UNIVERSITY OF SUSSEX | BUSINESS SCHOOL

ECONOMICS

Working Paper Series

No. 04-2021

Trade Costs and Patterns of Trade in the Philippines

Eugenia C. Go
Asian Development Bank
ego@adb.org

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JEL codes: F14, F63, R40

Key words: Trade cost, transport cost, trade patterns

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25 February 2021

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I investigate the effect of a transport program in the Philippines on domestic maritime trade patterns. The Roll-on Roll-off Terminal System (RRTS) introduced in 2003 promotes the use of roll-on roll-off ships for interisland trade. Exploiting the variation in the availability of services between ports and the timing at which they were introduced, I find that port-pairs in RRTS trade 35% more compared to unconnected pairs with comparable characteristics. This gain largely comes from the greater variety of products traded along RRTS pairs. Transactions are 7.7% to 9.3% more frequent in RRTS routes, suggestive of inventory management as an avenue of trade costs savings. The strong responses in the extensive margin and transaction frequency highlight how the RRTS reduced the fixed cost of trade. High value and time-sensitive products systematically benefit more from the RRTS. These gains do not come from displacing trade from competing non-RRTS ports. Instead, the RRTS complements trade in liner routes by supporting feeder traffic.

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*Asian Development Bank, ego@adb.org. The author is grateful for the thoughtful guidance of Ingo Borchert and L. Alan Winters. The work benefited from the comments of colleagues in the Economic Research and Regional Cooperation Department of the Asian Development Bank, most especially Benno Ferrarini. I received very helpful feedback from colleagues and the faculty of the Department of Economics at the University of Sussex. Michael Gasiorek (University of Sussex) and Richard Anthony Kneller (University of Nottingham) gave the work a very thorough reading and offered detailed comments. All errors are my responsibility.

1 Introduction

Trade costs play an important role in economic development. They determine relative prices, and therefore patterns of production and trade. In domestic settings, trade costs influence the distribution of surplus and adjustment costs of policies and shocks across regions, thereby affecting the trajectory of regional development. Studies of rail and road network development demonstrate impacts on market access that translate to persisting effects on real incomes, food security, production patterns, and urbanization (Allen and Atkin, 2019; Burgess and Donaldson, 2010; Donaldson and Hornbeck, 2016; Donaldson, 2018; Faber, 2014; Jedwab and Moradi, 2016).

The Philippines presents an interesting setting for studying trade costs. It is an archipelago and faces serious challenges in integrating the economies across its more than 7,000 islands. Maritime transport has a crucial role in supporting economic development. However, maritime shipping cost has been notoriously expensive. In the early 2000s, shipping a twenty-foot equivalent unit (TEU) container costs USD 1.50 per nautical mile from Davao in the country's south, to Manila, the capital located in the main island in the north. In contrast, a TEU from Bangkok, Thailand or Port Klang, Malaysia to Manila cost about USD 0.50 (Basilio, 2008).

The Philippine Government introduced the Roll on Roll off Terminal System (RRTS) in 2003 with the aim of bringing down interisland domestic trade costs. By integrating roll-on roll-off (RORO) shipping routes with land-based national highway networks, cargo-bearing trucks can arrive at a port, board directly onto a RORO ship, and continue to drive off to their final destinations. The time and monetary savings from skipping cargo handling procedures can be substantial. Cargo loading and unloading is one of the most labor intensive and time consuming processes in maritime trade and is a major contributor to port congestion (Brancaccio et al., 2019). Savings also arise from foregoing warehousing because direct deliveries to institutional buyers are possible with RORO ships. Trucks that make deliveries can return to their point of destination within a day or two. Finally, a typical RORO ship has less than half the capacity of the median domestic container ship. Given the high minimum efficient scale in shipping, this means that RORO is more cost-effective in servicing short-haul journeys, and areas outside the major demand centers of Metro Manila and Cebu, the country's second largest economic center.

