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Facilitating International Production Networks

The Role of Trade Logistics

Daniel Saslavsky
Ben Shepherd

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Abstract

This paper shows that networked trade in parts and components is more sensitive to the importing country's logistics performance than is trade in final goods. In the baseline specification, the difference between the two trade semi-elasticities is around 45 percent, which suggests that the effect is quantitatively important. In addition, the analysis finds that logistics performance is particularly important for trade in the Asia-Pacific region, which is exactly where the emergence of international production networks has been most pronounced over recent years. The results suggest that policymakers can support the development of international production networks by helping improve trade logistics performance.

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Facilitating International Production Networks:

The Role of Trade Logistics

Daniel Saslavsky[1] and Ben Shepherd[2, 3]

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[1] Consultant, World Bank. Contact: DSaslavsky@WorldBank.org.

[2] Principal, Developing Trade Consultants Ltd. Contact: Ben@Developing-Trade.com.

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1 Introduction

The emergence of international production networks has been a notable feature of the global economy in recent years. This dynamic has been particularly marked in East Asia, where parts and components frequently cross borders a number of times before assembly into a final product is completed. Although a wide range of countries in Asia and elsewhere are now actively seeking greater integration into international production networks, relatively little is known about the kinds of policies that can promote the growth and development of cross-border production chains. This paper makes a first step towards filling that gap in the literature by focusing on one area—trade logistics—that we believe is likely to have a profound impact on the ability of firms to produce goods using network methods.

Trade logistics is a crucial part of the modern, globalized economy (Arvis et al. 2010). Better logistics performance enables firms to move goods across borders quickly, cheaply, and reliably. It helps reduce cost overheads by lowering inventory levels and making it possible to adopt "just-in-time" techniques. Networked production of goods such as consumer electronics relies particularly heavily on logistics to coordinate the production and distribution of large numbers of parts and components, and their final assembly into a finished product. Apple's iPod, for example, contains over four hundred intermediate components sourced from domestic and overseas operators mostly in the Asia-Pacific region, for final assembly in Taiwan, China (Lo 2008). Such a business model can only be profitable if it is supported by high quality trade logistics. Similarly, the auto cable industry in Tunisia has substantial advantages such as geographical proximity to European customers and low wage rates, but its future expansion depends on the development of high quality logistics platforms that can reduce inventories and improve reliability and reactivity to customer requirements (World Bank, 2007).

Against this background, we use a gravity model to investigate the links between logistics performance and the growth of international production networks. By distinguishing in the data between trade in parts and components versus trade in final goods, we test the hypothesis that trade in parts and components—which we assume takes place largely within network structures—is more sensitive to improvements in logistics performance than is trade in final goods. We find substantial support for this hypothesis in the data, a conclusion which is robust to the use of a variety of estimation methods and samples. In line with the importance of networked production in the Asia-Pacific, we find that the association between trade and logistics performance is particularly strong in that region.

Our paper builds on and extends the existing literature in two ways. First, it adds a policy dimension to the analysis of international production networks. As the next section will show, the bulk of quantitative work in relation to parts and components trade has largely relied on descriptive methods, or on econometric modeling without explicit policy variables. The result is that we know something about the extent to which trade costs matter for the development of production networks, but very little about the particular types of trade costs—and thus policies—that matter most. Our paper addresses this gap in the literature by focusing on logistics, an important part of overall trade facilitation policies, which we show to be a key determinant of trade in parts and components. As such, our approach fits well with recent work on the determinants of trade costs, which has shown that logistics performance plays a fundamental role (Arvis et al., forthcoming).

The second novelty of our paper is in relation to the trade facilitation literature. A number of papers have clearly demonstrated the potential of trade facilitation to help boost trade. Examples include Wilson et al. (2005), and, in the case of logistics as one type of trade facilitation, Behar et al (2011), Hoekman and Nicita (2010), and Portugal-Perez and Wilson (2008). All four papers, however, only consider the association between trade facilitation and total (aggregate) trade flows. There is as yet relatively little sector- or product-specific work on trade facilitation, which means that we have relatively little information as to which types of trade respond most strongly to improvements in trade facilitation.[4] What sectorally-disaggregated work there is tends to focus on broad categories rather than particular sectors that might be thought to be particularly sensitive to improvements in trade facilitation. Zaki (2010), for example, uses data disaggregated into 25 sectors to assess the effects of administrative burdens on bilateral trade. For the case of ASEAN, Shepherd and Wilson (2009) disaggregate trade flows into seven sectors using the one digit level of the Broad Economic Categories (BEC). In their analysis of transparency as one type of trade facilitation measure, Helble et al. (2009) split the data into trade in agriculture versus manufactures, and differentiated versus homogeneous goods. Other examples of exploiting these kinds of broad splits in the data include Persson (2010; homogeneous versus differentiated, and agriculture), and Portugal-Perez and Wilson (2010; fuels, ores and metals, manufactures, and textiles).

The two papers closest to ours in terms of sectoral disaggregation are Nordas et al. (2006) and Djankov et al. (2010). Both papers use Doing Business data on the time taken for export and import transactions as a measure of trade facilitation performance. Nordas et al. (2006) explicitly consider trade in intermediates, while Djankov et al. (2010) split the data between time-sensitive and time-insensitive products. The value added of our paper in relation to these two previous contributions comes from focusing on the distinction between final products and parts and components, which has not previously been examined in the literature. As we show in the next section, there are good theoretical reasons to believe that trade facilitation should have a particularly strong impact on parts and components trade. Our approach therefore expands on the level of sectoral analysis currently available in the trade facilitation literature.

The paper proceeds as follows. The next section reviews the theoretical and empirical literature on production networks, focusing on the role of trade costs and facilitation. Section 3 presents our dataset,

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[4] A number of papers use disaggregated trade data, but do not examine in detail the possibility that the sensitivity of trade flows with respect to trade facilitation performance differs systematically across sectors. Examples include: Dennis and Shepherd (2010), and Shepherd (2010).

discusses methodology, and provides some preliminary analysis based on graphical methods and descriptive statistics. Section 4 contains our model and estimation results, and Section 5 concludes with a number of policy implications that flow from our findings, as well as suggestions for further research.

