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Jane Korinek, Patricia Sourdin

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Abstract

TO WHAT EXTENT ARE HIGH-QUALITY LOGISTICS SERVICES TRADE FACILITATING?

by

Jane Korinek, OECD Trade and Agriculture Directorate
Patricia Sourdin, University of Adelaide and Johns Hopkins University SAIS Bologna Center

Trade logistics facilitate trade. Quality logistics services play an important role in facilitating the transportation of international trade in goods: inefficient logistics services impede trade by imposing an extra cost in terms of time as well as money. As developed nations shift from traditional manufacturing and agriculture and are increasingly engaging in international vertical specialization, the need for efficient logistics services becomes ever more important. High quality logistics services improve the competitiveness of a country's exports by reducing the cost involved in transporting goods – especially for countries that are disadvantaged by being far from major markets. This paper investigates the role that trade logistics play in the volume and value of international trade and the extent to which poor quality logistics constitute a barrier to trade. It examines the different impact of logistics quality on goods that are transported by sea and by air. The differentiated impact of trade logistics such as infrastructure on low, middle and higher-income countries is analysed.

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JEL classification: E6, F0, F13

Keywords: Logistics, trade, infrastructure, border administration, tracking and tracing, trade logistics, trade facilitation, trade costs, transport infrastructure, ports, air infrastructure, customs procedures, logistics competence, trade policy working paper, logistics services, freight forwarding.

Table of contents

Tables

Figures

Executive Summary

Quality logistics services play an important role in facilitating the transportation of international trade in goods: inefficient logistics services impede trade by imposing an extra cost in terms of time as well as money. Trade logistics include the range of services and processes that are involved in moving goods from one country to another: customs and administrative procedures, organization and management of international shipment operations, tracking and tracing, and the quality of transport and information technology infrastructures. This study uses a variety of measures of logistics quality to examine their impacts on trade.

This study confirms the strong impact on trade of logistics quality using indicators such as the World Economic Forum's *Enabling Trade Index* and the World Bank's *Logistics Performance Index*. Enhancements in the quality of logistics services are associated with strong increases in trade, in particular as regards exports. Overall, enhancements in transport infrastructure also strongly positively affect trade, and these investments have a greater impact in middle-income countries.

Trade logistics quality impacts exports more than imports overall. Improvements in a given country's trade logistics will improve its export situation: infrastructure improvements are particularly important for exporters and seem to drive this general result. Improvements in the administration of borders impact both exports and imports positively and impact imports even more than exports.

When comparing air infrastructure and sea infrastructure and their impacts on airborne and seaborne trade, it is found that infrastructure improvements have a particularly strong impact on airborne trade. This may reflect the importance of high-value goods arriving by air as well as their importance in global supply chains in terms of timeliness and efficient processing.

Across the board, elements of trade logistics such as customs procedures, tracking and tracing services, overall infrastructure and logistics competence are shown to impact trade relatively more than less policy-dependent trade determinants such as distance and transport costs. Results of this study using indicators of the time required to complete both importing and exporting procedures indicate that every extra day needed to ready goods for export and import reduces trade by around 4%. This finding suggests that the impact of an extra day that goods spend at the border has a greater negative impact on trade flows than an extra day spent at sea delivering a container of goods. This may be due in part to more uncertainty in time delays at borders that traders are less able to predict and respond to. The estimates for the impact on trade of increases in the cost associated with completing procedures for importing and exporting a container are also higher than estimates of an incremental increase in the cost of transportation according to results in a companion study.

These findings confirm other research that suggests that investments in logistics services and infrastructure can be highly trade enhancing and further infer which infrastructure investments are likely to bring the largest gains and whether lower, middle or upper-income countries are likely to benefit most. They highlight the importance of promoting policies to continue to move trade facilitation reforms forward and confirm that spillovers from improved logistics services can be significant. The findings in this study regarding landlocked countries and their present reliance on airborne trade due to disadvantaged seaborne trade also point to the importance of regional cooperation in the area of trade facilitation reforms.

1. Introduction

International maritime and air carriers moved more than eight million tons of freight globally in 2008. Quality logistics services play an important role in facilitating the transportation of international trade in goods: inefficient logistics services impede trade by imposing an extra cost in terms of time as well as money. Trade logistics facilitate trade. As developed nations shift from traditional manufacturing and agriculture and are increasingly engaging in international vertical specialization, the need for efficient logistics services becomes ever more important. High quality logistics services improve the competitiveness of a country's exports by reducing the cost involved in transporting goods – especially for countries that are disadvantaged by being far from major markets. Devlin and Yee (2005) highlight the disadvantage faced by certain countries in the Middle East where high logistics costs negatively influence a country's international competitiveness.

For the purposes of this study, trade logistics is defined to include the range of services and processes that are involved in moving goods from one country to another. It includes customs and administrative procedures, organization and management of international shipment operations, tracking and tracing, and the quality of transport and information technology infrastructure. Only logistics services that are directly related to international trade and the transport of goods from one economy to another are covered; the analysis does not pertain, for example, to logistics that are directly related to end-user distribution subsequent to goods' arrival in the destination country. The analysis here should therefore not be regarded as a complete view of the full producer-to-consumer logistics chain but only to trade-related logistics. Since logistics services impact trade monetarily and in terms of time, both of these impacts will be examined.

This paper investigates the role that trade logistics play in the volume and value of international trade and the extent to which poor quality logistics constitute a barrier to trade. This paper contributes to the work already completed in the context of the OECD Trade Costs project on maritime transport costs and trade. The maritime transport costs project measured the cost of transportation from the time of portside loading (e.g., of a container) in the exporting country to the portside unloading in the importing country. This study extends that research by moving down the export chain to encompass different aspects of logistics services. This empirical study will contribute to and expand the body of research already available on the link between logistics and international trade.

Maritime container cargo is the foundation of the world trading system so the ability to efficiently move containers and avoid bottlenecks at every stage is crucial to minimize money and time costs. To achieve this, countries need to ensure that they have in place smooth and efficient customs procedures, high quality port and airport infrastructure,

quality transport logistics for multimodal (air, rail or road) transferring of goods to final destinations, and high quality telecommunications and general infrastructure. Time-sensitive merchandise trade is typically transported via air so that air logistics services and airport infrastructure are required to be of the highest standard to avoid spoilage and time delays. This study sheds some light on the differential trade impacts of logistics quality in sea and air transport.

The paper is organized as follows. Section 2 discusses previous research on the relationship between certain aspects of logistics quality and trade flows. Section 3 describes the data used in this study and in section 4 the results of the econometric analysis is presented. In section 5 we discuss policy implications and conclude. A technical annex discusses the empirical method used and data sources.

2. The relationship between logistics services and trade

There are many components of trade logistics that interact to impact supply chains and ultimately influence trade flows. The importance of trade logistics in determining the magnitude of international trade flows has been studied by several authors and will be discussed below. For this study the focus will be on components of trade logistics that are determined at the country level such as quality of transport infrastructure and border administration.

2.1 Transport infrastructure

Transport is the single most expensive component of trade logistics and adequate infrastructure is required to facilitate transportation. Whether these logistics providers supply their own transportation or whether they rely on transport services provided by third parties, the quality of transport infrastructure is critical. This may include such elements as the availability of pallets, shipping containers, vehicles, corridors and terminals. Corridors are the facilities used by transport vehicles. These include roads, railways lines, sea-lanes and air corridors and facilities such as signalling and traffic control. Terminals comprise uni-modal operations as well as multi-modal facilities that handle two or more modes of transportation. Additionally, associated facilities such as signalling and traffic control ensure that the system functions. They also include ports and airports. For example, airport infrastructure, which includes runway length and terminal size, determines the size of aircraft that can be accommodated and the frequency of landing and unloading. Similarly, port infrastructure includes terminal facilities for loading and unloading containers. The availability of well-connected, high-speed roads and rail ensures that once goods leave the airport or container terminals, they are able to reach their final, inland destinations with a minimum delay: this is especially important for perishable goods.

An important aspect of transport logistics is the relationship between different modes of transport. For goods arriving by air or sea, the ability to swiftly and efficiently transfer to another mode – road or rail – for inland transportation is particularly important for remote destinations and landlocked countries. While one mode may function efficiently, for example the sea or air component, the quality of the additional mode's infrastructure may let down the connection. The quality of the trade logistics as well as infrastructure in the destination country is therefore of importance.

Papers that specifically study the link between infrastructure and trade and transport costs include Limao and Venables (2001) who estimate an empirical model of maritime trade flows. Their research examines the role that transport costs as well as the quality of port infrastructure in the importing and exporting countries play in determining the volume of trade. Clark *et al.* (2004) find that the effect of port efficiency on transport costs and the effect of transport costs on maritime trade flows are significantly negative.

2.2 Information flows

A significant component of logistics services is a well developed information system. Information flows may be electronic, paper-based or voice based. Advances in information and communication technology (ICT) quality and coverage in recent years means that increasingly information is stored and processed electronically. The need for a high standard of telecommunications services is imperative to permit the timely and reliable flow of information. Telecommunications and electricity infrastructure are required to be of a sufficiently elevated standard in order for information systems to work smoothly and reliably. If economies, and in particular, developing economies, are to participate fully in global production and supply of intermediate and finished goods, their ability to do so will be affected by the standards of their ICT infrastructure as an important component of trade and transport facilitation. Such measures include customs automation, the ability to track and trace goods in transit at every stage of the process, pre-arrival clearance, risk-analysis, the electronic submission of customs forms and documents, information management and terminal operations and electronic single windows. Implementation of these measures can help reduce transaction costs. For example, the introduction of a Single Window to fulfil requirements for import and export, transit regulation and clearance aims to expedite and simplify information flows between the trading community and the government. Advantages include cutting costs through reducing delays with faster clearance and release, and more effective and efficient use of resources.