I investigate how the change in trade costs stemming from the RRTS influence patterns of domestic maritime trade in the Philippines. The variation in RRTS connections by route and the time of their introduction are used to identify effects along the intensive and extensive margins. This study also examines the relationship between specific features of the RRTS like smaller scale trade and lane meter charging to trade outcomes - inventory management and the kinds of products that benefited the most from the RRTS.

Table 1 presents average trade figures for different types of shipping services. The value and volume of trade are largest for a typical liner route, which also ships the greatest variety of products in a given year. In comparison, average trade in RRTS routes were a quarter of that in liners prior to connection, increasing to over half of what liners carried when routes became connected by RRTS. Albeit less dramatically, the average number of product types and the monthly frequency of trade also increased after RRTS connection. The short-distance nature of the RRTS is apparent, with an average distance of less than 80 kilometers whereas other vessels serve routes that are twice as distant.

RORO transport accounted for 14% of average domestic throughput in 2015 and 2016.[1] Products that can be transported by RORO coincide with break-bulk cargoes or those that can be packaged with bags, boxes, drums, and containers. Wood products, *abaca* (Manila hemp), tobacco and manufactures, transport parts, and meat and dairy have substantial shares of RORO cargo throughput. Finally, fuels, minerals, coconut products, and cement use RORO the least (PPA, 2017).

Figure 1 shows that RRTS pairs accounted for about a quarter of trade value and volume when the program started in 2003 and increased to 50% by 2014. The observed growth is not merely an artifact of the increasing

[1] The PPA only started compiling RORO cargo statistics in 2015.

Table 1: Average trade indicators by shipping service, 2000-2014

	Liner	RRTS		Others	Total
		Pre	Post		
Value (million PhP)	12.9	3.2	8.4	9.4	9.5
Volume (MT)	409.8	134.6	231.1	355.2	323.3
Product no. (count)	40.6	19.7	20.4	18.2	25.9
Frequency (months/yr)	4.0	4.2	4.4	3.2	3.8
Distance (km)	272.4	87.6	70.1	189.7	180.6
Observations	156,311	60,670	98,688	229,383	545,052

Source: Author

Note: ‘Pre’ represents average before routes became connected by RRTS, and ’post’ refers to the average after the same port-pairs became RRTS-linked.

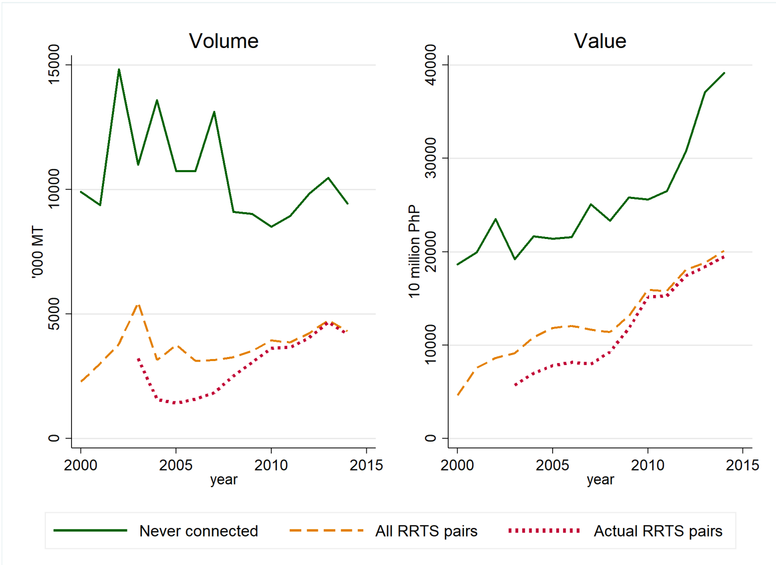
number of RRTS-linked pairs over time as shown by the long-dashed lines.[2]

The effects of the RRTS on trade patterns is estimated through a structural gravity model. I rely on an identification strategy widely employed in the international literature in the context of trade agreements and currency unions (Head and Mayer, 2013), which uses pair fixed effects to partial out non-time varying port-pair characteristics that influence the likelihood investing in an RRTS connection.