2 Trade Costs, Trade Facilitation, and International Production Networks

As many authors note, vertical specialization has been at the center of international organization of production in recent decades (Helpman, 2006). Trade costs and other barriers to trade have been greatly reduced. Lower transportation costs, better and cheaper access to communication technologies, and even the reduction of tariffs have allowed firms to relocate their supply chains and production processes across multiple countries. One of the most important issues in the literature on vertical specialization is the role of trade costs within global production networks (GPNs). Yi (2003) argues that intra-GPN trade should be more sensitive to changes in trade costs, since vertical specialization causes products to move across borders many times before reaching their final consumption location. The author proves that three of the main paradigms in international trade (Ricardian, increasing returns, and Armington) are unable to mimic the nonlinearities in trade growth after WWII, without resorting to extremely high elasticities. The author develops a two-country dynamic Ricardian model of vertical specialization that is able to account for the substantial increase in trade since the 1940s.

Evidence regarding the extent and impact of trade costs within GPNs is rather limited. One interesting exception is Hanson et al. (2004), which examines the role of trade costs in U.S. multinational firms' decision to export intermediate goods to their affiliates abroad for processing. Trade costs variables were obtained from the Feenstra (1996) dataset, based on the cost of insurance and freight, expressed as a percentage of the customs value of imports. The authors find that affiliate demand for imported inputs is higher in host countries with lower trade costs, among other things (wages, tax rates, etc), while exports by affiliates show similar correlation patterns.

On the other hand, Ma and Van Assche (2010) analyze the role of trade costs on intra-GPN trade using a comprehensive dataset on China's processing trade regime, enabling the authors to map the location of input production, the location of processing, and the location of consumption. Using a three-country industry-equilibrium model with heterogeneous firms from two advanced countries, the authors find that Chinese processed exports not only depend on *downstream trade costs* (export distance), but also on *upstream trade costs* (import distance), and the interaction of both. Unfortunately, trade logistics costs are only captured indirectly through the distance to the suppliers and customers of the firm, and then using oil prices.

Another approach to modeling GPNs employs Input-Output tables. These tables link the input with the output of an industry in different countries or domestically, as a customer and supplier of intermediate goods (Escaith et al., 2010). For instance, Hummels et al. (2001) use this methodology to compute the degree of vertical specialization for OECD countries, attributing 30 to 40 percent of exports (OECD and World) to vertical specialization. On the other hand, they develop a multi-stage production model, allowing higher specialization due to comparative advantage, and multiple trade barriers as the different stages take place in different countries. Hence, the model predicts that small reductions in trade barriers provide strong incentives for vertical specialization. However, the I-O approach does not come without setbacks, namely the need for improvement in the quality of data and the frequency with which the tables are updated.

Lastly, GPNs in recent years have been examined thoroughly from the perspective of outsourcing. However, the main focus in this case is somewhat different from the previous approaches, and so is its relevance for trade facilitation. In a nutshell, most of this body of knowledge has been focused on understanding the actual determinants, drivers, and mechanisms of fragmentation in production networks—and especially under what circumstances firms decide to outsource—whether motivated by strategic or cost-saving decisions (for a complete review of the literature on outsourcing, see Mankiw and Swagel, 2006; and Escaith et al., 2010).

A substantial portion of empirical work devoted to trade almost invariably suggests that reductions in logistics costs have a positive impact on aggregated trade flows (e.g., Hoekman and Nicita, 2010). Similarly, recent work on the determinants of trade costs has found that logistics performance plays an important role (Arvis et al., Forthcoming). However, the link between reduction of logistics costs and GPNs has been mostly neglected in applied research, except for a few cases discussed above. Logistics costs have not been captured in a straightforward manner in those cases, leaving open the question for further examination in the remainder of this paper.

3 Data and Methodology

3.1 Data

For full details of our data and sources, see Table 1. In this section, we discuss two novel aspects of our dataset. First, we rely on a parts and components product list based on Ando and Kimura (2005) and Obashi and Kimura (2010), which allows us isolate trade in parts and components from trade in final goods. According to the Harmonized System, manufactured goods range from Chapters HS28 to HS92. Hence, we include all relevant goods classified as part of general machinery (HS84), electric machinery (HS85), transport equipment (HS86-89), and precision machinery sectors (HS90-92). According to these authors, the distinction between intermediate goods and finished products is far from obvious, not only because of the level of aggregation in HS 6-digit information, "but because the HS classification is not designed on the basis of the functionality of goods". Hence components are only incorporated into this list if all the products within the code can be unambiguously considered as intermediate goods, not finished products. Hence, approximately 440 parts and components are built into a filter to isolate parts and components trade in aggregate trade flows. This filter is applied to bilateral trade flow data obtained from WITS/UN COMTRADE.

The other main source of information comes from the World Bank's Logistics Performance Index (LPI). The LPI is based on a worldwide survey of logistics service providers -namely freight forwarders and express carriers- who evaluate logistics "friendliness" (on a numeric scale, from 1 to 5) of countries where they are based, and those with which they trade. This index is available for 155 countries, for the years 2007 and 2010, and is based on over 5,000 single country evaluations made by approximately 1,000 logistics professionals.[5] The final index is a weighted average of six main components, covering the following policy areas pertaining to logistics performance: efficiency of the clearance process, quality of infrastructure, ease of arranging competitively priced shipments, competence and quality of logistics services, ability to track and trace consignments, and timeliness of shipments.

3.2 Preliminary Analysis

The remainder of the paper develops a fully specified econometric model and uses it to test the hypothesis parts and components trade is more sensitive to logistics performance than trade in final goods. Before moving to that context, however, it is useful to conduct some preliminary analysis based on graphical methods and descriptive statistics.

Figure 1 (sourced from Arvis et al. 2010) shows that there is a clear positive association between logistics performance and the share of parts and components in total exports. Countries with superior logistics performance tend to be relatively specialized in that sector. This finding is exactly what we

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[5] We use LPI data for 2007 only due to the fact that many countries lag considerably in their provision of trade data.

would expect to see if our hypothesis is true and logistics performance matters more for trade in parts and components than for trade in final goods.

Simple bivariate analysis of our dataset tells a similar story. The coefficient of correlation between exports (in logarithms) and logistics performance in the importing country is more than three times as strong for parts and components as for final goods (0.107 versus 0.033). Similarly, the fact that the line of best fit for parts and components in Figure 2 is steeper than that for final goods provides further preliminary evidence in favor of our contention. In fact, the slope coefficient for the parts and components line of best fit is over twice as large as that for final goods (0.526 versus 0.215). A given improvement in logistics performance would therefore seem to be associated with relatively larger trade gains in parts and components than in final goods.