2.3 Time delays

Indirect costs such as time delays in shipping can take several forms but ultimately they increase the cost to firms that are then passed on to consumers. The cost of holding inventory and depreciation is higher for ocean shipped goods.[1] Lower shipping times are associated with higher volumes of trade, and there is some evidence that shipping time rather than distance is a more accurate reflection of shipping costs since it better captures the time-sensitivity of certain goods. Recent work underway in OECD suggests that a 10% increase in shipping time lowers imports by about 7% (OECD, 2011). Lengthy time delays for ocean shipping can be experienced due to port congestion and/or inefficient port infrastructure for loading and unloading cargo. Time delays at the border due to inefficient and lengthy administrative procedures related to importing and exporting can also have a detrimental effect on trade volumes. In addition, time delays may affect firms that rely on just-in-time deliveries of critical components to their manufacturing processes as well as firms who require short lead times between placing an order and getting it to market (e.g. fashion items or technology items). Countries which have introduced a Single Window have experienced significant reductions in time delays and

1. Lengthy shipping times on some routes due to distance, logistics, infrastructure etc means goods are already partially depreciated before getting to market (Hummels, 2001).

include, for example, Mauritius where the clearance time for goods decreased from an average of four hours to around 15 minutes. Similarly, in Senegal, clients are able to obtain in a single day what previously took two to three days.[2]

Hummels (2001) finds that for manufactured goods, each day of travel is worth close to 1% of the goods value per day and that higher ocean transit times significantly reduce the probability that a country will export to the United States. Freund and Rocha (2010) using the World Bank's *Doing Business* metrics, find that inland transit times have a larger negative effect on exports in Sub-Saharan Africa than do other time delay variables such as the time taken to deal with customs and port procedures or the time necessary to comply with documentation requirements. Further research which focuses on the role of time for exporting and importing procedures include Nordas *et al.* (2006) who shows that the longer times for exporting related to administrative procedures are an important barrier to market entry for exports of both intermediate and final goods as well as impacting negatively on the size of observed trade flows in these same goods. Djankov *et al.* (2010) using aggregate bilateral trade flows find a statistically and economically significant reduction in seaborne exports when there are longer export times and this matters more for time-sensitive perishable goods.

2.4 Logistics services and trade facilitation

Quality trade logistics are very much related to trade facilitation reforms – particularly with respect to customs operations or procedures and border administration. As international trade volumes expand over time, as well as the increased importance of global value or supply chains, as well as just-in-time delivery, the need to streamline customs procedures to prevent time delays or border bottlenecks takes on greater importance. Numerous and complex customs documents impose higher transactions costs on businesses in terms of financial and time costs. The more cumbersome, time-consuming and costly are trade procedures, the less competitive will be traders in international markets. Trade facilitation reform in this area is especially significant for developing countries wishing to participate in the global economy.

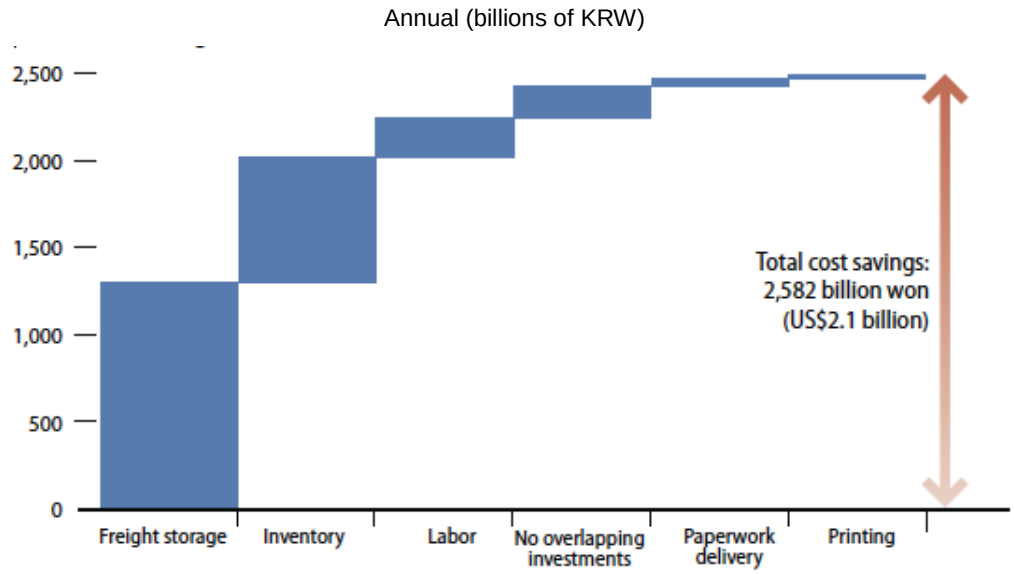
For example, it takes 24 days to ready goods for export in Vietnam at a cost of USD 669 while it takes twice that long from a landlocked country such as Rwanda where it is more than four times as costly.[3] On a positive note, Rwanda has been one of the Sub-Saharan African nations who have recently reformed many customs procedures. These include reducing the number of trade documents required, improving customs administration and implementing border cooperation agreements (World Bank, *Doing Business,* 2010). Other countries have embarked upon trade facilitation reform with varying success. For instance, Moise (2009) notes that Peru's introduction of electronic cataloguing and identification of high- and low-risk shipments has significantly reduced physical inspection rates from 70-100 % to a maximum of 15% thereby reducing average clearance times. Electronic data interchange systems for processing export documents as well as implementing a single window for trade transactions are ways in which time delays due to administrative procedures can be reduced. The introduction of such technology can significantly reduce the amount of paperwork required to process

2. UN/CEFACT (2005)

3. The World Bank. *Doing Business* 2010. Time to export includes document preparation, customs clearance, port and terminal handling as well as inland transport and handling. Cost to export is in USD per 20-foot container.

transactions and therefore, reduce costs. Korea Customs Service is an example of a national administration that has recently completed the introduction of a single window allowing traders and government agencies to exchange information and speed up the processes required to export. Estimates of Korean firms' cost savings due to trade facilitation reforms are presented in Figure 1.

Figure 1. Cost saving to Korean firms due to trade facilitation reforms



Source: World Bank, *Doing Business*, 2010.

Hausman *et al.* (2005) using both a composite measure of logistics performance quality and an early version of logistics data compiled by the World Bank, investigate the role of logistics cost, time and variability in time, and the complexity of export procedures on bilateral trade flows for 2005. They find that poor logistics performance significantly reduces trade flows in many of their empirical results. Wilson (2006), using data for 2004, analyzes the role that certain customs procedures have on bilateral exports of a narrow range of goods (SITC 07, SITC 65 and SITC 84). The results show that some of the procedures included in the *Doing Business* metrics, such as days spent at the border and certain administrative procedures, impose significant costs to trade in these goods.

3. Data

The present empirical research is based on indicators of trade logistics quality obtained from several sources.[4] The first source of logistics data is the World Bank's *Logistics Performance Index* (LPI) 2010 and is a survey of global freight forwarders and express carriers. The Index is a weighted average of the country scores on 6 dimensions: efficiency of the clearance process; quality of trade and transport related infrastructure; ease of arranging competitively priced shipments; competence and quality of logistics services; ability to track and trace consignments; and timeliness of shipments reaching destination. Since the 2010 survey was undertaken in 2009, using the LPI in the analysis

4. Further details on data sources are provided in the data appendix.

of 2008 bilateral trade is appropriate due to the fact that this type of information tends to change gradually over time.

All the components of the LPI are strongly positively correlated with each other so that countries with high quality logistics will also have a strong ability to ensure timely delivery of shipments.[5] The reporting country indicators are weakly negatively correlated with the partner country indicators suggesting that countries trade somewhat more with others that have a similar quality of logistics services. Table 1 presents averages by region and income group and for selected importers. Higher values of the index signify higher quality logistics services.

The positive impact of higher quality infrastructure on higher quality trade logistics is well established. The second data source used in the econometric analysis is the infrastructure component of the *Global Competitiveness Index* from the World Economic Forum's *Global Competitiveness Report* (GCR). It includes an overall measure of infrastructure quality as well as sub-components relating to the quality of air, road, port, rail, telecommunications and electricity infrastructure. The indicators used are for the year 2008. Similar to the LPI indicators, the individual components of the GCR infrastructure index are highly correlated amongst each other but not so between reporter and partner countries (Appendix Table 9).

The GCR's *Global Enabling Trade Index* (ETI) is an additional proxy measure of trade logistics quality. In order for freight forwarders to efficiently deliver goods across borders in a timely manner, they depend crucially on effective trade facilitation measures being in place. This index is constructed to measure the institutions, policies, and services facilitating the free flow of goods across borders. It is composed of four subindexes each of which captures elements considered important for enabling international trade. These are: (1) market access, (2) border administration, (3) transport and communications infrastructure, and (4) the business environment. The focus is on the overall composite index since all of the sub-indexes are too highly correlated to include together.[6] Table 2 presents averages for OECD and non-OECD members as well as for selected importers.

Finally, The World Bank's *Doing Business: Trading across borders* metrics measure the ease with which countries are able to trade internationally. *Doing Business* compiles all procedural requirements for exporting and importing a standardized container of goods by ocean transport. It records the number of documents per shipment required to import and export goods in a 20-foot container by ocean freight. Also recorded is the time, in days, that it takes to complete the transaction as well as all costs levied on a 20-foot container to complete the procedures to export or import.[7]

These foregoing trade logistics measures are then used to assess how changes in logistics quality impact on international trade flows. Several models are estimated using aggregate bilateral imports obtained from COMTRADE. Additionally, and in contrast to earlier studies using these measures, customs level data from Australia, Brazil, Chile and the United States are used to distinguish between modes of transport for imports into these four reporting countries. These unique data are available at the product level

5. The simple pairwise correlations are given in Appendix Table 8.

6. Appendix Table 10 presents the simple correlations between the individual components of the index as well as between reporter and partner components. Country-specific basic data for LPI and ETI indices and selected components are included in Appendix Table 7.

7. A full description of the *Trading across borders* metrics is provided in the data appendix.

(6-digit level of aggregation of the Harmonised System) and report the value of imports, transport costs and weight for both seaborne and airborne imports. These data are used to identify how the logistics measures identified above affect imports by mode of transport. Since the *Trading across borders* metrics relate specifically to seaborne, containerized trade, we estimate how changes in the metrics impact aggregate imports in addition to controlling for ad valorem transport costs and traditional determinants of trade. Regional averages for exporting are reported in Table 3 together with values for Australia, Brazil, Chile and the United States.

Table 1. Logistics Performance Index by region, income group and selected importers.