The results show that port-pairs with RRTS connections increased trade by 35% compared to pairs with similar characteristics that do not have access to the RRTS. This growth in trade comes from an average increase of 18% in the intensive margin, an expansion of 36.6% in the types of products traded, and a 1% point increase in the probability of exporting to new non-RRTS destinations. Average transaction frequency along RRTS routes are higher by 7.7%, suggesting inventory management as an important avenue of trade costs savings from the RRTS. Time-sensitive and high-value products systematically gain from the RRTS in terms of product variety and transaction frequencies. These gains do not come from displacing trade from non-RRTS ports. Finally, there is evidence of the complementary role of the RRTS to

[2]The volume and value increases in non-RRTS routes from 2012 to 2014 are due to the expansion of trade along liner routes. short-dashed trend representing the actual years in which ports become RRTS-enabled do not meet the long-dashed line because of service suspensions in some routes.

Figure 1: Trade by RRTS status



Source: Author based on PSA (2016)
Note: The following are excluded – arms and ammunition, fuel and by products, crude minerals, and cement.

other routes. On average, liners that have RRTS connections in both origin and destination have 55% more trade than liners without RRTS connections.

To the best of my knowledge, this is the first empirical study that relates the RRTS to changes in patterns of trade. This is a first step in unpacking the welfare distribution implications of the RRTS and how related policies can be designed to optimize development goals. The study contributes to the literature that demonstrate importance of domestic trade costs to regional development.

The Roll-on Roll-off Terminal System

The Roll-on Roll-off Terminal System (RRTS) was introduced in the Philippines in 2003 as a priority project of the President of the Republic of the Philippines through Executive Order 170. Roll-on roll-off (RORO) ships can reduce trade costs by facilitating a seamless interface between land and sea transport. With a RORO ship, goods can be loaded and discharged by self-powered vehicles between ships and ports (Odchimar and Hanaoka, 2015). This represents a streamlined process of trade. Firms can skip cargo handling procedures inherent in containerized shipping and directly deliver to institutional buyers.

The Philippines presents a unique setting for studying trade costs and their implications on trade patterns. Distances between the major islands of the archipelago are substantial, and the seabed structure is deemed too complex for connection through subterranean tunnels or long-span bridges (JICA, 2007). It is easy to appreciate the importance of the domestic shipping industry, especially for the smaller islands where maritime transport is the only viable means of sustained trade. In 2017, domestic maritime trade was valued at PhP 765 billion (USD 15.3 billion), close to 5% of national output, which corresponded to 23 million metric tons of goods (PSA, 2017).

Despite its centrality to internal connectivity, domestic shipping is notoriously expensive, especially when compared with international shipping. In 2010, transporting a TEU from Manila to Cagayan de Oro, a major port in the south, cost more than twice as much as moving the same cargo via transshipment through Kaoshung in Taiwan (Llanto and Navarro, 2014).

As early as the 1990s, RORO was identified as a commercially viable and cost effective means of linking the Philippine islands (Basilio, 2008; JICA, 1992). There were RORO ships operating even before the RRTS. For example, RORO-carried trade in the Batangas City-Calapan route in the northwest was already growing early 1990s. Nonetheless, the policy environment was not conducive for RORO. Its development was discouraged by contradictory policies such as regulations that required ROROs to pay cargo handling fees even when this service was unnecessary. Truck "clearances" were required for interisland movement as if a cargo was moving from one country to another (USAID, 1994). The Philippine Ports Authority's (PPA) revenue generating structure was also biased towards cargo handling operations (Llanto et al., 2005). Domestic cargo handling fees accounted for 18% of the total revenues generated from port operations in 2001.