3.3 The Gravity Model

The gravity model is the standard framework for analyzing hypotheses similar to the one set out in this paper. We introduce some simple modifications into the benchmark gravity model by postulating that logistics performance impacts trade costs differently in different sectors—specifically in parts and components versus final goods. We start from the canonical, theory-consistent gravity model of Anderson and Van Wincoop (2003):

$$(1)\ \log\left(X_{ij}^{\ k}\right) = \log\left(E_j^k\right) + \log\left(Y_i^k\right) - \log\left(Y^k\right) + \left(1 - s^k\right)\log\left(t_{ij}^k\right) - \left(1 - s^k\right)\log\left(P_j^k\right) - \left(1 - s^k\right)\log\left(\Pi_i^k\right) + e_{ij}$$

where: X_{ij} is exports from country *i* to country *j* in sector *k*; E_j is sectoral expenditure in country *j*; Y_i is sectoral production in country *i*; t_{ij}^k is bilateral trade costs; s^k is the intra-sectoral elasticity of substitution (between varieties within a sector); and e_{ij} is a random error term satisfying standard assumptions. The P_j^k and Π_i^k terms represent multilateral resistance, i.e. the fact that trade patterns are determined by the level of bilateral trade costs relative to trade costs elsewhere in the world. Inward multilateral resistance $(P_j^k)^{(1-s^k)} = \sum_{i=1}^{N} \left(\Pi_i^k\right)^{(s^k-1)} w_i^k \left(t_{ij}^k\right)^{(1-s^k)}$ captures the dependence of economy *j*'s imports on trade costs across all suppliers. Outward multilateral resistance $(\Pi_i^k)^{(1-s^k)} = \sum_{i=1}^{N} \left(P_j^k\right)^{(s^k-1)} w_j^k \left(t_{ij}^k\right)^{(1-s^k)}$ captures the dependence of economy *i*'s exports on trade costs across all destination markets. The w terms are weights equivalent to each economy's share in global output or expenditure.

To implement (1) empirically, we need to specify the trade costs function t_{ij}^k in terms of observables. Our approach follows the gravity modeling literature in using geographical distance as a proxy for transport costs, and dummy variables to account for countries that share a common border, language, or colonial past. Our variables of primary interest are the importer and exporter LPI scores, as measures of overall logistics performance. To assess whether trade in parts and components is indeed more sensitive to logistics performance than trade in final goods, we interact the two logistics variables with a dummy equal to one in the case of parts and components trade. We therefore assume that trade costs take the following form:

$$\begin{aligned}(2)\ \log\left(t_{ij}^k\right) = {} & b_1 LPI_i + b_2 LPI_i * Parts^k + b_3 LPI_j + b_4 LPI_j * Parts^k + b_5 Parts^k \\ & + b_6 \log\left(Distance_{ij}\right) + b_7 Contiguous_{ij} + b_8 Language_{ij} + b_9 Colony_{ij} \\ & + b_{10} Colonizer_{ij}\end{aligned}$$

Although it is possible to directly estimate (1) and (2) by nonlinear least squares, most empirical work using the Anderson and Van Wincoop (2003) model relies on fixed effects to control for production, expenditure, and multilateral resistance. Such an approach is problematic in the present case, however, because the exporter and importer logistics performance coefficients could not be separately identified.

To deal with this problem, we follow Baier and Bergstrand (2009) who propose a first-order Taylor series approximation of the multilateral resistance terms:

$$\text{(3a)} \log \Pi_i^{(1-s^k)} \approx \left(s^k - 1\right)\left[\sum w_j^k \log t_{ij}^k - \frac{1}{2}\sum\sum w_i^k w_j^k \log t_{ij}^k\right]$$

$$\text{(3b)} \log P_j^{(1-s^k)} \approx \left(s^k - 1\right)\left[\sum w_i^k \log t_{ji}^k - \frac{1}{2}\sum\sum w_i^k w_j^k \log t_{ij}^k\right]$$

The gravity model given by equations (1) through (3b) can be estimated in a way that is consistent with theory, but without using fixed effects. Baier and Bergstrand (2009) show that estimation results obtained in this way are very close to those from nonlinear least squares or fixed effects estimation (without collinear variables), which supports the robustness of this methodology. All results presented in the next section are based on the Baier and Bergstrand (2009) transformation of the trade costs variables, which enables us to retain the importer- and exporter-specific LPI data as measures of logistics performance.

Although Baier and Bergstrand (2009) estimate their model using OLS, another branch of the gravity literature has recently proposed a variety of alternative econometric estimators that might be better suited to the empirical international trade context. Santos Silva and Tenreyro (2006) make a strong argument in favor of using the Poisson pseudo-maximum likelihood estimator as the gravity model workhorse. It has two main advantages over OLS. First, it is consistent under very weak assumptions—the data need not be distributed as Poisson, for example—and it is robust to a common type of heteroskedasticity that can result in biased estimates of parameters and standard errors under OLS. Second, Poisson's discrete foundation means that it is natural for the estimation sample to include observations where trade is equal to zero, i.e. a country pair does not engage in trade at all. Such observations are common in the bilateral trade matrix (Haveman and Hummels, 2004), but are dropped from OLS estimates because $\log(0)$ is undefined. For both of these reasons, we use Poisson to estimate the Baier and Bergstrand (2009) model, but present results from OLS and a variety of other estimators to show that our conclusions are robust.

4 Estimation Results and Interpretation

4.1 Baseline Results

Estimates for the baseline model appear in Table 3. Taking Poisson (column 1) as the benchmark results, we find that standard gravity model variables have coefficients that are correctly signed, of appropriate magnitude, and at least 10% statistically significant. The only exception is the colony dummy, which carries an unexpected negative and 5% significant coefficient. The model's overall explanatory power is relatively good, with an R-square of over 50%.

Of course, our primary interest is in the coefficients on the logistics variables. The data show that logistics clearly matters for trade performance in general: the exporter and importer LPIs both have coefficients that are positive and 1% statistically significant. This result is in line with other findings in the trade literature using the LPI as an explanatory variable, such as Hoekman and Nicita (2010). In quantitative terms, half-point increases in the exporter and importer LPIs are associated with trade increases of around 35% and 16% respectively.

