade liberalisation and import margins. *Emerging Markets Finance & Trade*, 46(3), 2010, 4-22.

Frensch, Richard, and Vitalija Gaucaite Wittich, Product variety and technical change. *Journal of Development Economics 88*, 2, March 2009, pp. 242–257.

Fujita, Masahisa, and Jacques-François Thisse, Globalization and the evolution of the supply chain: who gains and who loses? *International Economic Review 47*, 3, 2006, pp. 811–836.

Geishecker, Ingo, and Holger Görg, Winners and losers: a micro-level analysis of international outsourcing and wages. *Canadian Journal of Economics 41*, 1, 2008, pp. 243-270.

Geishecker, Ingo, Holger Görg, and Jakob R. Munch, Do labor market institutions matter? Micro-level wage effects of international outsourcing in three European countries. Kiel Working Papers, 1404, Kiel Institute for the World Economy, 2008.

Görg, Holger, Fragmentation and trade: US inward processing trade in the EU. *WeltwirtschaftlichesArchiv 136*, 3, 2000, pp, 403–422.

Grossman, Gene M., and Esteban Rossi-Hansberg, Trading tasks: a simple theory of offshoring. *American Economic Review 98*, 5, 2008, pp. 1978–1997.

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.

Hayakawa, Kazunobu, Measuring barriers to international division of labor in East Asia. *Asian Economic Journal 21*, 2, 2007, pp. 139–153.

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, May 2008, pp. 441–487.

Hummels, David, Jun Ishii, and Kei-Mu Yi, The nature and growth of vertical specialization in world trade. *Journal of International Economics 54,* 1, 2001, pp. 75–96.

Johnson, Robert C., and Guillermo Noguera, Fragmentation and trade in value added over four decades. NBER Working Paper 18186, Cambridge, MA, June 2012

Johnson, Robert C., and Guillermo Noguera, Accounting for intermediates: production sharing and trade in value added. *Journal of International Economics 86*, 2012, pp. 224–236.

Jones, R., and H. Kierzkowski, The role of services in production and international trade: A theoretical framework. In R. Jones & A. Krueger (Eds.), The political economy of international trade: Essays in honor of Robert E. Baldwin. Oxford: Basil Blackwell, 1990.

Jones, R.W. and H. Kierzkowski, 2001, A framework for fragmentation. In: S.W. Arndt and H. Kierzkowski (eds.), *Fragmentation: New Production Patterns in the World Economy*, OxfordUniversity Press, Oxford, pp. 17-34.

Keller, Wolfgang, International technology diffusion. *Journal of Economic Literature 42*, 3, 2004, pp. 752–782

Kimura, Fukunari, International production and distribution networks in East Asia: eighteen facts, mechanics, and policy implications. *Asian Economic Policy Review*, 1, 2006, pp. 326–344.

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.

Kimura, Fukunari, Kazunobu Hayakawa, and ZhengJi, Does International Fragmentation Occur in Sectors Other Than Machinery? *Asian Economic Journal 22*, 4, 2008, pp. 343–358.

Kohler, Wilhelm, Aspects of international fragmentation. *Review of International Economics 12*, 5, 2004, pp. 793–816.
Koopman, Robert, Zhi Wang, and Shang-Jin Wei, Tracing value-added and double counting in gross exports. NBER Working Paper 18579, Cambridge, MA, November 2012.
Krugman, Paul R., Scale economies, product differentiation, and the pattern of trade. *American Economic Review* 70, 5, 1980, pp. 950–59.
Levchenko, Andrei A., Institutional quality and international trade. *Review of Economic Studies 74*, 2007, pp. 791–819.
Marin, Dalia, A new international division of labor in Europe: Outsourcing and offshoring to Eastern Europe. *Journal of the European Economic Association 4*, 2-3, 2006, pp. 612–622.
Navaretti, Giorgio Barba, and Anthony J. Venables, *Multinational Firms in the World Economy*. Princeton University Press, 2004.
Robert-Nicoud, Frédéric, Offshoring of routine tasks and (de)industrialisation: threat or opportunity—and for whom? *Journal of Urban Economics 63*, 2008, pp. 517–535.
Romer, Paul, Endogenous technological change. *Journal of Political Economy 98*, 5, 1990, pp. S71–S102.
Sinn, Hans-Werner, *Die Basarökonomie. Deutschland Exportweltmeister oder Schlusslicht?* Econ, Berlin, 2005.
Uzagalieva, A., Kočenda, E., Menezes, A., 2012. Technological Innovation in New European Union Markets. *Emerging Markets Finance and Trade*, 48(5), 51–69.