The reforms that came with the RRTS are twofold.[3] One group directly affected shipping activities – the waiving of cargo handling charges and wharfage dues; freight charging based on lane meter;[4] the replacement of port authorities' share in port revenues with registration fees; and simplified documentary requirements vis-à-vis conventional shipping. Another group promoted investments in RORO ports and ships – the participation of private ports equipped to handle RORO vessels; and financing from the Development Bank of the Philippines for port development and vessel acquisition. This study focuses on the first set of reforms, which are expected to be felt immediately in terms of reduced monetary and inventory costs associated with shipping, and time savings from the simplification of procedures and sidestepping of cargo handling.

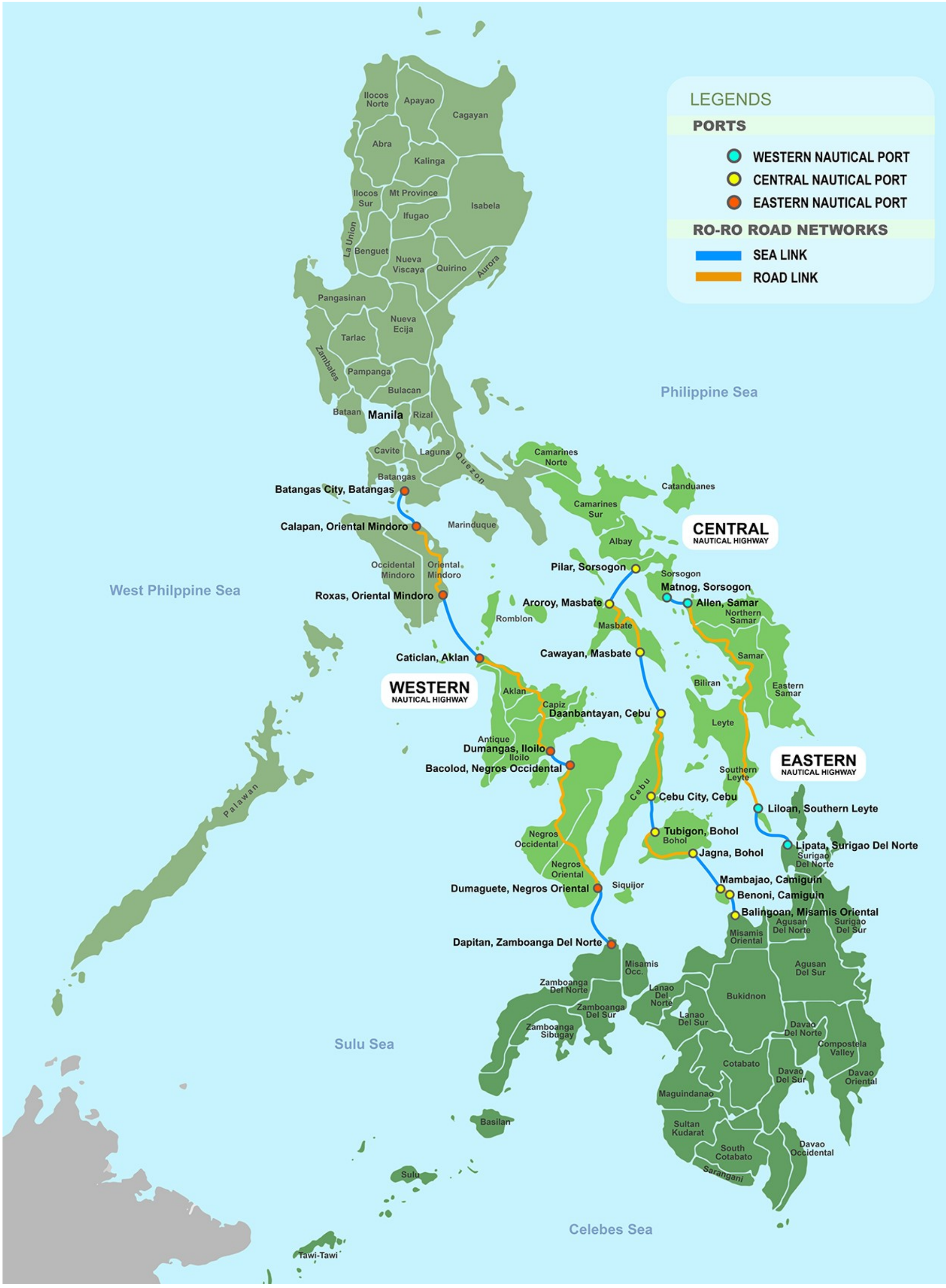
Figure 2 presents the major routes of the RRTS. A truck coming from Manila can board a RORO ship in Batangas City and in principle drive all the way down south to Dapitan in the Zamboanga Peninsula through various RRTS connections. The RRTS has three main trunks which are called 'nautical highways'. RORO operations in the Eastern Highway predate the RRTS; the Western Highway started operating within the RRTS in 2003; and the Central Highway was launched in 2008. However, there were RORO ships operating within the Western and Central highway before 2003, and there are lateral links that are not captured by the three trunks that focus on vertical connectivity. As such, a historical data set that tracks the development of RRTS services by route is necessary for an empirical evaluation. The process of building the data set is described in Section 3.