The estimated coefficients on the two interaction terms between logistics performance and parts and components trade tell a mixed story in terms of our hypothesis. As noted above, we expect both coefficients to be positive and statistically significant. The importer interaction term is indeed signed as we expect, and is 1% significant. Its magnitude suggests that the semi-elasticity of trade with respect to importer logistics performance is about 45% stronger for parts and components than for final goods.

The interaction term with exporter logistics performance is harder to interpret: it is negative, and 10% statistically significant, which is contrary to expectations. In terms of relative magnitude, the difference between the estimated elasticities for parts and components versus final goods is considerably smaller than on the import side (16% compared with 45%). Moreover, we show below that the sign and significance of this coefficient is in fact subject to considerable variation when different estimators and country samples are applied. It would therefore be inappropriate to put too much weight on this initial result.

4.2 Results Using Alternative Estimators

As noted above, there are good reasons for preferring Poisson as a workhorse gravity model estimator. However, the trade literature discloses a variety of alternative estimators that are commonly applied in the gravity model context, and it is important to ensure that our results are not overly reliant on the choice of Poisson. Columns 2 through 6 of Table 3 therefore present a range of alternative estimates based on different econometric models.

In columns 2 and 3, we present results using two alternative pseudo-maximum likelihood estimators, namely those based on the negative binomial distribution and the gamma distribution. The reason for considering these estimators is that the Park-type test proposed by Santos Silva and Tenreyro (2006, equation 13) rejects at the 5% level the null hypothesis that the Poisson pseudo-maximum likelihood variance assumption is appropriate (prob. = 0.024). Although the Poisson estimator remains consistent notwithstanding this result, there are possible efficiency gains to be had by using alternatives such as the negative binomial and gamma distributions. Nonetheless, we continue to prefer Poisson as a baseline estimator for the reasons set out by Santos Silva and Tenreyro (2006), in particular the fact that it does not overweight small and potentially unreliable observations relative to the other estimators.

Use of the two alternative pseudo-maximum likelihood estimators does not fundamentally change the Poisson results. In columns 2 and 3, we find that importer and exporter logistics performance both have positively signed and 1% statistically significant coefficients. Interestingly, the magnitude of both semi-elasticities is noticeably larger than with Poisson, about double in each case. The interaction terms display the same pattern of signs as in the Poisson estimates: the importer interaction term has a positive and 1% statistically significant coefficient, while the exporter interaction term has a negative coefficient in both cases, but it is only statistically significant for the negative binomial model. As with Poisson, the relative magnitude of the interaction effect is much stronger on the import side than on the export side. This finding, combined with the statistical insignificance of the exporter interaction coefficient in the gamma estimates, reinforces our conclusion that it would be inappropriate to put too much weight on the unexpected negative sign in the baseline Poisson results.

In light of the continued use of the OLS estimator in the literature, column 4 presents results using that method. The pattern of signs and significance of the coefficients of interest is the same as for the Poisson estimates. These results are presented for comparative purposes only, however, since they suffer from two major defaults. First, observations for which trade is equal to zero cannot be included in the estimation sample, which reduces the sample size by about half relative to Poisson. Second, the Park-type test proposed by Santos Silva and Tenreyro (2006, equation 11) strongly rejects the adequacy of the OLS log-linearization of the gravity model (prob. = 0.000).

Another common gravity model estimator is the Heckman sample selection model (Helpman et al., 2008), which, unlike OLS, allows for the presence of zero entries in the bilateral trade matrix.[6] Results for the outcome (trade intensity) and selection (trade propensity) equations are in columns 5-6. We use Doing Business data on the time required to start a business (in logarithms) as the over-identifying

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[6] We apply the standard Heckman estimator, but do not pursue the additional correction introduced by Helpman et al. (2008) to deal with firm heterogeneity.

variable, as in some of the regressions in Helpman et al. (2008). The estimated coefficients for the outcome equation are very close to those from OLS, even though the Heckman model strongly rejects the null hypothesis of independence between the selection and outcome equations (prob. = 0.000). Interestingly, the selection equation suggests that similar dynamics to those from the outcome equation may also be present in relation to trade propensity: exporter and importer logistics both have a positive and significant effect on trade propensity, as well as trade intensity. This result sits well with recent findings indicating that trade facilitation, of which logistics is a key part, can play an important role in expanding trade at the extensive, as well as intensive, margin (Dennis and Shepherd, 2011; and Shepherd, 2010). Again, there is also evidence from both the outcome and selection equations that importer logistics performance has a greater impact on parts and components trade than trade in final goods; however, the exporter interaction has an unexpected negative and statistically significant coefficient.

4.3 Results Using Separate Models by Sector

One possible objection to the interaction term approach used in the two previous sections is that it constrains the other parameters of the model—such as income elasticities and trade cost elasticities—to be uniform across the two sectors we are considering, namely final goods and parts and components. To address this issue, we re-estimate the baseline and alternative models from the previous two sections separately for each of the two sectors (Table 4). A comparison of coefficients across models allows us to draw inferences about the relative importance of logistics in each sector.

In each of the six columns of Table 4, importer and exporter logistics performance both have positive and 1% statistically significant coefficients, which is in line with expectations. As was the case for the interaction term regressions in Table 4, the magnitude of the estimated coefficients tends to be smaller with Poisson than with alternative estimators. In each case, the estimated coefficient on importer logistics performance is noticeably larger in the case of parts and components (columns 2, 4, and 6) than final goods (columns 1, 3, and 5), which lines up well with the results in Table 4. With Poisson, the difference between the two coefficients is not statistically significant at the 10% level, but it is significantly different at the 10% level for the negative binomial estimator and at the 5% level for the gamma model. These results clearly support our hypothesis that the impact of logistics (at least on the importer side) is particularly strong in sectors where networked production is common.

As was the case in Table 4, interpretation of the export side coefficients for Poisson is more problematic: the coefficient on final goods is stronger than the one for parts and components, which is contrary to expectations. However, the difference is not statistically significant at the 10% level. Moreover, the export coefficient is stronger for parts and components when alternative estimators such as the negative binomial and gamma models are used. In both cases, however, the difference is not statistically significant at the 10% level. Taking these results together, we conclude that the impact of exporter logistics performance does not vary noticeably between final goods and parts and components sectors.