Country	LPI	Customs	Infrastructure	International shipments	Logistics competence	Tracking & tracing	Timeliness
United States	3.86	3.68	4.15	3.21	3.92	4.17	4.19
Australia	3.84	3.68	3.78	3.78	3.77	3.87	4.16
Brazil	3.2	2.37	3.1	2.91	3.3	3.42	4.14
Chile	3.09	2.93	2.86	2.74	2.94	3.33	3.8
Regions							
Europe	3.50	3.28	3.40	3.30	3.44	3.62	3.97
East Europe & Central Asia	2.74	2.35	2.41	2.92	2.6	2.75	3.33
Latin America & Caribbean	2.74	2.38	2.46	2.7	2.62	2.84	3.41
East Asia & Pacific	2.73	2.41	2.46	2.79	2.58	2.74	3.33
Middle East & North Africa	2.6	2.33	2.36	2.65	2.53	2.46	3.22
South Asia	2.49	2.22	2.13	2.61	2.33	2.53	3.04
Sub-Saharan Africa	2.42	2.18	2.05	2.51	2.28	2.49	2.94
Income Groups							
High income:	3.55	3.36	3.56	3.28	3.5	3.65	3.98
Upper middle income	2.82	2.49	2.54	2.86	2.71	2.89	3.36
Lower middle income	2.59	2.23	2.27	2.66	2.48	2.58	3.24
Low income	2.43	2.19	2.06	2.54	2.25	2.47	2.98
Median	2.84	2.57	2.64	2.99	2.76	2.98	3.52
Minimum	2.02	1.63	1.63	1.91	1.85	1.99	2.05
Maximum	4.11	4.04	4.04	4.34	4.32	4.27	4.58

Source: The World Bank. Country groupings are based on World Bank country classifications.

Table 2. GCR's Enabling Trade Index and Infrastructure quality index

Importer	GCR Enabling Trade Index	GCR Infrastructure index
Australia	5.22	5.16
Brazil	3.63	2.75
Chile	4.88	5.09
United States	5.42	6.07
OECD	5.04	4.85
Non-OECD	4.24	3.97
Median	3.9	3.54
Minimum	2.6	1.56
Maximum	6.04	6.76

Source: World Economic Forum.

Table 3. Doing Business: Trading across borders, by region and selected importers

Region or economy	Documents to export[1] (number)	Time to export[2] (days)	Cost to export[3] USD/container
Europe	4.8	12.4	918
East Asia and Pacific	6.7	23.1	909.3
Eastern Europe and Central Asia	6.5	26.8	1,581.80
Latin America and Caribbean	6.8	18.6	1,243.60
Middle East and North Africa	6.4	22.5	1,034.80
OECD	4.3	10.5	1,089.70
South Asia	8.5	32.4	1,364.10
Sub-Saharan Africa	7.8	33.6	1,941.80
Australia	6	9	1,060
Brazil	8	12	1,540
Chile	6	21	745
United States	4	6	1,050
Minimum	3	5	390
Maximum	13	102	4867
Median	7	22	1032

1. *Documents*: the number of documents required to import and export a shipment of goods. See Data Appendix.

2. *Time*: the number of days required to complete a procedure. See Data Appendix.

3. *Cost*: includes all costs associated with completing procedures for importing or exporting a 20 foot container but does not include transport, insurance charges or tariffs or other trade taxes. See Data Appendix

Source: The World Bank.

4. Empirical methodology

This section presents the econometric methodology and estimates of the effect of the various proxies for trade logistics quality on bilateral trade. Several gravity models are estimated to quantify how logistics quality influences trade flows using the logistics proxies outlined above for 2008, after controlling for other trade cost measures and determinants of bilateral trade. Our approach differs from earlier studies in several respects. Not only are the traditional determinants of international trade controlled for, but we are also able to provide a detailed analysis by taking into account freight charges and transport mode (air and sea) for a select group of importers using customs level data.[8] While quality trade logistics services are important for both modes of transport, the nature of the traded merchandise arriving by each mode is very different and, particularly for time-sensitive merchandise arriving by air, may require different approaches to handling. By including such detailed information on transport costs and logistics quality it is possible to identify which impediments to international trade are most significant and how best to implement policy to remove or reduce these trade costs. At the same time, low quality trade logistics hinder trade by imposing a barrier in its own right such as was found in Nordas *et al.* (2006).

The basic model used in the analyses that follow is the gravity model that has been used extensively in the empirical trade literature. Following the established gravity model literature, bilateral trade is modelled as a function of the following core gravity model variables: bilateral distance and variables to capture geographic and historical features of the countries. The latter includes indicator variables to capture if the countries were ever in a colonial relationship or whether the country pair speaks the same language, as well as variables to capture whether either country is landlocked or the country pair shares a border. A full explanation of the models estimated is available in the technical appendix.

4.1 Model results

Results of this study show that overall, higher-quality trade logistics, as captured by the logistics proxies, and improvements in infrastructure enhance trade very significantly. Overall, this is particularly true for exports. [9] Gravity model results show that higher quality trade facilitation measures – proxied here by a 10% improvement in the importing country's *Enabling Trade Index* (ETI), – is associated with an increase in trade on

8. The question of endogeneity may be raised in this context, as in most other econometric analysis: do logistics quality and other trade costs impact trade flows or is the relationship rather trade volumes impacting logistics quality and other trade costs? Although this problem is real, as in most other econometric studies, it is thought that it is perhaps less of an issue in this study because many of the logistics indicators vary relatively little over time (e.g. infrastructure indicators, ease of customs procedures, etc.) as opposed to trade flow data which is relatively reactive.

9. The gravity model results are presented in Tables 4 to 6 in the technical appendix. Since the majority of the logistics policy variables are available for 2008, we restrict our analysis to trade for this year for reasons of consistency and comparability Estimates for the baseline gravity model using these data (Table 4, column 1) reveal that magnitudes, signs and statistical significance of the elasticity estimates are consistent with many other studies. The baseline gravity model is augmented in turn with different logistics indicators (Table 4, columns 2 – 5).

average of 19%, while a 10% improvement in the index in the exporting country is associated with increased trade of 36%, all else equal (see column 3 of Appendix Table 4). For example, for an exporting country, a 1 standard deviation improvement at the mean ETI (mean ETI=4.13), e.g. Slovenia's trade facilitation rising to the quality of Korea (ETI=4.96), would be associated with an increase in bilateral imports of its partner countries on average of around 72%.[10] This is a similar magnitude as the effect of a one standard deviation decrease in distance. On the other hand, a one standard deviation increase in the ETI of the importing country has an effect that is half that of the exporter's.

Further model results show that more efficient border administration, facilitating the entry and exit of goods, is associated with higher values of trade, particularly as regards imports. On average, for every one-unit increase in the border administration indicator in the importing country, e.g. if Indonesia increases the quality of its border administration to equal that of Korea, bilateral trade is predicted to increase by 39%. For every one-unit increase in the measure in the exporting country, bilateral trade is predicted to rise by 19%, all else equal (column 2 of Appendix Table 4). These effects are stronger as regards border administration of imports as compared to exports; this is unsurprising since the border administration of imports is generally more stringent than that of exports and therefore impact trade more directly. Relative to distance, the impact of the importer's border administration is almost half as important. Where a one standard deviation fall in distance would see increases in trade of approximately 70%, a one standard deviation improvement in the importer's border administration would see an increase of around 40%.

The strong results of the impact of logistics quality on trade are confirmed in models using the World Bank's *Logistics Performance Index* (LPI) as the proxy for logistics quality. Improvements in general logistics quality using this proxy have a stronger trade-enhancing effect on exports as compared to imports (column 4 of Appendix Table 4). On average, for every 10% increase in the LPI of a typical exporter, bilateral imports increase by more than 69%, holding fixed the influence of the remaining determinants of trade. For every 10% increase in the LPI of a typical importing country, bilateral imports increase by 54%, on average. This would be the case of an average lower middle income country, e.g. Egypt, Nigeria or Yemen, that improves its logistics performance to equal that of an upper middle income country such as Bulgaria or Kazakhstan. If Egypt's logistics services were on a par with Bulgaria's, its imports would increase by 54% on average, all else equal, and its exports would increase by 69%. Changes in both importer and exporter LPI have a more significant impact on trade than does distance – 37% and 96% greater impact respectively.

High quality infrastructure is an important factor in determining the quality of a country's trade logistics services. Incremental increases in the quality of infrastructure impact countries with lower quality infrastructure more. Enhanced infrastructure impacts exports even more than imports. A general infrastructure quality index obtained from the World Economic Forum's Global Competitiveness Report is included for each exporting and importing country in an alternative model specification (column 5, Appendix

10. Standardized coefficients are listed below the estimated coefficients in Tables 4 to 6 in the appendix where appropriate. These estimates allow us to identify the relative importance of logistics policy variables as compared to non-policy variables such as distance or transport costs. We are able to determine whether a one standard deviation change in the explanatory variables produces more of a change in trade than another variable.

Table 4). Higher quality infrastructure is shown to be an important determinant of average bilateral imports but the effect is non-linear and depends on the value of the infrastructure index. For example, a one-point increase in the importer infrastructure index at the first quartile, for example as for the Philippines, is associated with a 64% increase in the value of imports, while a one-point increase at the median, for example China, is associated with a smaller increase in imports of 37%. A similar, but stronger, pattern can be seen for the exporting country where a one point rise in the index at the median value of the index (e.g. Morocco) is associated with a significant increase in imports of more than 79% and a 47% rise at the 3rd quartile value of the index such as for Thailand.

These results indicate the strong impact of trade logistics on trade flows and the important potential gains from trade that result from increases in the quality of trade logistics. Although not strictly comparable due to different samples and methodologies, this finding echoes some of the findings in previous studies. Wilson (2007), for example, finds important trade impacts of better logistics quality and furthermore that the greatest benefits accrue to those countries with the least efficient customs and administrative procedures.

The results presented thus far refer to trade by all modes of transport and for all country pairs in the sample. However, trade logistics are generally specific to each mode of transport (sea, air, road, rail) and the impacts of their quality on trade may differ by mode. In order to better understand these differences, this study further regarded the impact of trade logistics quality on goods imported by sea as opposed to those by air in four countries: Australia, Brazil, Chile and the United States. By isolating trade by mode of transport (sea and air) the impacts of logistics quality can be identified on seaborne versus airborne imports taking into account actual freight charges paid.[11] Transport costs have been found to be a significant deterrent to trade (Korinek and Sourdin, 2009), therefore including detailed freight charges as an additional variable in the analysis allows more accurate specification of the trade cost function. Estimated elasticities of imports with respect to ad valorem freight are in the range of -0.63 to –0.80.[12] Unsurprisingly, the effect of ad valorem freight charges has more of an impact on sea freight relative to air freight, reflecting the fact that higher value goods are shipped by air where freight charges as a proportion of the value matter less. Distance, which also reflects time costs, similarly has a greater impact on sea freight than on air freight with estimated elasticities of -1.30 and -0.61 respectively. The magnitude of the standardized coefficients reveal that the impact of *ad valorem* freight charges is around a 75% more important trade cost than is physical distance. When separately analysing seaborne and airborne trade, freight charges are twice as important as distance for airborne trade but distance is a more significant deterrent than freight costs for sea borne imports (columns 5 and 6, Appendix Table 5).