Table 1. Definitions of variables and descriptive statistics

Variable	Definition	Source	Average, min, max
$EX_{ji,t}$ *(PC)*	Exports of parts and components of capital goods from country *j* to country *i* at time *t* in current dollars	UN Comtrade	Levels: 93,660 0.0 7.12e07 Logs: 6.36 0.0 18.1
Extensive margin of $EX_{ji,t}$ *(PC)*	Variety of parts and components of capital goods exported from country *j* to country *i* at time *t*	UN Comtrade, own computation	Levels: 65.1 0.0 629 Logs: 2.5 0.0 6.4
Intensive margin of $EX_{ji,t}$ *(PC)*	Intensity of parts and components exports from country *j* to country *i* at time *t*	UN Comtrade, own computation	Levels: 508.3 1.0 1.37e06 Logs: 3.8 0.0 14.1
Y_j, Y_i	Export and import, country GDP in current dollars	*World Development Indicators 2011*	Levels: 9.8e05 1172 1.4e07
y_j, y_i	Export and import, country GDP per capita in current dollars	*World Development Indicators 2011*	Levels: 20,504 260 93,017
y_w	World average GDP per capita in current dollars	*World Development Indicators 2011*, own computation	Levels: 16,662 10,042 25,566
w_j, w_i	Average wage in manufacturing in export and import countries in current dollars	LABORSTA, ILO database, available online at http://laborsta.ilo.org/ plus country statistical offices	Levels: 1,272 405 3,561
p_i	Country population in millions	*World Development Indicators 2011*	Levels: 54.2 0.2 1,354

Table 2: Parts and components exports, w=wages (simple world averages)

			Flows	Extensive Margin	Intensive Margin
log Y_j Y_i		β_1	0.718***	0.254***	0.464***
			(0.023)	(0.013)	(0.014)
log ($\lvert w_j - w_w\rvert \times \lvert w_i - w_w\rvert$)		β_2	-0.101***	-0.040***	-0.061***
			(0.020)	(0.010)	(0.013)
log ($\lvert w_j - w_w\rvert \times \lvert w_i - w_w\rvert$) for EU-15 / EU-10 pairs	1992-1995	γ_1	0.183***	0.104***	0.079***
			(0.036)	(0.020)	(0.021)
	1996-1998	γ_2	0.202***	0.117***	0.085***
			(0.036)	(0.019)	(0.021)
	1999-2001	γ_3	0.241***	0.145***	0.096***
			(0.035)	(0.019)	(0.020)
	2002-2004	γ_4	0.251***	0.157***	0.094***
			(0.034)	(0.018)	(0.020)
	2005-2008	γ_5	0.230***	0.132***	0.099***
			(0.033)	(0.018)	(0.020)
N			27,354	27,354	27,354

Notes to Tables 2–5: Variables are defined in Table 1. Fixed effects not reported, *t*-statistics in parentheses.

*, **, and *** indicate significance at the 10, 5, and 1 percent levels, respectively.