As an additional set of robustness checks based on the same considerations outlined above, Table 5 presents results for sectoral models estimated using OLS, and the Heckman sample selection model. In both cases, there is consistent evidence that the impact of importer logistics performance is stronger for parts and components than for final goods. However, the difference is not statistically significant in either case. On the export side, the estimated semi-elasticity for parts and components is weaker than for final goods, and is 1% significant for the outcome equation. The difference is statistically insignificant for the selection equation.

4.4 Results Using Alternative Country Samples

In Table 6, we retain the Poisson model with interaction terms as the baseline and exploit the possibility for variation across country groups to examine in greater detail the links between logistics performance and trade in production networks.

First (columns 1-3), we limit the estimation sample to countries in the World Bank's East Asia and Pacific (EAP) region. The reason for doing so is that production networking is widespread and particularly well developed in that region. We would therefore expect to see stronger evidence of the role that logistics can play when we limit consideration to the set of countries that are most actively engaged in this type of production. In column 1, we limit the sample to EAP exporters, but include all importers. In column 2, we consider only EAP importers, but include all exporters. Column 3 limits the sample to EAP exporters and EAP importers only, i.e. intra-regional trade.

In all three cases, we find continued strong evidence of the importance of logistics as a determinant intra-network trade relative to trade in final goods: the import side interaction term is positive and 5% significant in each of the three regressions. The export side interaction term is only negative and statistically significant in one regression (column 2), and is statistically insignificant in the other two. Interestingly, for the case of intra-regional trade, the data suggest that the impact of logistics performance is only statistically significant in the case of parts and components, thus highlighting again the importance of this area for regional production networks. It is important to be cautious in interpreting this result, however, due to the greatly reduced sample size that results when only intra-regional trade flows are considered.

Another potentially informative split in the data is between South-South and South-North trade. For definitional purposes, we take the "North" as including all high income countries (OECD members and others), while the "South" consists of all other countries (i.e., all World Bank low and middle income countries). Since there is a strong South-South element to the emergence of production networks—components are often produced in one developing country, while assembly takes place in another—we would expect to see some differences in the importance of trade logistics between South-South and South-North trade flows in this case.

Indeed, that is exactly what we find in the data. The coefficients on importer and exporter logistics performance in the South-South model (Table 6 column 4) are much stronger than in the baseline model using all countries (Table 3 column 1). Interestingly, the exporter interaction term has an unexpected negative sign, but it is statistically insignificant. The importer interaction term, on the other hand, is positive and 1% statistically significant. In terms of magnitude, it is much larger than the corresponding term in the baseline model, which suggests that South-South flows of parts and components are particularly sensitive to logistics performance on the import side. This finding is quite consistent with the expansion of developing country production networks that has been taking place over recent years.

These impressions are reinforced by the South-North model (Table 6 column 5). The exporter logistics performance coefficient is again much stronger than in the baseline model. The importer coefficient, however, is statistically insignificant. On the import side, only the parts and components interaction term is positive and 5% statistically significant, which again indicates that logistics performance is particularly important for intra-network trade, although the magnitude of the effect is smaller for South-North trade than it is for South-South trade.

5 Conclusion and Policy Implications

This paper has presented evidence that trade in parts and components within international production networks is more sensitive to logistics performance than is trade in final goods. The difference between the two effects is quantitatively significant: the semi-elasticity of trade with respect to importer logistics performance is about 45% larger for parts in components than for final goods. In addition, trade in the Asia-Pacific region—which is where international production networks are most developed—is particularly sensitive to logistics performance. We also find evidence that South-South trade is more sensitive than average to logistics performance.

At least two important policy implications flow from our results. First, development of the logistics sector can obviously play a key role in promoting greater integration in international production networks. There is much that policymakers can do to assist that process. Building logistics competence is a many-faceted process, however, involving issues such as regulation of transport and related sectors, border procedures, infrastructure, and private sector development. Diagnostics exercises using the World Bank's LPI database are a logical place to start for policymakers interested in addressing the key bottlenecks in national logistics performance (Arvis et al. 2010).

Second, developing country policymakers should pay particular note to the importance of logistics performance in the context of South-South trade flows, particularly in parts and components. With some degree of global rebalancing possible in the future, South-South trade is likely to assume increased prominence as a driver of worldwide demand (Haddad and Shepherd, 2011). Barriers to further South-South economic integration—including those related to logistics performance—should therefore be a priority for policymakers going forward.

In terms of future research, there is considerable scope for confirming and extending our results. First, estimation in a true panel data framework would make it possible to control for an additional array of country-specific factors using fixed effects. Such an approach is not currently feasible, however. The LPI is now available for three years—2007, 2010, and 2012—but the lag with which trade data become available, especially for developing countries, means that a true panel data approach will need to be left for later versions of the LPI.

Second, we have focused on trade in machinery parts and components and final goods as one example of the distinction between networked production and sales of finished products. Production networks also exist in other areas, however. Textiles and apparel is one example. Future work could examine whether our findings can be replicated in other networked production settings.

References

Anderson, J.E., and E. Van Wincoop. 2003. “Gravity with Gravitas: A Solution to the Border Puzzle.” *American Economic Review* 93(1): 170–192.

Ando, M., and F. Kimura. 2005. “The Formation of International Production and Distribution Networks in East Asia.” In T. Ito and A.K. Rose eds. *International Trade in East Asia*. Chicago: University of Chicago Press.

Arvis, J.-F., Y. Duval, B. Shepherd, and C. Utoktham. Forthcoming. “Trade Costs in the Developing World: 1995-2010.” Working Paper.

Arvis, J.-F., M. Mustra, L. Ojala, B. Shepherd, and D. Saslavsky. 2010. *Connecting to Compete 2010: Trade Logistics in the Global Economy*. Washington, D.C.: The World Bank.

Baier, S., and J. Bergstrand. 2009. “Bonus Vetus OLS: A Simple Method for Approximating International Trade Cost Effects Using the Gravity Equation.” *Journal of International Economics* 77(1): 77-85.

Behar, A., P. Manners, and B. Nelson. 2011. “Exports and International Logistics.” Policy Research Working Paper 5691, World Bank.