11. Customs level data that records mode of transport as well as freight charges for import transactions is available for few countries. Apart from the four countries used in the present study, these include several Latin American countries and New Zealand.

12. The dependent variable in the models referred to here is the log of bilateral imports from all exporters towards the four importing nations. An elasticity in the present analysis is interpreted as a percentage change in imports from a percentage change in the variable of interest – *ad valorem* freight costs in this case. Distance is also statistically significant in all specifications. This reinforces previous findings that the distance variable captures more than transport costs such as cultural distance and business networks.

In order to isolate the relative importance of specific features of trade logistics on trade, further analysis was performed using a selection of individual components of the trade logistics indicators, for example, the individual components of the LPI, ETI and GCR infrastructure indices. On average, improvements in exporting country trade logistics as measured by the proxies from the LPI, are associated with large increases in exports. For example, a one-unit improvement in the indicator for the quality of customs procedures in the exporting country – for instance, from a value 2 to 3 such as the difference between Algeria and Thailand – is associated with an increase in bilateral exports of close to 500% for airborne trade. The effect is somewhat smaller for seaborne trade – to around 400% (column 1, appendix Table 5).[13] Similar magnitudes of the effects have been estimated for the other components of trade logistics such as tracking and tracing, infrastructure and logistics competence (columns 2 to 4, Appendix Table 5) and the estimated effects are more important for airborne trade in all cases. Standardized coefficients suggest that the effects of improving logistics measures in these areas are three to four times more important as determinants of trade than reductions in freight charges.

The impact on trade of infrastructure quality, measured separately from other components of trade logistics, and specifically related to air infrastructure and port infrastructure was examined for seaborne and airborne trade. The effect of infrastructure quality was ascertained at different income levels: low income, lower-middle income, upper-middle income and high income countries, since improvements in infrastructure quality may have a differential impact according to a country's level of development.

Airport infrastructure has a strong effect on trade flows at all levels of development, with the weakest effect estimated for low-income countries. Results show that a one-unit increase in the quality of the exporter's air infrastructure at low levels of income as measured by the index, results in more than 140% increase in trade and the effect of improvements at the lower-middle income and upper-middle income levels is associated with increases in exports of 258% and 213% respectively. The estimated impact at high income levels is around 227% for a one-unit increase in the air infrastructure index.

For seaborne imports, changes in low-income exporters' port infrastructure do not have a statistically significant impact on trade. However strong estimated effects can be found for higher levels of income with the maximum estimated effect in the upper–middle income category. A one-unit improvement in port infrastructure for a lower-middle income country is associated with an estimated increase in trade of 139%. In contrast, for upper-middle and high-income countries, a one-unit improvement leads to a much larger rise in trade: 236% and 171% respectively. Since the maximum estimated gain is found for the upper-middle income group, countries in this group stand to gain the most from improvements in port infrastructure, at least as regards their trade with the four

13. The impact of this incremental increase in trade logistics quality on trade is very large. It should be noted, however, the logistics quality is very different in a country such as Thailand as compared with one such as Algeria. In Thailand, it takes an exporter less than half the amount of lead time for air- or seaborne exports to cross a border as in Algeria (1.59 days on average as compared to 4.58 days). Customs clearance alone takes 4.47 days in Algeria, assuming no physical inspection is required, as compared to 0.71 days in Thailand. Thai exporters must complete 2.67 documents to clear customs as compared with 9 documents required to export goods from Algeria (World Bank, 2010). Of course, in every document there is an opportunity for error or misinterpretation either by the exporter or his/her representative or by customs officials which could lead to further time and monetary cost.

countries in the sample. The impact of infrastructure improvements, for both sea and airborne trade, is much higher relative to ad valorem transport costs – on average its impact is 5 times more in the case of middle income countries.

The finding that low-income countries exports are not impacted by changes in port infrastructure is somewhat surprising. There may be two possible explanations for this finding. Firstly, the evidence is abundant regarding supply side factors that are most important in order to promote production and trade, particularly in poor developing countries. Some of the basic necessities for a functioning economy – security, basic human capital requirements, favourable business and investment climates, macro-economic fundamentals – are absent or function poorly in many low income countries.[14] With such economic fundamentals lacking, trade is not impacted by greater investment in port infrastructure. Secondly, almost half of low income countries are landlocked therefore port infrastructure will not be significant or present in these countries. This influences the overall result that low income countries' port infrastructure levels do not significantly impact their trade.

A further set of models includes measures of the quality of border administration and quality of transport and communications (columns 7 and 8, Appendix Table 5) as determinants of exports. One-unit increases in both the indices for border administration and transport and communication have a similar estimated impact on trade volumes: 224% and 235% increases, on average, respectively. Their impact on trade in both cases, relative to ad valorem transport costs, is around three to four times more.

A final set of models estimates the effect of the World Bank's *Doing Business* metrics on imports to Australia, Brazil, Chile and the United States (Appendix Table 6) and includes variables for time to trade and cost of trading. The time to trade is defined as the number of days required to complete both importing and exporting procedures and the cost of trading is defined as all costs associated with completing procedures for importing and exporting a 20-foot container, but does not include transport, insurance charges or tariffs or other trade taxes.[15] The estimated effects of distance, language and colonial ties are robust and confirm earlier results. Every extra day needed to ready goods for export and import is found to reduce trade by around 4% (column 1, Appendix Table 6). A one standard deviation increase (33.3) at the mean (49.7) in the total days required to ready goods for trade would see a fall in the value of imports of around 133%, all else equal. This implies that if Cambodian exports to the United States were handled as efficiently as those of the Slovak Republic, for example, Cambodian exports would increase by 133%.

When investigating the effect of total cost to export and import, the model results indicate that for every extra USD 100 cost per container, imports decline on average by 20%. This estimate is perhaps too high but it should be kept in mind that it only applies to a limited sample of four importing countries.

These results show very strong trade impacts of time spent at the border and the cost of getting containers across borders. Although not strictly comparable due to different time periods under consideration and country coverage in the samples, they suggest that

14. See, among many others, World Bank, *Trade and Poverty Reduction*, *http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:20040979~menuPK:34480~pagePK:34370~theSitePK:4607,00.htm*l

15. Time to trade and cost of trading are not measured bilaterally so it is not necessarily implied that it is the actual time and cost required for trading between any country pair.

the impact of an extra day spent getting across borders has a significantly greater negative impact on trade flows as compared with an extra day spent at sea delivering a container of goods.[16] This may be due in part to more uncertainty in time delays at borders that traders are less able to predict and respond to. The estimates for the impact on trade of increases in the cost associated with completing procedures for importing and exporting a container are also higher than estimates of an incremental increase in the cost of transport (OECD, 2011).

5. Policy implications and conclusions

5.1. Conclusions from this analysis

This paper has analysed the importance of the quality of trade logistics for merchandise trade. Using a set of gravity models, this paper finds strong support for a number of hypotheses with important policy implications. First, higher quality trade logistics are positively, significantly and robustly associated with higher bilateral merchandise trade. Second, the impact of improved trade logistics is greater for goods that are transported by air than those via sea. This is possibly due to the fact that time-sensitive merchandise requires higher quality logistics services. Third, improvements in port, and particularly air, infrastructure benefit middle-income countries more than lower income countries. This may be due to their ability to reap the gains from trade that such trade facilitating investments offer which lower income countries may be less able to do. Higher income countries also profit significantly from such investments, although somewhat less so than middle income countries, probably because they have already undertaken investments with the highest returns.

Additionally, our results suggest that time and costs associated with completing procedures for importing and exporting containerized goods impact trade even more than time and costs associated with their transport. All components of trade logistics – customs procedures, tracking and tracing, overall infrastructure and logistics competence – impact trade more significantly, by several magnitudes, than do distance or freight costs. This finding further underlines the importance of the policy-related components of trade facilitation.

Trade logistics quality impacts exports more than imports, overall. Improvements in a given country's trade logistics will improve its export situation in general: infrastructure improvements are particularly important for exporters. Improvements in the administration of borders impact both exports and imports positively but impact imports even more than exports.

Analysis of the impacts of trade logistics on a given country's trade by income category indicates that customs administration, tracking and tracing and logistics competence seem to impact trade flows by a similar magnitude regardless of countries' level of development.[17] Incremental improvements in these logistics services seem to impact trade by similar magnitudes whether the country in question is lower-income,

16. The estimate for the impact of time at sea on trade flows is taken from *Maritime Transport Costs and their Impacts on Trade*, OECD, forthcoming. That study finds that a 10% increase in the time spent at sea implies a 7% drop in trade on average, other things being equal.

17. Results of this set of models are not shown here for reasons of brevity. Full results are available on demand.

middle-income or even higher-income. In the case of infrastructure improvements, however, middle-income countries reap the trade benefits more than lower income countries. The case of port infrastructure is particularly telling: lower income countries do not improve their trade significantly with incrementally higher quality port infrastructure. This may indicate that lower income countries cannot take full advantage of easier access afforded by better ports due to other supply constraints or internal barriers.

5.2. Implications for policy

The analysis in this paper signals a number of policy priorities for countries at different levels of development and for exporters as opposed to importers. It should be kept in mind that these are broad policy recommendations based on a large number of countries and cannot be viewed as necessarily applying to all countries in a given group.

This analysis confirms much of the existing literature that suggests that improvements in trade logistics significantly augment trade overall. Given that a large magnitude of existing studies indicate that trade is good for growth, improving trade logistics can therefore be seen as growth-enhancing.

Improvements in trade logistics associated with airborne trade are especially trade-enhancing. Trade in goods that are transported by air, as opposed to over land or sea, is particularly dependent on high-quality trade logistics. Landlocked countries that rely heavily on air carriers to trade, and exporters that are specialized in goods that are transported by air (e.g. high value-added goods, highly time sensitive goods including flowers and agricultural products and some fashion items) will particularly benefit from investments in trade logistics that facilitate trade in goods transported by air.