Table 3: Parts and components exports, w=GDP per capita (simple world averages)

			Flows	Extensive Margin	Intensive Margin
log Y_j Y_i		β_1	0.728***	0.262***	0.465***
			(0.019)	(0.011)	(0.013)
log ($\lvert w_j - w_w\rvert \times \lvert w_i - w_w\rvert$)		β_2	-0.069***	-0.020	-0.049***
			(0.027)	(0.014)	(0.017)
log ($\lvert w_j - w_w\rvert \times \lvert w_i - w_w\rvert$) for EU-15 / EU-10 pairs	1992-1995	γ_1	0.161***	0.108***	0.053***
			(0.024)	(0.014)	(0.014)
	1996-1998	γ_2	0.176***	0.117***	0.059***
			(0.024)	(0.014)	(0.014)
	1999-2001	γ_3	0.193***	0.124***	0.070***
			(0.024)	(0.014)	(0.014)
	2002-2004	γ_4	0.198***	0.126***	0.072***
			(0.023)	(0.013)	(0.013)
	2005-2008	γ_5	0.186***	0.110***	0.076***
			(0.023)	(0.013)	(0.013)
N			33,034	33,034	33,034

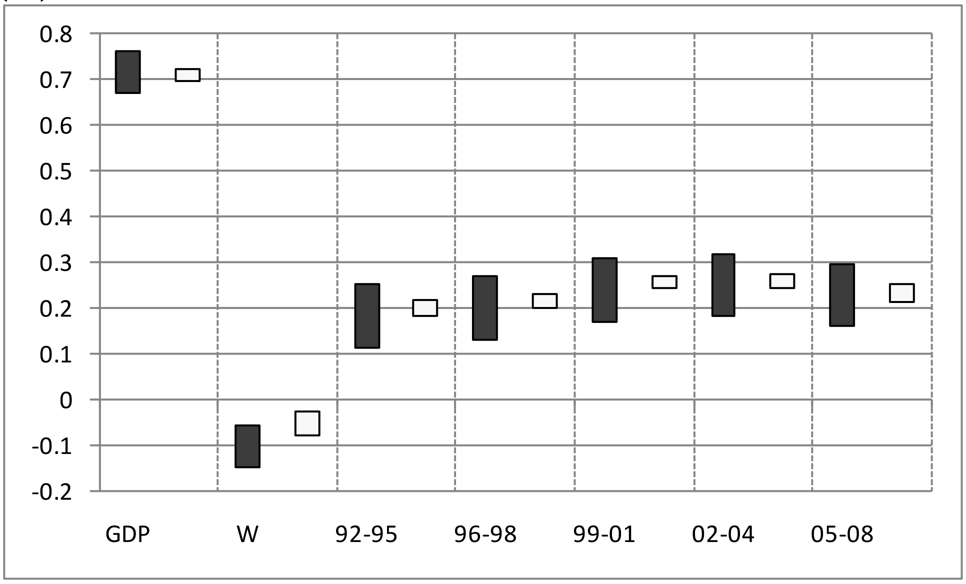
Table 4: Parts and components exports, w=wages (population weighted world averages)

			Flows	Extensive Margin	Intensive Margin
$\log Y_j Y_i$		β_1	0.711***	0.250***	0.462***
			(0.007)	(0.003)	(0.006)
$\log (\lvert w_j - w_w \rvert \times \lvert w_i - w_w \rvert)$		β_2	-0.052***	-0.015***	-0.037***
			(0.012)	(0.005)	(0.011)
$\log (\lvert w_j - w_w \rvert \times \lvert w_i - w_w \rvert)$ for EU-15 / EU-10 pairs	1992-1995	γ_1	0.200***	0.111***	0.089***
			(0.009)	(0.004)	(0.008)
	1996-1998	γ_2	0.217***	0.123***	0.095***
			(0.008)	(0.003)	(0.007)
	1999-2001	γ_3	0.257***	0.152***	0.105***
			(0.007)	(0.003)	(0.007)
	2002-2004	γ_4	0.260***	0.161***	0.100***
			(0.008)	(0.003)	(0.007)
	2005-2008	γ_5	0.234***	0.133***	0.101***
			(0.008)	(0.003)	(0.007)
N			27,354	27,354	27,354

Table 5: Parts and components exports, w=GDP per capita (population weighted world averages)