Dennis, A., and B. Shepherd. 2011. “Trade Facilitation and Export Diversification.” *World Economy* 34(1): 101-122.

Djankov, S., C.S. Pham, and C. Freund. 2010. "Trading on Time." *Review of Economics and Statistics* 92(1): 166-173.

Escaith, H., Lindenberg, N., and S. Miroudot. 2011. "Global Value Chains and the Crisis: Reshaping the International Trade Elasticity?" in Cattaneo, O., Gereffi, G., and C. Staritz eds. Global Value Chains in a Postcrisis World. Washington, D.C.: World Bank.

Feenstra, R. 1996. "U.S. Imports: Data and Concordances." National Bureau of Economic Research Working Paper 5515.

Haddad, M., and B. Shepherd. 2011. "Managing Openness: From Crisis to Export-Led Growth Version 2.0." in M. Haddad and B. Shepherd eds. *Managing Openness: Trade and Outward-Oriented Growth after the Crisis*. Washington, D.C.: World Bank.

Hanson, G., Mataloni, R., and M. Slaughter. 2005. "Vertical Production Networks in Multinational Firms." Review of Economics and Statistics, 87(4), 664-678.

Haveman, J., and D. Hummels. 2004. "Alternative Hypotheses and the Volume of Trade: The Gravity Equation and the Extent of Specialization." *Canadian Journal of Economics* 37(1): 199-218.

Helble, M., B. Shepherd, and J.S. Wilson. 2009. "Transparency and Regional Integration in the Asia-Pacific." *World Economy* 32(3): 479-508.

Helpman, E. 2006. "Trade, FDI, and the Organization of Firms." Journal of Economic Literature 44(3), 589–630.

Helpman, E., M. Melitz, and Y. Rubinstein. 2008. "Estimating Trade Flows: Trading Partners and Trading Volumes." *Quarterly Journal of Economics* 123(2): 441-487.

Hoekman, B., and A. Nicita. 2010. “Assessing the Doha Round: Market Access, Transactions Costs, and Aid for Trade Facilitation.” *Journal of International Trade and Economic Development* 19(1): 65-79.

Hummels, D., Ishii, I., & Yi, K.-M. 2001. “The Nature and Growth of Vertical Specialization in World Trade.” Journal of International Economics 54(1), 75-96.

Lo, C.-P. 2008. “Global Outsourcing or FDI: How did Apple Launch its iPod?” Working Paper, http://202.28.25.84/conference/Eng%20Paper/Global%20outsourcing%20or%20FDI--How%20Apple%20Launched%20its%20iPod-II%28Prof.%20Chu-Ping%20Lo%29.pdf.

Ma, A., and A. Van Assche. 2010. “The Role of Trade Costs in Global Production Networks.” Policy Research Working Paper 5490, World Bank.

Mankiw, G., and P. Swagel. 2006. “The Politics and Economics of Offshore Outsourcing.” Harvard Institute of Economic Research Working Papers 2120, Harvard - Institute of Economic Research.

Nordas, H.K., E. Pinali, and M. Geloso Grosso. 2006. “Logistics and Time as a Trade Barrier.” Trade Policy Working Paper 35, OECD.

Obashi, A., and F. Kimura. 2010. “International Production Networks in Machinery Industries: Structure and Its Evolution.” ERIA Discussion Paper Series, ERIA-DP-2010-09.

Persson, M. 2010. “Trade Facilitation and the Extensive Margin.” Working Paper 828, Research Institute of Industrial Economics.

Portugal-Perez, A., and J.S. Wilson. 2008. “Trade Costs in Africa: Barriers and Opportunities for Reform.” Policy Research Working Paper 4619, World Bank.

Portugal-Perez, A., and J.S. Wilson. 2010. “Export Performance and Trade Facilitation Reform: Hard and Soft Infrastructure.” Policy Research Working Paper 5261, World Bank.

Santos Silva, J., and S. Tenreyro. 2006. “The Log of Gravity.” *Review of Economics and Statistics* 88(4): 641-658.

Shepherd, B. 2010. “Geographical Diversification of Developing Country Exports.” *World Development* 38(9): 1217-1228.

Shepherd, B., and J.S. Wilson. 2010. “Trade Facilitation in ASEAN Member Countries: Measuring Progress and Assessing Priorities.” *Journal of Asian Economics* 20(4): 367-383.

Wilson, J., C. Mann, and T. Otsuki. 2005. “Assessing the Benefits of Trade Facilitation: A Global Perspective.” *The World Economy*, 28(6), 841-871.

World Bank. 2007. “Stratégie de Développement des Services et Infrastructures Logistiques en Tunisie.” Working Paper.

Yi, K.-M. 2003. “Can Vertical Specialization Explain the Growth of World Trade?” Journal of Political Economy 111, 52-102.

Zaki, C. 2010. “Does Trade Facilitation Matter in Bilateral Trade?” Working Paper, Paris School of Economics, http://www.parisschoolofeconomics.eu/IMG/pdf/JobMarket-1paper-ZAKI-PSE.pdf.

Tables

Table 1: Data and sources.

Variable	Definition	Source
$Colony_{ij}$	Dummy variable equal to unity if countries i and j were once in a colonial relationship.	CEPII.
$Colonizer_{ij}$	Dummy variable equal to unity if countries i and j were colonized by the same power.	CEPII.
$Contiguous_{ij}$	Dummy variable equal to unity if countries i and j share a common land border, else zero.	CEPII.
$Distance_{ij}$	Geodesic distance between the main cities of country i and country j.	CEPII.
$Exports_{ij}^{k}$	Exports from country i to country j in sector k.	UN Comtrade via WITS.
GDP_i	GDP in country i.	World Development Indicators.
$Language_{ij}$	Dummy variable equal to unity if countries i and j share a common language, else zero.	CEPII.
LPI_i	Logistics Performance Index score for country i.	World Bank LPI database.
$Parts^k$	Dummy variable equal to unity for trade in parts and components, else zero.	Classification based on Ando and Kimura (2005).

Note: All variables are for 2007.

Table 2: Summary statistics.