Some of the results in this study regarding landlocked countries point to the paramount importance of regionalism in trade facilitation reforms. As in all econometric models of the type used here, results are controlled for whether or not a country is landlocked. As regards seaborne trade, a given landlocked country is strongly disadvantaged by its geography – landlocked countries are five times less likely to trade in shipped goods than countries with direct access to a port. Landlocked countries are just as likely, however, to trade in goods that are transported by air as other countries, controlling for other aspects such as national income. Since 80% of trade in value is seaborne, regional trade facilitation improvements are particularly important for some countries.

In general, improvements in trade logistics impact exports more than imports. Investments in trade logistics will enhance the potential for exporters to compete on international markets. Improvements in infrastructure are particularly trade-enhancing for exporters. Improvements in border administration however, although impacting both exports and imports positively, have an even stronger effect on imports. Countries experiencing delays or difficulties in receiving imports, therefore, should particularly examine their border procedures and regulations when undertaking trade reforms.

Investments in some of the components of trade logistics are trade-enhancing for countries at all levels of development. This is true for improvements in customs administration, tracking and tracing, and logistics competence. In the case of infrastructure, however, improvements impact trade most in middle-income countries. In the case of port infrastructure, improvements do not seem to affect trade in lower-income countries at all. This is possibly largely due to the fact that other supply-side constraints – basic security issues, health and basic education and macro-economic fundamentals to

name just a few –that would allow some lower-income countries to benefit from the gains in trade from improvements in trade logistics may not be in place. However, since lower income countries do benefit significantly from improved border procedures, tracking and tracing and greater logistics competence, these areas could be regarded as priorities for their future investments in trade logistics.

High income countries also benefit somewhat less than middle income countries from improvements in infrastructure possibly because they have already undertaken the most necessary investments. This finding may suggest that some countries are experiencing diminishing returns from further infrastructure improvements. High-income countries do not, however, show diminishing returns from improvements in border administration, tracking and tracing, and greater logistics competence.

The findings in this study highlight the importance of promoting policies to continue to move trade facilitation reforms forward. This analysis confirms that spillovers from improvements in trade logistics can be significant. By reducing the time and cost involved in administrative procedures, businesses stand to gain very significantly in terms of their ability to trade competitively in international markets. Developing and least developed countries gain particularly from these investments which will contribute to economic development through increased trade flows.

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Technical Appendix

Empirical methodology

The widely used gravity model in international trade has its origins in the equation for gravity. In its simplest form the model expresses bilateral trade between countries *i* and *j* as a function of economic mass and which is inversely related to the distance between them. The empirical gravity equation for trade can be expressed as follows:

$$M_{ij} = G\frac{Y_i Y_j}{Dist_{ij}} \tag{1}$$

where M_{ij} is bilateral imports from country *j* to country *i*, *G* is a constant, Y_i and Y_j are the GDPs of countries *i* and *j* respectively and $Dist_{ij}$ is distance between *i* and *j*.

Theoretical developments by Anderson and van Wincoop (2003) typically implies an estimating equation of trade determination taking the following form:

$$ln\left(M_{ij}\right) = \beta_0 + \beta_1 ln Y_i + \beta_2 ln Y_j + \sum_{i=1}^{N} d_i + \sum_{j=1}^{N} f_j + ln\, t_{ij} + \varepsilon_{ij} \tag{2}$$

where the *d* and *f* terms are, respectively, exporter and importer fixed effects. These latter consistently estimate multilateral resistance terms that capture relative prices and which, if not accounted for, leads to a misspecified model that suffers from omitted variable bias. Distance, which is included as a proxy for transport costs, has been subsumed into the trade cost function, t_{ij} which additionally includes a set of observables representing other barriers to trade, and ε_{ij} is a classic random error term with the usual properties. In addition to distance, the trade cost function in (2) typically includes indicator variables to capture geographic and historic country characteristics, for example, any colonial relationship between the country pairs and whether the countries share a common official language as well as a dummy for countries sharing a common border. Including a general logistics variable, the trade cost function in (2) can be specified as follows:

$$\begin{aligned} ln\, t_{ij} = {} & \alpha_1 logistics + \alpha_2 ln\left(dist_{ij}\right) + \alpha_3 border_{ij} + \alpha_4 language_{ij} \\ & + \alpha_5 colony + \alpha_6 llck \end{aligned} \tag{3}$$

The drawback to estimating (2) is that since the log of zero is undefined, by log-linearizing (1), we lose the observations for which bilateral trade is zero. A recent literature highlights the importance of accounting for zero trade flows as well as addressing the form of heteroskedasticitiy inherent in standard gravity models. Santo-Silva and Tenreyro (2006) find that the Poisson pseudo maximum likelihood estimator provides consistent estimates of the gravity model parameters while simultaneously

correcting for the bias generated by the heteroskedasticity in the log-linearization of the gravity equation. However, the preponderance of zero trade in the matrix suggests that modelling the probability of trading as a separate process may be more appropriate. To that end, we estimate a zero-inflated Poisson pseudo maximum likelihood (ZIP) model as in Burger *et al.* (2009).[18] This estimator simultaneously models the probability that trade is zero as well as the volume of trade conditional on observing trade. The advantage of this estimator lies in not requiring the exclusion restriction inherent in the Heckman sample selection estimator as well as removing the bias arising from heteroskedasticity as found in Santo-Silva and Tenreyro (2006).[19]

Whether trade between a country-pair is zero is a binary outcome that can be modelled using a probit model,

$$\psi_{ij} = Pr(trade_{ij} = 0 | \mathbf{z}_{ij}) = 1 - \Phi(\mathbf{z}_{ij}\gamma) \tag{4}$$

where $\mathbf{z}_{ij}$ is a vector of explanatory variables which determine the probability of two countries engaging in trade and Φ is the standard normal cumulative distribution function. For country- pairs who do engage in trade, the probability is determined by a Poisson regression conditioning on a set of explanatory variables, x_k, and on $trade = 0$ and where the two sets of variables x_k and z_k in the first step may be the same. For the ZIP model, we have

$$Pr(M_{ij} | x_{ij}, trade_{ij} = 0) = \frac{e^{-\mu_{ij}} \mu_{ij}^{M_{ij}}}{M_{ij}!} \tag{5}$$

in which $$\mu_{ij} = \exp\left(\beta_0 + \sum_{i=1}^{N} d_i + \sum_{j=1}^{N} f_j + \log(t_{ij})\right)$$

In our model specifications, the trade cost function t_{ij} additionally contains measures for logistics quality.

We apply the ZIP estimator to aggregate bilateral import data for 2008 from UN Comtrade. The probability of zero trade is modelled as a function of trade costs such as bilateral distance and importer and exporter fixed effects and the volume of trade, in levels and which includes zero trade flows, is modelled as discussed above in (5).

Results from estimating the gravity model in (5) are presented in Table 4.[20] The exporter and importer income terms have dropped out due to the presence of exporter and

18. Helpman *et al.* (2008) model the process using a Heckman sample selection model.

19. For a general discussion of the ZIP estimator, see Long (1997) and for an application to international trade see Burger *et al.* (2009).

20. As with many economic relationships, there is always potential bias introduced due to the simultaneous determination of variables. For example, it is likely that while trade responds to improved logistics services, the reverse is also true where increased trade flows serve to stimulate investment in infrastructure and improve logistics quality. Since infrastructure and logistics services are slow to change, at any given point in time we can treat logistics quality

importer fixed effects dummy variables which account for all country-specific effects including income effects.

Data sources

Doing business, trading across borders

The World Bank's, *Doing Business* survey with respect to *Trading across Borders* compiles information on the various procedures required to import and export ocean-shipped goods. We use the 2010 survey data and apply to 2008 trade flows. The data listed under the various years of the *Doing Business* surveys relate to the previous year. The variables included are:

- *Documents*: the number of documents required to import and export a shipment of goods.
- *Time*: the number of days to import and export required to complete a procedure.
- *Cost*: includes all costs associated with completing procedures for importing or exporting a 20 foot container but does not include transport, insurance charges or tariffs or other trade taxes.

Logistics Performance Index

We use the World Bank's LPI for 2010 and apply it to the analysis of export data for 2008. It consists of an index constructed from surveys of global freight forwarders and express carriers regarding the logistics friendliness of various countries. The LPI is a composite index made up of the following seven components:

- *Customs*: efficiency of customs clearance procedures
- *Infrastructure*: quality of transport and information technology infrastructure
- *International Shipments*: ease and affordability of arranging international shipments
- *Logistics competence*: competence of local logistics
- *Tracking and tracing*: ability to track and trace international shipments
- *Timeliness*: of shipments reaching destinations.

Global Competitiveness Report

We make use of the infrastructure component of the *Global Competitiveness Index* data from the World Economic Forum for 2010 and apply this to 2008 trade data. Data on infrastructure quality is used that measures the quality of air, port, road and rail infrastructure and are combined to form a single index. These data are used to measure the quality of inland transport logistics (rail and road) as well as the quality of infrastructure for importing and exporting. The *Global Enabling Trade Index* is composed of the following four subindexes: (1) market access, (2) border administration, (3) transport and communications infrastructure, and (4) the business environment.

as given and therefore predetermined (weak exogeneity) since there are lags involved with improved services coming online.

International trade data

International trade data are obtained from United Nations Commodity Trade Statistics Database (Comtrade) for 2008. For the United States, the data is obtained from US Census Bureau and for Chile and Brazil from Associação Latino-Americana de Integração (ALADI). Customs level data for Australia is obtained from Australian Bureau of Statistics. All data are in expressed in USD.

Gravity model variables

Gravity model variables are obtained from the following sources:

Gross Domestic Product in current USD from World Bank – World Development Indicators. All remaining gravity variables obtained from CEPII.

The set of models presented in Tables 5 and 6 are estimated using customs level aggregate bilateral imports for Australia, Brazil, Chile and the United States for 2008 for two modes of transport – air and sea. For Table 6 the sample is restricted to seaborne containerized trade and includes variables for total time to trade defined as (time for export) + (time for import) in days and total cost of trading defined as (cost to import)+(cost to export). These latter are from the World Bank's Doing business database and are described below.