			Flows	Extensive Margin	Intensive Margin
$\log Y_j Y_i$		β_1	0.712***	0.256***	0.456***
			(0.006)	(0.002)	(0.005)
$\log (\lvert w_j - w_w \rvert \times \lvert w_i - w_w \rvert)$		β_2	-0.041***	-0.006	-0.035***
			(0.010)	(0.004)	(0.009)
$\log (\lvert w_j - w_w \rvert \times \lvert w_i - w_w \rvert)$ for EU-15 / EU-10 pairs	1992-1995	γ_1	0.172***	0.112***	0.060***
			(0.006)	(0.002)	(0.005)
	1996-1998	γ_2	0.187***	0.120***	0.066***
			(0.005)	(0.002)	(0.005)
	1999-2001	γ_3	0.203***	0.127***	0.077***
			(0.005)	(0.002)	(0.005)
	2002-2004	γ_4	0.207***	0.129***	0.078***
			(0.005)	(0.002)	(0.005)
	2005-2008	γ_5	0.197***	0.114***	0.083***
			(0.005)	(0.002)	(0.005)
N			33,034	33,034	33,034

Figure 1. Comparison of confidence intervals for coefficients from specification (23)



Note: Black and white bars depict simple and weighted means, respectively. Confidence intervals are labeled in the following way: *GDP* denotes the coefficient of log Y_j Y_i (β_1) and *W* denotes the coefficient of log ($|w_j - w_w| \times |w_i - w_w|$), where *w* stands for wages, (β_2). The remaining confidence intervals refer to the coefficients of log ($|w_j - w_w| \times |w_i - w_w|$) for the EU15/10 dummy, computed over the specified time periods, i.e., 1992–1995 (γ_1), 1996–1998 (γ_2), 1999–2001 (γ_3), 2002–2004 (γ_4), and 2005–2008 (γ_5).

Appendix A: Commodity classifications, country, and time coverage

Commodity classifications

SITC

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. We use *basic categories* to distinguish and count SITC categories for the definition of the *extensive versus intensive* margins of trade flows).

BEC

The United Nations Statistics Division's *Classification by BEC* (*Broad Economic Categories*, available online at:
http://unstats.un.org/unsd/class/family/family2.asp?Cl=10)
allows for headings of the SITC, Rev.3 to be grouped into 19 activities covering primary and processed foods and beverages, industrial supplies, fuels and lubricants, capital goods and transport equipment, and consumer goods according to their durability. The BEC also provides for the rearrangement of these 19 activities (on the basis of SITC categories' *main* end-use) to approximate the basic System of National Accounts (SNA) activities, namely, primary goods, intermediate goods, capital goods, and consumer goods.

Specifically, the BEC permits the identification of a subset of about 300 intermediate goods used as inputs for capital goods, i.e. parts and accessories of capital goods. In this paper, consistent with the use in the rest of the literature, these are referred to as *parts and components*.

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

1	AUT	Austria (1992–2008)	9	FRA	France (1992–2008)	17	LVA	*Latvia* (1995–2008)
2	BEL	Belgium and Luxembourg (1992–2008)	10	GBR	United Kingdom (1992–2008)	18	NLD	Netherlands (1992–2007)
3	BGR	*Bulgaria* (1996–2008)	11	GER	Germany (1992–2008)	19	POL	*Poland* (1992–2008)
4	CZE	*Czech Republic* (1993–2008)	12	GRC	Greece (1992–2008)	20	PRT	Portugal (1992–2008)
5	DNK	Denmark (1992–2008)	13	HUN	*Hungary* (1992–2008)	21	ROM	*Romania* (1992–2008)
6	ESP	Spain (1992–2008)	14	IRL	Ireland (1992–2008)	22	SVK	*Slovakia* (1993–2008)
7	EST	*Estonia* (1995–2008)	15	ITA	Italy (1992–2008)	23	SVN	*Slovenia* (1995–2008)
8	FIN	Finland (1992–2008)	16	LTU	*Lithuania* (1995–2008)	24	SWE	Sweden (1992–2008)

Note: Belgium and Luxembourg are treated as one country. EU-15 underlined; EU-10 in *italics*. Each reporting country's import data are given for all reporter countries for the indicated time period. For the computation of our world averages the "world" constitutes the EU countries in the table plus the following countries: Albania, Armenia, Azerbaijan, Bosnia & 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. Hence, the "world" encompasses 54 countries that on average account for more than 90 percent of reported imports.