Variable	Obs.	Mean	Std. Dev.	Min.	Max.	Corr. with Log Exports
$Colony_{ij}$	93744	0.010	0.099	0	1	0.0897
$Colonizer_{ij}$	93744	0.117	0.322	0	1	-0.0295
$Contiguous_{ij}$	93744	0.013	0.112	0	1	0.1459
$Distance_{ij}$	93744	8541.281	4687.455	10.479	19951.160	-0.1644
$Exports_{ij}^{k}$	103512	8366.421	190979.700	0	2.02E+07	n/a
GDP_i	82639	2.99e+11	1.17e+12	1.37e+08	1.37e+13	0.086
$Language_{ij}$	93744	0.170	0.375	0	1	0.012
LPI_i	67657	2.744	0.631	1.212	4.190	0.0703
$Parts^k$	103539	0.500	0.500	0	1	-0.3455

Note: $Exports_{ij}^{k}$ *contains 75,217 observations equal to zero.*

Table 3: Baseline estimation results and alternative estimators.

	(1)	(2)	(3)	(4)	(5)	(6)
	Poisson	Neg. Bin.	Gamma	OLS	Heckman	
					Outcome	Selection
LPI (exp.)	0.693***	1.381***	1.350***	2.029***	2.199***	1.093***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LPI (exp.) * Parts	**-0.116***	**-0.313***	**-0.227**	**-0.828*****	**-0.852*****	**-0.156*****
	(0.061)	**(0.066)**	**(0.184)**	**(0.000)**	**(0.000)**	**(0.000)**
LPI (imp.)	0.328***	0.750***	0.721***	0.381***	0.471***	0.724***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LPI (imp.) * Parts	**0.148*****	**0.413*****	**0.462*****	**0.067****	**0.079*****	**0.029****
	(0.003)	**(0.001)**	**(0.000)**	**(0.016)**	**(0.005)**	**(0.040)**
Parts	-2.990***	-2.270***	-2.651***	0.021	0.078	0.506***
	(0.000)	(0.001)	(0.000)	(0.885)	(0.601)	(0.000)
Log(distance)	-0.347***	-0.755***	-0.776***	-0.906***	-0.951***	-0.397***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Contiguous	0.661***	0.738***	0.703***	0.994***	0.949***	-0.170
	(0.003)	(0.000)	(0.001)	(0.000)	(0.000)	(0.229)
Language	0.293*	0.556***	0.574***	0.408***	0.449***	0.265***
	(0.070)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
Colony	-0.454**	0.682**	0.644**	0.583***	0.648***	0.828***
	(0.033)	(0.021)	(0.026)	(0.000)	(0.000)	(0.000)
Colonizer	1.219**	-0.013	-0.042	0.641***	0.464***	-0.776***
	(0.015)	(0.951)	(0.851)	(0.000)	(0.003)	(0.000)
Log(GDP exp.)	0.861***	0.863***	0.875***	0.845***	0.891***	0.288***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log(GDP imp.)	0.745***	0.688***	0.709***	0.591***	0.626***	0.240***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log(Doing Business)						-0.177***
						(0.000)
Constant	-32.789***	-31.995***	-32.484***	-29.989***	-32.645***	-14.040***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R2	0.541	0.306	0.308	0.675	0.031	
Observations	41760	41760	41760	19183	41472	41472

*Note: The dependent variable in each case is exports. All trade costs variables are transformed as per Baier and Bergstrand (2009), as discussed in the main text. Estimation methods are indicated at the top of each column. Prob. values based on robust standard errors adjusted for clustering by country pair are in parentheses beneath the parameter estimates. Statistical significance is indicated by * (10%), ** (5%), and *** (1%).*

Table 4: Poisson, negative binomial, and gamma estimation results for final goods and parts and components separately.

	(1) Poisson Final	(2) Poisson Parts	(3) Neg. Bin. Final	(4) Neg. Bin. Parts	(5) Gamma Final	(6) Gamma Parts
LPI (exp.)	**0.695***** **(0.000)**	**0.558***** **(0.000)**	**1.120***** **(0.000)**	**1.400***** **(0.000)**	**1.105***** **(0.000)**	**1.443***** **(0.000)**
LPI (imp.)	**0.327***** **(0.001)**	**0.479***** **(0.000)**	**0.674***** **(0.000)**	**1.227***** **(0.000)**	**0.664***** **(0.000)**	**1.241***** **(0.000)**
Log(distance)	-0.345*** (0.000)	-0.372*** (0.000)	-0.811*** (0.000)	-0.682*** (0.000)	-0.804*** (0.000)	-0.729*** (0.000)
Contiguous	0.667*** (0.002)	0.562** (0.041)	0.788*** (0.003)	0.646*** (0.002)	0.796*** (0.003)	0.585** (0.013)
Language	0.286* (0.076)	0.419** (0.027)	0.659*** (0.002)	0.518*** (0.008)	0.683*** (0.002)	0.535*** (0.009)
Colony	-0.464** (0.027)	-0.273 (0.302)	0.777** (0.017)	0.527** (0.029)	0.763** (0.018)	0.481* (0.056)
Colonizer	1.207** (0.016)	1.345** (0.011)	0.008 (0.975)	0.003 (0.991)	-0.002 (0.993)	-0.026 (0.932)
Log(GDP exp.)	0.866*** (0.000)	0.787*** (0.000)	0.972*** (0.000)	0.729*** (0.000)	0.980*** (0.000)	0.752*** (0.000)
Log(GDP imp.)	0.748*** (0.000)	0.682*** (0.000)	0.733*** (0.000)	0.638*** (0.000)	0.746*** (0.000)	0.669*** (0.000)
Constant	-33.028*** (0.000)	-31.756*** (0.000)	-34.422*** (0.000)	-31.487*** (0.000)	-34.902*** (0.000)	-32.606*** (0.000)
R2	0.296	0.283	0.160	0.143	0.159	0.144
Observations	20880	20880	20880	20880	20880	20880

*Note: The dependent variable in each case is exports. All trade costs variables are transformed as per Baier and Bergstrand (2009), as discussed in the main text. Estimation methods are indicated at the top of each column. Prob. values based on robust standard errors adjusted for clustering by country pair are in parentheses beneath the parameter estimates. Statistical significance is indicated by * (10%), ** (5%), and *** (1%).*

Table 5: OLS and Heckman estimation results for final goods and parts and components separately.