Table 4. Gravity models of bilateral imports and logistics measures

	Baseline (1)	ETI border admin (2)	ETI overall index (3)	LPI (4)	Infrastructure (5)
Poisson regression. Dependent variable: imports					
Ln(distance)	-0.857***	-0.850***	-0.850***	-0.854***	-0.859***
	-0.662	-0.706	-0.706	-0.673	-0.693
	-(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
Landlocked - importer	-5.512***	-3.208	-1.058***	-3.359***	-1.298***
	(0.185)	(0.282)	(0.132)	(0.288)	(0.158)
Landlocked - exporter	-6.770***	-2.651**	0.628***	-4.198***	-0.926***
	(0.530)	(1.228)	(0.238)	(0.134)	(0.183)
Border	0.411***	0.393***	0.393***	0.399***	0.384***
	(0.067)	(0.066)	(0.066)	(0.067)	(0.065)
Common language	0.173***	0.182***	0.182***	0.172***	0.180***
	(0.066)	(0.068)	(0.068)	(0.067)	(0.067)
Colony	0.050	-0.021	-0.021	-0.000	0.004
	(0.101)	(0.097)	(0.097)	(0.099)	(0.100)
Border admin - importer		0.388***			
		0.396			
		(0.046)			
Border admin – exporter		0.186**			
		0.197			
		(0.078)			
Ln (ETI) importer			1.906***		
			0.364		
			(0.223)		

Table 4. Gravity models of bilateral imports and logistics measures (*cont*.)

	Baseline (1)	ETI border admin (2)	ETI overall index (3)	LPI (4)	Infrastructure (5)
Poisson regression. Dependent variable: imports					
Ln(ETI) exporter			3.560***		
			0.726		
			(0.945)		
Ln(LPI) importer				5.367***	
				0.966	
				(0.885)	
Ln(LPI) exporter				6.995***	
				1.385	
				(0.458)	
Infrastructure index (importer)					1.455***
					1.967
					(0.292)
Infrastructure index (exporter)					1.708***
					2.333
					(0.589)
Infrastructure index sq (importer)					-0.142**
					-1.614
					(0.055)
Infrastructure index sq (exporter)					-0.129***
					-1.493
					(0.029)
Constant	22.775***	25.813***	18.313***	13.255***	20.591***
	(0.572)	(0.599)	(1.778)	(1.421)	(1.712)
Probit regression. Dependent variable: trade=0					
Ln(distance)	0.756***	0.802***	0.802***	0.876***	0.862***
	(0.026)	(0.061)	(0.061)	(0.053)	(0.050)
Constant	-11.795***	-11.984***	-11.984***	-13.920***	-10.875***
	(0.458)	(0.811)	(0.811)	(0.703)	(0.580)
N	28980	11466	11466	16761	14170

*p<0.1, ** p<0.05, *** p<0.01. Robust standard error (Huber/White) with clustering by country-pair are given in parentheses. Importer and exporter fixed effects included in all regressions and in both stages. All models estimated for 2008 using the zero-inflated poisson regression. The dependent variable in the volume equation is aggregate bilateral imports. Standardized coefficients are presented below coefficients where applicable and represent estimated effects of standardized independent variables on unstandardized dependent variables.

Table 5. Gravity models using customs data for Australia, Brazil, Chile and United States

	LPI customs procedures (1)	LPI tracking and tracing (2)	LPI infrastructure (3)	LPI logistics competence (4)	Air (5)	Sea (6)	ETI border (7)	ETI transport and communication (8)
Dependent variable: ln(imports)								
Ln(freight)	-0.746***	-0.763***	-0.755***	-0.756***	-0.639***	-0.803***	-0.678***	-0.692***
	-0.681	-0.696	-0.689	-0.699	-0.671	-0.513	-0.589	-0.601
	(0.098)	(0.098)	(0.099)	(0.099)	(0.119)	(0.247)	(0.118)	(0.117)
Ln(distance)	-0.875***	-0.868***	-0.870***	-0.870***	-0.608***	-1.303***	-0.851***	-0.849***
	-0.421	-0.418	-0.419	-0.419	-0.299	-0.647	-0.417	-0.416
	(0.181)	(0.181)	(0.182)	(0.181)	(0.197)	(0.252)	(0.176)	(0.176)
Colony	1.784	1.771	1.778	1.776	-0.689	-1.047	-0.962	-0.962
	(1.706)	(1.701)	(1.703)	(1.704)	(0.957)	(0.895)	(0.591)	(0.589)
Land locked	-2.245***	-6.523***	-1.370	0.624**	0.679	-5.251***	0.884	0.864
	(0.737)	(0.323)	(0.871)	(0.252)	(0.791)	(0.435)	(0.992)	(0.993)
Language	0.917***	0.909***	0.913***	0.913***	0.891***	0.804**	0.926***	0.925***
	(0.215)	(0.216)	(0.216)	(0.216)	(0.246)	(0.318)	(0.220)	(0.220)
Common border	-0.021	-0.009	-0.014	-0.012	0.485	-0.317	0.030	0.031
	(0.533)	(0.532)	(0.532)	(0.532)	(0.586)	(0.676)	(0.528)	(0.527)
Sea	4.446***	3.137***	3.508***	3.533***			4.129***	3.585***
	(0.640)	(0.667)	(0.580)	(0.660)			(0.598)	(0.536)
Customs	4.927***							
	2.620							
	(0.535)							
SeaXCustoms	-0.825***							
	-1.088							
	(0.224)							

	LPI customs procedures (1)	LPI tracking and tracing (2)	LPI infrastructure (3)	LPI logistics competence (4)	Air (5)	Sea (6)	ETI border (7)	ETI transport and communication (8)
Dependent variable: ln(imports)								
Track&trace		5.160***						
		2.947						
		(0.199)						
SeaXtrack&trace		-0.274						
		-0.407						
		(0.215)						
Infrastructure			5.470***					
			3.480					
			(0.331)					
Sea Infrastructure			-0.448**					
			-0.610					
			(0.198)					
Logistics competence				4.631***				-
				2.557				
				(0.262)				
seaXlogistics competence				-0.436**				
				-0.612				
				(0.218)				
Air infrastructure					1.403***			
					1.518			
					(0.521)			
Air infrXlow middle income					1.173***			
					2.333			
					(0.202)			

	LPI customs procedures (1)	LPI tracking and tracing (2)	LPI infrastructure (3)	LPI logistics competence (4)	Air (5)	Sea (6)	ETI border (7)	ETI transport and communication (8)
Dependent variable: ln(imports)								
Air infrXupper middle income					0.724***			
					1.455			
					(0.221)			
Air infrXhigh income					0.869***			
					2.206			
					(0.200)			
Port infrastructure					-0.689			
					(0.620)			
Port infrXlow middle income					1.392***			
					2.296			
					(0.426)			
Port infrXupper middle income					2.359***			
					3.978			
					(0.635)			
Port infrXhigh income					1.712***			
					3.946			
					(0.463)			
Border admin							2.236***	
							2.175	
							(0.425)	
seaXborder admin							-0.459***	
							-0.950	
							(0.138)	

	LPI customs procedures (1)	LPI tracking and tracing (2)	LPI infrastructure (3)	LPI logistics competence (4)	Air (5)	Sea (6)	ETI border (7)	ETI transport and communication (8)
Dependent variable: ln(imports)								
Transport & comm								2.351***
								2.071
								(0.467)
SeaXtrans & comm								-0.359***
								-0.665
								(0.136)
Constant	8.703***	9.681***	8.718***	7.326***	11.910***	22.265***	9.463***	9.399***
	(2.403)	(1.877)	(2.199)	(1.772)	(2.662)	(3.200)	(3.181)	(3.269)
R-squared	0.817	0.815	0.815	0.815	0.894	0.790	0.841	0.840
N	962	962	962	962	420	411	781	781

p<0.1, ** p<0.05, *** p<0.01. Robust standard errors (Huber/White) with clustering by country-pair are given in parentheses. All models estimated by least squares for 2008 using aggregated customs data and include importer and exporter fixed effects. Reporting countries include Australia, Brazil, Chile and the United States. A landlocked indicator was included but was dropped due to perfect collinearity. All logistics indicators apply to exporting country. Dummy variables were included for the following income levels: low income, lower middle income, upper middle income and high income but dropped due to perfect collinearity. The omitted category in the interaction terms between these dummies and the infrastructure variables is low income. Standardized coefficients are presented below coefficients where applicable and represent estimated effects of standardized independent variables on unstandardized dependent variables.

Table 6. Aggregate gravity regressions for seaborne trade using The World Bank's "Doing Business" metrics

	Total time	Total cost
Dependent variable: log(imports)		
Ln(distance)	-1.011***	-1.011***
	-0.507	-0.507
	(0.218)	(0.218)
Language	0.837***	0.837***
	(0.283)	(0.283)
Colony	2.044*	2.044*
	(1.082)	(1.082)
Total time	-0.041***	
	-1.313	
	(0.019)	
Total cost		-0.002***
		-0.311
		(0.000)
Constant	23.605***	-32.150***
	(1.869)	(3.509)
R-squared	0.821	0.821
N	485	485

* p<0.1, ** p<0.05, *** p<0.01. Robust standard error (Huber/White) with clustering by country-pair given in parentheses. Importer and exporter fixed effects included in all regressions. All models estimated by least squares for 2008 using aggregated customs data for seaborne containerized exports to Australia, Brazil, Chile and the United States. Standardized coefficients are presented below coefficients where applicable and represent estimated effects of standardized independent variables on unstandardized dependent variables.

Table 7. Exporting country logistics index value and value of exports to Australia, Brazil, Chile and United States for 2008.