DAVIDSON INSTITUTE WORKING PAPER SERIES - Most Recent Papers

The entire Working Paper Series may be downloaded free of charge at: www.wdi.umich.edu

CURRENT AS OF 03/06/13

Publication	Authors	Date
No. 1044: Incomplete Specialization & Trade in Parts & Components	Richard Frensch, Jan Hanousek & Evzen Kocenda	Mar 2013
No. 1043: Tax evasion, tax corruption and stochastic growth	Fred Célimène, Gilles Dufrénot, Gisèle Mophou, and Gaston N.Guérékata	Feb 2013
No. 1042: Public debt, economic growth and nonlinear effects: Myth or reality?	Balázs Égert	Feb 2013
No. 1041: Interest Rate Pass-Through and Monetary Policy Asymmetry: A Journey into the Caucasian Black Box	Rustam Jamilov and Balázs Égert	Feb 2013
No. 1040: Myths about Beta-Convergence	Konstantin Gluschenko	Nov 2012
No. 1039: South East Asian Monetary Integration: New Evidences from Fractional Cointegration of Real Exchange Rates	Gilles de Truchis and Benjamin Keddad	Oct 2012
No. 1038: Transmission Lags of Monetary Policy: A Meta-Analysis	Tomas Havranek & Marek Rusnak	Oct 2012
No. 1037: The Dynamics of the Regulation of Labor in Developing and Developed Countries since 1960	Nauro Campos and Jeffrey Nugent	Sept 2012
No. 1036: Sovereign Wealth Fund Issues and The National Fund(s) of Kazakhstan	David Kemme	August 2012
No. 1035: Stock Market Comovements in Central Europe: Evidence from Asymmetric DCC Model	Dritan Gjika and Roman Horvath	August 2012
No. 1034: Regional Motives for Post-Entry Subsidiary Development: The Case of Poland	Agnieszka Chidlow, Christine Holmstrom-Lind, Ulf Holm & Heinz Tuselmann	June 2012
No. 1033: The Effects Of Network's Structural Holes: Polycentric Institutions, Product Portfolio, And New Venture Growth In China And Russia	Bat Batjargal	May 2012
No. 1032: The Bulgarian Foreign and Domestic Debt – A No-Arbitrage Macrofinancial View	Vilimir Yordanov	March 2012
No. 1031: Macroeconomic Shock Synchronization in the East African Community	Albert Mafusire & Zuzana Brixiova	March 2012
No. 1030: Does Human Capital Endowment of FDI Recipient Countries Really Matter? Evidence from Cross-Country Firm Level Data	Sumon K. Bhaumik & Ralitza Dimova	Feb 2012
No. 1029: Does institutional quality affect firm performance? Insights from a semiparametric approach	Sumon K. Bhaumik, Ralitza Dimova, Subal C. Kumbhakar & Kai Sun	Feb 2012
No. 1028: International Stock Market Integration: Central and South Eastern Europe Compared	Roman Horvath & Dragan Petrovski	Feb 2012
No. 1027: LABOUR MARKET REFORMS AND OUTCOMES IN ESTONIA	Zuzana Brixiova and Balazs Egert	Feb 2012
No. 1026: The Impact Of Capital Measurement Error Correction On Firm-Level Production Function Estimation	Lubomir Lizal & Kamil Galuscak	Jan 2012
No. 1025: CREDIT CONSTRAINTS AND PRODUCTIVE ENTREPRENEURSHIP IN AFRICA	Mina Baliamoune-Lutz, Zuzana Brixiová & Léonce Ndikumana	Dec 2011
No. 1024: Entry Costs and Increasing Trade	William F. Lincoln and Andrew McCallum	Nov 2011
No. 1023: The Dependence Of CEECs On Foreign Bank Claims: Direct And Indirect Risks Of Capital Withdrawal	Sophie Brana and Delphine Lahet	Nov 2011
No.1022: The Development Effects Of Natural Resources: A Geographical Dimension	Fabrizio Carmignani & Abdur Chowdhury	Nov 2011