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	Heckman		Heckman	
	Final	Parts	Final	Final	Parts	Parts
			Outcome	Selection	Outcome	Selection
LPI (exp.)	**1.841*****	**1.387*****	**2.005*****	**1.067*****	**1.537*****	**0.962*****
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
LPI (imp.)	**0.365*****	**0.466*****	**0.452*****	**0.720*****	**0.568*****	**0.758*****
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Log(distance)	-0.978***	-0.837***	-1.024***	-0.411***	-0.882***	-0.384***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Contiguous	1.063***	0.923***	1.027***	-0.133	0.872***	-0.206
	(0.000)	(0.000)	(0.000)	(0.363)	(0.000)	(0.137)
Language	0.469***	0.359***	0.507***	0.294***	0.403***	0.236***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Colony	0.570***	0.590***	0.636***	0.876***	0.655***	0.776***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Colonizer	0.709***	0.600***	0.581***	-0.739***	0.377**	-0.809***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.019)	(0.000)
Log(GDP exp.)	0.962***	0.740***	1.011***	0.305***	0.783***	0.273***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log(GDP imp.)	0.625***	0.560***	0.661***	0.247***	0.594***	0.235***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log(Doing Business)				-0.172***		-0.181***
				(0.000)		(0.000)
Constant	-32.667***	-27.710***	-35.404***	-14.438***	-30.220***	-13.189***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R2	0.654	0.600	0.026		0.027	
Observations	9231	9952	20736	20736	20736	20736

*Note: The dependent variable in each case is exports. All trade costs variables are transformed as per Baier and Bergstrand (2009), as discussed in the main text. Estimation methods are indicated at the top of each column. Prob. values based on robust standard errors adjusted for clustering by country pair are in parentheses beneath the parameter estimates. Statistical significance is indicated by * (10%), ** (5%), and *** (1%).*

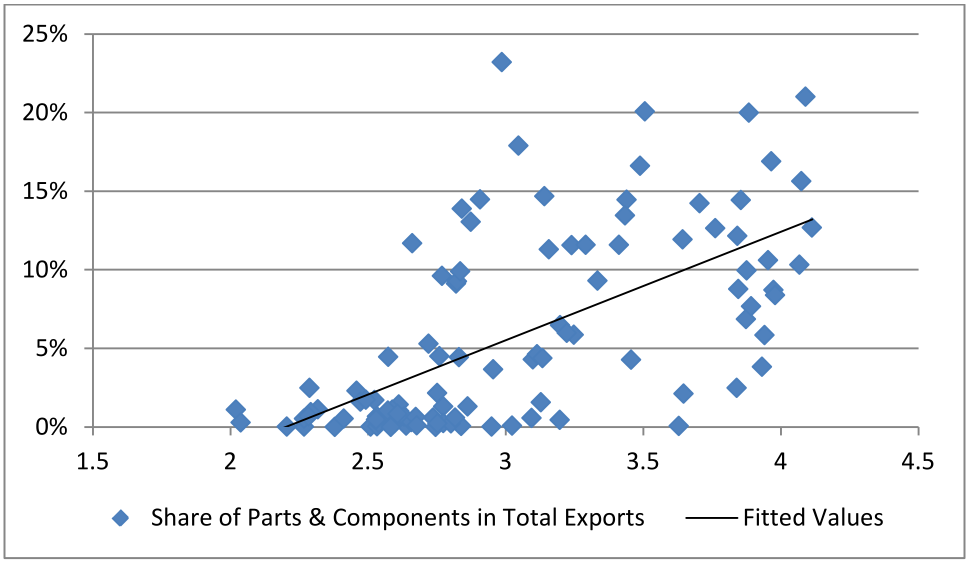
Table 6: Estimation results using restricted country samples.

	(1) Poisson	(2) Poisson	(3) Poisson	(4) Poisson	(5) Poisson
Exporter sample:	Asia	All	Asia	South	South
Importer sample:	All	Asia	Asia	South	North
LPI (exp.)	0.965**	0.838***	0.176	2.170***	2.484***
	(0.030)	(0.001)	(0.793)	(0.000)	(0.000)
LPI (exp.) * Parts	**0.197**	**-0.211****	**-0.201**	**-0.380**	**-0.299**
	(0.686)	**(0.019)**	**(0.664)**	**(0.308)**	**(0.214)**
LPI (imp.)	0.328*	1.948***	0.400	0.469*	-0.069
	(0.065)	(0.000)	(0.327)	(0.080)	(0.733)
LPI (imp.) * Parts	**0.337****	**0.381****	**0.486****	**1.055*****	**0.348****
	(0.014)	**(0.030)**	**(0.048)**	**(0.000)**	**(0.017)**
Parts	-4.669***	-2.887***	-3.267**	-4.649***	-3.175***
	(0.002)	(0.000)	(0.043)	(0.000)	(0.000)
Log(distance)	-0.699***	-1.433***	-3.274***	-1.083***	-0.816***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Contiguous	0.524*	-1.155***	-1.896***	-0.172	0.704**
	(0.063)	(0.007)	(0.003)	(0.665)	(0.042)
Language	1.577***	1.089***	-0.361	0.590	0.302
	(0.000)	(0.000)	(0.712)	(0.129)	(0.412)
Colony	-0.883**	0.113	-1.509*	0.873*	0.024
	(0.026)	(0.582)	(0.092)	(0.097)	(0.952)
Colonizer	0.025	-0.640	-1447.517	-1.368**	-1.153*
	(0.958)	(0.158)	(0.195)	(0.030)	(0.079)
Log(GDP exp.)	0.805***	0.622***	1.055***	1.011***	1.028***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log(GDP imp.)	0.803***	0.510***	1.261***	0.880***	0.895***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-29.766***	-16.074***	-26.706***	-38.791***	-41.458***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
R2	0.263	0.200	0.055	0.281	0.286
Observations	3456	3456	264	22260	27772

*Note: The dependent variable in each case is exports. All trade costs variables are transformed as per Baier and Bergstrand (2009), as discussed in the main text. Estimation methods are indicated at the top of each column. Prob. values based on robust standard errors adjusted for clustering by country pair are in parentheses beneath the parameter estimates. Statistical significance is indicated by * (10%), ** (5%), and *** (1%).*

Figures

Figure 1: Logistics performance vs. trade in parts and components.



Source: Arvis et al. (2010).

Figure 2: Logistics performance vs. trade in final goods and trade in parts and components.