Exporter	ETI border	ETI trans & comm	LPI customs	LPI infrastruc-ture	LPI Logistics competence	LPI Tracking and tracing	Value of exports USD millions
ABW	.	.	.	.	.	.	889 053
AFG	.	.	2.22	1.87	2.09	2.37	11 411
AGO	.	.	1.75	1.69	2.02	2.54	3348 706
AIA	.	.	.	.	.	.	1 106
ALB	3.91	2.82	2.07	2.14	2.39	2.39	1 578
AND	.	.	.	.	.	.	0 227
ANT	.	.	.	.	.	.	124 593
ARE	5.34	4.91	3.49	3.81	3.53	3.58	497 213
ARG	3.35	3.33	2.63	2.75	3.03	3.15	1941 158
ARM	3.25	3.42	2.1	2.32	2.59	2.26	6 838
ATF	.	.	.	.	.	.	0 263
ATG	.	.	.	.	.	.	0 927
AUS	5.54	5.39	3.68	3.78	3.77	3.87	2053 694
AUT	5.92	5.55	3.49	3.68	3.7	3.83	1263 372
AZE	2.91	3.4	2.14	2.23	2.48	2.65	637 191
BDI	2.57	2.16	.	.	.	.	0 740
BEL	5.02	5.45	3.83	4.01	4.13	4.22	2582 946
BEN	2.97	2.6	2.38	2.48	2.64	3.07	10 947
BFA	2.64	2.58	2.22	1.89	2.02	2.77	0 185
BGD	2.88	2.5	2.33	2.49	2.44	2.64	510 515
BGR	3.64	3.68	2.5	2.3	2.85	2.96	70 041
BHR	5.17	4.07	3.05	3.36	3.36	3.63	95 980
BHS	.	.	2.38	2.4	2.69	2.81	79 782
BIH	3.44	2.98	2.33	2.22	2.3	2.68	3 570
BLR	.	.	.	.	.	.	306 894
BLZ	.	.	.	.	.	.	23 152
BMU	.	.	.	.	.	.	30 871
BOL	3.55	2.53	2.26	2.24	2.38	2.38	82 471
BRA	3.53	3.33	2.37	3.1	3.3	3.42	5659 319
BRB	.	.	.	.	.	.	11 513
BRN	.	.	.	.	.	.	172 929
BTN	.	.	2.14	1.83	2.24	2.54	0 158
BWA	.	.	2.09	2.09	2.29	2.59	43 786
CAF	.	.	.	.	.	.	1 993
CAN	5.64	5.27	3.71	4.03	3.99	4.01	5236 075
CCK	.	.	.	.	.	.	0 586
CHE	5.8	5.49	3.73	4.17	4.32	4.27	2660 962
CHL	5.31	3.87	2.93	2.86	2.94	3.33	2151 182
CHN	4.43	4.16	3.16	3.54	3.49	3.55	50309 510
CIV	2.55	2.7	2.16	2.37	2.57	2.95	212 070
CMR	3.07	2.55	2.11	2.1	2.53	2.6	92 121
COD	.	.	2.6	2.27	2.93	2.43	134 929

Exporter	ETI border	ETI trans & comm	LPI customs	LPI infrastruc-ture	LPI Logistics competence	LPI Tracking and tracing	Value of exports USD millions
COG	.	.	2.02	1.62	2.42	2.33	1039 476
COK	.	.	.	.	.	.	0 194
COL	3.55	3.13	2.5	2.59	2.75	2.75	2005 963
COM	.	.	1.96	1.76	2.26	2.79	0 210
CPV	.	.	.	.	.	.	0 099
CRI	4.31	3.24	2.61	2.56	2.8	3.13	549 995
CUB	.	.	1.79	1.9	1.88	2.03	8 837
CXR	.	.	.	.	.	.	4 549
CYM	.	.	.	.	.	.	6 179
CYP	4.31	4.6	2.92	2.94	2.82	3.51	12 998
CZE	4.92	4.32	3.31	3.25	3.27	3.6	393 948
DEU	5.65	5.77	4	4.34	4.14	4.18	14404 770
DJI	.	.	2.25	2.33	2.17	2.42	2 398
DMA	.	.	.	.	.	.	0 754
DNK	6.31	5.5	3.58	3.99	3.83	3.94	929 776
DOM	3.8	3.2	2.51	2.34	2.42	3.17	498 188
DZA	3.24	2.9	1.97	2.06	2.24	2.26	2837 180
ECU	2.8	2.97	2.32	2.38	2.6	2.84	1370 111
EGY	3.78	3.35	2.11	2.22	2.87	2.56	342 633
ERI	.	.	1.5	1.35	1.88	1.55	0 037
ESH	.	.	.	.	.	.	0 004
ESP	5.07	5.13	3.47	3.58	3.62	3.96	2031 956
EST	5.58	4.64	3.14	2.75	3.17	2.95	54 140
ETH	3.22	2.71	2.13	1.77	2.14	2.89	32 822
FIN	5.8	5.37	3.86	4.08	3.92	4.09	967 626
FJI	.	.	1.95	1.98	2.11	1.96	38 934
FLK	.	.	.	.	.	.	2 468
FRA	5.46	5.54	3.63	4	3.87	4.01	6029 067
FRO	.	.	.	.	.	.	7 189
FSM	.	.	.	.	.	.	0 868
GAB	.	.	2.23	2.09	2.31	2.67	334 765
GBR	5.62	5.47	3.74	3.95	3.92	4.13	8326 071
GEO	.	.	2.37	2.17	2.57	2.67	36 884
GHA	3.45	2.56	2.35	2.52	2.42	2.51	32 168
GIB	.	.	.	.	.	.	0 373
GIN	.	.	2.34	2.1	2.68	2.89	27 177
GLP	.	.	.	.	.	.	2 515
GMB	3.63	3	2.38	2.17	2.37	2.27	0 169
GNB	.	.	1.89	1.56	1.56	1.71	0 168
GNQ	.	.	.	.	.	.	643 190
GRC	3.99	4.58	2.48	2.94	2.69	3.31	165 114
GRD	.	.	.	.	.	.	1 346
GRL	.	.	.	.	.	.	2 024
GTM	4.07	3.22	2.33	2.37	2.74	2.71	477 798

Exporter	ETI border	ETI trans & comm	LPI customs	LPI infrastruc-ture	LPI Logistics competence	LPI Tracking and tracing	Value of exports USD millions
GUF	.	.	.	.	.	.	0 130
GUY	3.14	2.9	2.02	1.99	2.25	2.28	25 345
HKG	5.89	5.57	3.83	4	3.83	3.94	1395 036
HMD	.	.	.	.	.	.	0 013
HND	3.42	3.01	2.39	2.31	2.57	2.83	528 716
HRV	4.16	4.18	2.62	2.36	2.53	2.82	38 433
HTI	.	.	2.12	2.17	2.46	2.43	57 928
HUN	4.69	4.34	2.83	3.08	2.87	2.87	439 673
IDN	3.75	3.04	2.43	2.54	2.47	2.77	2813 621
IND	3.94	3.36	2.7	2.91	3.16	3.14	4043 780
IOT	.	.	.	.	.	.	0 193
IRL	5.82	4.94	3.6	3.76	3.82	4.02	4116 442
IRN	.	.	2.22	2.36	2.65	2.5	27 871
IRQ	.	.	2.07	1.73	2.1	1.96	3928 116
ISL	.	.	3.22	3.33	3.14	3.14	35 671
ISR	5.25	4.37	3.12	3.6	3.5	3.39	2927 070
ITA	4.25	4.75	3.38	3.72	3.74	3.83	5621 943
JAM	3.59	3.56	2	2.07	2.32	3.07	96 162
JOR	4.62	3.61	2.31	2.69	2.49	2.33	151 280
JPN	5.63	5.38	3.79	4.19	4	4.13	20932 540
KAZ	2.27	3.39	2.38	2.66	2.6	2.7	208 055
KEN	2.77	2.88	2.23	2.14	2.28	2.89	46 120
KGZ	2.46	2.98	2.44	2.09	2.37	2.33	0 564
KHM	3	2.5	2.28	2.12	2.29	2.5	319 816
KIR	.	.	.	.	.	.	0 521
KNA	.	.	.	.	.	.	18 143
KOR	5.28	4.99	3.33	3.62	3.64	3.83	7879 711
KWT	3.52	3.55	3.03	3.33	3.11	3.44	1305 032
LAO	.	.	2.17	1.95	2.14	2.45	6 316
LBN	.	.	3.27	3.05	3.73	3.16	19 508
LBR	.	.	2.28	2	2.16	2.38	24 589
LBY	.	.	2.15	2.18	2.28	2.08	1425 068
LCA	.	.	.	.	.	.	4 098
LIE	.	.	.	.	.	.	38 423
LKA	3.75	3.29	1.96	1.88	2.09	2.23	272 196
LSO	2.84	2.33	.	.	.	.	64 809
LTU	4.46	4.28	2.79	2.72	2.85	3.27	109 223
LUX	5.19	5.41	4.04	4.06	3.67	3.92	75 038
LVA	4.6	4.09	2.94	2.88	2.96	3.55	31 507
MAC	.	.	.	.	.	.	160 910
MAR	4.21	3.36	.	.	.	.	298 389
MCO	.	.	.	.	.	.	7 669
MDA	3.59	3.46	2.11	2.05	2.17	3	4 833
MDG	3.26	2.37	2.35	2.63	2.4	2.51	42 173

Exporter	ETI border	ETI trans & comm	LPI customs	LPI infrastruc-ture	LPI Logistics competence	LPI Tracking and tracing	Value of exports USD millions
MDV	.	.	2.25	2.16	2.29	2.42	0 992
MEX	3.87	3.2	2.55	2.95	3.04	3.28	7450 027
MHL	.	.	.	.	.	.	4 000
MKD	3.6	3.46	2.55	2.55	2.76	2.82	10 466
MLI	2.64	2.4	2.08	2	2.13	2.31	1 239
MLT	.	.	2.65	2.89	2.89	2.56	44 990
MMR	.	.	1.94	1.92	2.01	2.36	3 368
MNE	.	.	2.17	2.45	2.32	2.44	0 191
MNG	2.71	2.82	1.81	1.94	2.24	2.42	10 530
MOZ	3.21	2.36	1.95	2.04	2.2	2.28	3 040
MRT	2.67	2.47	.	.	.	.	8 093
MSR	.	.	.	.	.	.	0 156
MTQ	.	.	.	.	.	.	2 441
MUS	4.62	3.55	2.71	2.29	2.43	2.57	23 713
MWI	3.06	2.44	.	.	.	.	9 955
MYS	4.66	4.59	3.11	3.5	3.34	3.32	4938 579
MYT	.	.	.	.	.	.	0 017
NAM	3.47	3.16	1.68	1.71	2.04	2.04	9 604
NCL	.	.	.	.	.	.	28 371
NER	.	.	2.06	2.28	2.42	2.45	8 419
NFK	.	.	.	.	.	.	0 050
NGA	2.98	2.6	2.17	2.43	2.45	2.45	5718 524
NIC	3.38	2.54	2.24	2.23	2.31	2.51	199 700
NIU	.	.	.	.	.	.	0 022
NLD	6.04	5.64	3.98	4.25	4.15	4.12	2988 442
NOR	5.47	5.11	3.86	4.22	3.85	4.1	1073 293
NPL	2.58	2.51	2.07	1.8	2.07	2.26	11 818
NRU	.	.	.	.	.	.	4 528
NZL	5.95	4.97	3.64	3.54	3.54	3.67	1259 198
OMN	4.23	3.74	3.38	3.06	2.37	2.04	123 880
PAK	3.85	3.04	2.05	2.08	2.28	2.64	507 364
PAN	4.22	3.75	2.76	2.63	2.83	3.26	52 005
PCN	.	.	.	.	.	.	0 269
PER	3.93	2.94	2.5	2.66	2.61	2.89	1100 476
PHL	3.72	3.09	2.67	2.57	2.95	3.29	1258 065
PLW	.	.	.	.	.	.	0 230
PNG	.	.	2.02	1.91	2.2	2.43	429 534
POL	4.37	3.71	3.12	2.98	3.26	3.45	407 401
PRI	.	.	.	.	.	.	140 517
PRK	.	.	.	.	.	.	32 123
PRT	4.63	4.74	3.31	3.17	3.31	3.38	411 422
PRY	3.16	2.56	2.37	2.44	2.59	2.72	37 317
PYF	.	.	.	.	.	.	11 610
QAT	4.63	4.04	2.25	2.75	2.57	3.09	131 541

Exporter	ETI border	ETI trans & comm	LPI customs	LPI infrastruc-ture	LPI Logistics competence	LPI Tracking and tracing	Value of exports USD millions
REU	.	.	.	.	.	.	0 853
ROM	4.39	3.62	2.36	2.25	2.68	2.9	8 319
ROU	4.39	3.62	2.36	2.25	2.68	2.9	228 353
RUS	2.82	3.49	2.15	2.38	2.51	2.6	3974 023
RWA	.	.	1.63	1.63	1.85	1.99	2 848
SAU	4.61	3.7	2.91	3.27	3.33	3.32	7532 282
SDN	.	.	2.02	1.78	2.15	2.02	0 728
SEN	3.54	3.01	2.45	2.64	2.73	3.08	4 162
SGP	6.49	5.64	4.02	4.22	4.12	4.15	3856 333
SHN	.	.	.	.	.	.	3 476
SJM	.	.	.	.	.	.	0 014
SLB	.	.	2.08	2.23	2.27	2.03	1 779
SLE	.	.	2.17	1.61	1.53	1.73	7 637
SLV	3.9	2.9	2.48	2.44	2.66	2.68	285 143
SMR	.	.	.	.	.	.	0 841
SOM	.	.	1.33	1.5	1.33	1.17	0 052
SPM	.	.	.	.	.	.	0 015
STP	.	.	.	.	.	.	0 058
SUR	.	.	.	.	.	.	27 971
SVK	4.52	4.36	2.79	3	3.15	3.54	207 458
SVN	5.16	4.55	2.59	2.65	2.9	3.16	72 992
SWE	6.41	5.63	3.88	4.03	4.22	4.22	2052 763
SWZ	.	.	.	.	.	.	31 742
SYC	.	.	.	.	.	.	2 438
SYR	3.17	2.96	2.37	2.45	2.59	2.63	49 942
TCA	.	.	.	.	.	.	3 860
TCD	2	1.96	2.27	2	2.04	2.62	1152 479
TGO	.	.	2.4	1.82	2.45	3.42	9 959
THA	4.48	4.07	3.02	3.16	3.16	3.41	4277 234
TJK	2.4	2.37	1.9	2	2.25	2.25	1 125
TKL	.	.	.	.	.	.	1 904
TKM	.	.	2.14	2.24	2.34	2.38	24 872
TMP	.	.	.	.	.	.	2 325
TON	.	.	.	.	.	.	0 937
TTO	.	.	.	.	.	.	1218 578
TUN	4.67	3.46	2.43	2.56	2.36	2.56	116 098
TUR	4.05	3.65	2.82	3.08	3.23	3.09	806 406
TUV	.	.	.	.	.	.	0 220
TWN	5.15	5.12	3.35	3.62	3.65	4.04	5508 943
TZA	3.17	2.25	2.42	2	2.38	2.56	7 122
UGA	2.99	2.61	2.84	2.35	2.59	2.45	8 129
UKR	3.07	3.43	2.02	2.44	2.59	2.49	429 637
URY	4.15	3.09	2.71	2.58	2.59	2.78	87 522
USA	5.58	5.48	3.68	4.15	3.92	4.17	10040 920

Exporter	ETI border	ETI trans & comm	LPI customs	LPI infrastruc-ture	LPI Logistics competence	LPI Tracking and tracing	Value of exports USD millions
UZB	.	.	2.2	2.54	2.5	2.96	50 945
VAT	.	.	.	.	.	.	0 109
VCT	.	.	.	.	.	.	0 205
VEN	2.25	3.01	2.06	2.44	2.53	2.84	6651 645
VGB	.	.	.	.	.	.	2 947
VIR	.	.	.	.	.	.	27 008
VNM	3.28	3.24	2.68	2.56	2.89	3.1	2300 286
VUT	.	.	.	.	.	.	0 477
WLF	.	.	.	.	.	.	0 004
WSM	.	.	.	.	.	.	10 252
YEM	.	.	2.46	2.35	2.35	2.63	1 637
YUG	.	.	.	.	.	.	1 099
ZAF	4.12	3.62	3.22	3.42	3.59	3.73	1546 897
ZAR	.	.	.	.	.	.	1 337
ZMB	2.96	2.45	2.17	1.83	2.01	2.35	7 154
ZWE	2.42	2.38	.	.	.	.	16 900

Table 8. Correlation between World Bank's LPI logistics metrics

		LPI score	Customs	Infra-structure	Interna-tional ship-ments	Logistics	tracking and tracing	Time-liness	LPI score	Customs	Infra-structure	Inter-national ship-ments	Logistics	Tracking and tracing
LPI reporter	LPI score reporter	1.0000												
	Customs	0.9630	1.0000											
	Infrastruc-ture	0.9733	0.9512	1.0000										
	International shipments	0.8289	0.7479	0.7597	1.0000									
	Logistics	0.9720	0.9301	0.9568	0.7532	1.0000								
	Tracking and tracing	0.9521	0.8846	0.9062	0.7694	0.9289	1.0000							
	Timeliness	0.9077	0.8616	0.8617	0.6559	0.8603	0.8401	1.0000						
LPI partner	LPI score partner	-0.0610	-0.0551	-0.0596	-0.0578	-0.0582	-0.0558	-0.0563	1.0000					
	Customs	-0.0567	-0.0514	-0.0553	-0.0535	-0.0541	-0.0518	-0.0522	0.9607	1.0000				
	Infra-structure	-0.0590	-0.0531	-0.0578	-0.0562	-0.0563	-0.0539	-0.0539	0.9698	0.9498	1.0000			
	International shipments	-0.0535	-0.0481	-0.0518	-0.0520	-0.0506	-0.0486	-0.0494	0.8594	0.7770	0.7921	1.0000		
	logistics	-0.0602	-0.0542	-0.0589	-0.0573	-0.0577	-0.0550	-0.0550	0.9736	0.9329	0.9566	0.7868	1.0000	
	Tracking and tracing	-0.0591	-0.0531	-0.0576	-0.0555	-0.0564	-0.0545	-0.0544	0.9525	0.8894	0.9033	0.7897	0.9283	1.0000
	Timeliness	-0.0551	-0.0502	-0.0542	-0.0509	-0.0525	-0.0498	-0.0517	0.9078	0.8448	0.8439	0.7159	0.8618	0.8436

Table 9. Correlation between GCR infrastructure indices

		Infrastructure partner							Infrastructure reporter						
		Overall index	**Air**	**Port**	**Tele-comm**	**Elect**	**Rail**	**Road**	**Overall index**	**Air**	**Port**	**Tele-com**	**Elect**	**Rail**	**Road**
Infrastructure partner	Overall index	1.0000													
	Air	0.8700	1.0000												
	Port	0.8914	0.8064	1.0000											
	Telecom	0.7264	0.6205	0.6184	1.0000										
	Elect	0.8118	0.6940	0.7225	0.7762	1.0000									
	Rail	0.8323	0.6609	0.7384	0.7309	0.7174	1.0000								
	Road	0.9653	0.8325	0.8540	0.6642	0.7421	0.7563	1.0000							
Infrastructure reporter	Overall index	-0.0257	-0.0279	-0.0246	-0.0213	-0.0258	-0.0226	-0.0249	1.0000						
	Air	-0.0249	-0.0292	-0.0244	-0.0219	-0.0256	-0.0225	-0.0239	0.8603	1.0000					
	Port	-0.0196	-0.0206	-0.0200	-0.0150	-0.0181	-0.0176	-0.0191	0.8984	0.7863	1.0000				
	Telecom	-0.0317	-0.0326	-0.0304	-0.0291	-0.0353	-0.0294	-0.0309	0.6989	0.5731	0.5846	1.0000			
	Elect	-0.0295	-0.0302	-0.0284	-0.0245	-0.0324	-0.0267	-0.0288	0.7997	0.6672	0.6918	0.7590	1.0000		
	Rail	-0.0297	-0.0319	-0.0291	-0.0252	-0.0305	-0.0269	-0.0291	0.8317	0.6560	0.7624	0.7161	0.7252	1.0000	
	Road	-0.0221	-0.0236	-0.0210	-0.0179	-0.0212	-0.0192	-0.0219	0.9646	0.8229	0.8566	0.6354	0.7174	0.7535	1.0000

Table 10. Correlation between GCR Enabling Trade indices

		Enabling trade reporter					Enabling trade partner				
		Overall index	**Market access**	**Border admin**	**Transport**	**Business**	**Overall index**	**Market access**	**Border admin**	**Transport**	**Business**
Enabling trade reporter	Overall index	1.0000									
	Market access	0.8177	1.0000								
	Border administration	0.9487	0.6528	1.0000							
	Transport	0.9477	0.6821	0.9061	1.0000						
	Business	0.8717	0.5915	0.8308	0.7802	1.0000					
Enabling trade partner	Overall index	-0.0363	-0.0268	-0.0358	-0.0382	-0.0274	1.0000				
	Market access	-0.0237	-0.0204	-0.0223	-0.0240	-0.0173	0.8389	1.0000			
	Border administration	-0.0380	-0.0270	-0.0379	-0.0405	-0.0285	0.9542	0.6932	1.0000		
	Transport	-0.0370	-0.0264	-0.0367	-0.0396	-0.0278	0.9482	0.7044	0.9149	1.0000	
	Business	-0.0314	-0.0222	-0.0315	-0.0324	-0.0251	0.8607	0.6061	0.8181	0.7684	1.0000