The number of RRTS routes grew at an average of over 10% per year between 2003 and 2014. The most dramatic growth occurred between 2005 to 2009 with new links introduced in the central islands of the Philippines (see Figures 3 and 4). The plateauing of new routes from 2010 onward coincides with a change in government that did not promote the RRTS as a priority project.

[3]It is worth clarifying that RORO is a vessel type, whereas the RRTS is a transport system introduced in 2003. There are RORO ships that do not function within the RRTS.

[4]Instead of commodity classification, freight charges are based on the space occupied by the cargo and the distance that the vessel traveled.

Figure 2: The RRTS in 2003

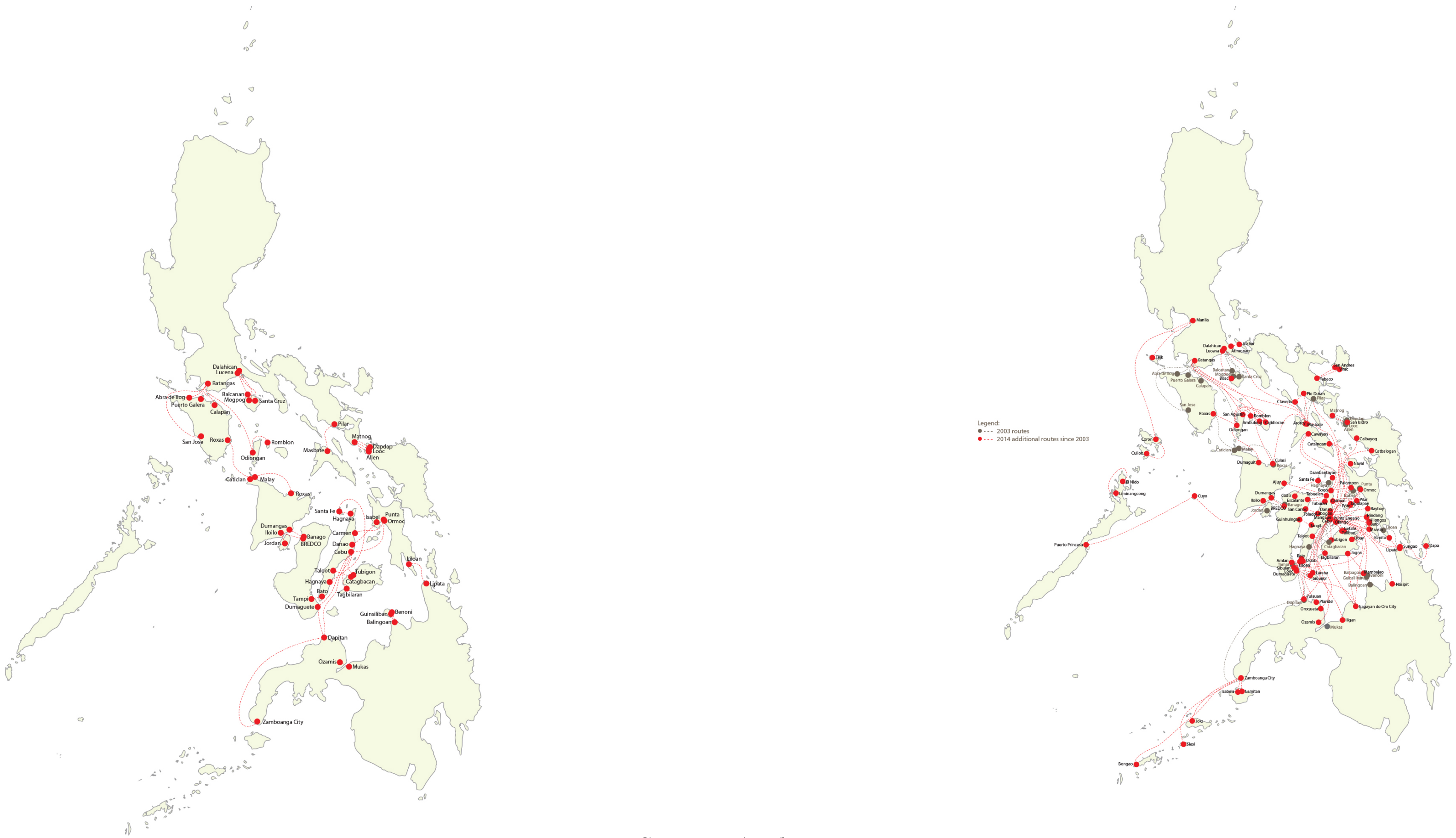


Source: Author

Figure 3: RRTS Connections

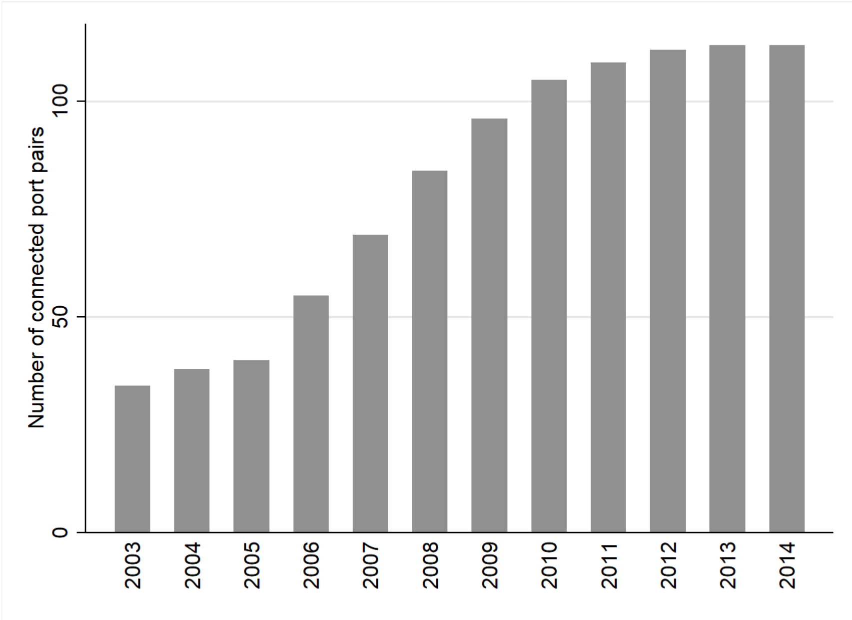
(a) 2003 Connections

(b) 2014 Connections



Source: Author

Figure 4: Number of RRTS linkages over time

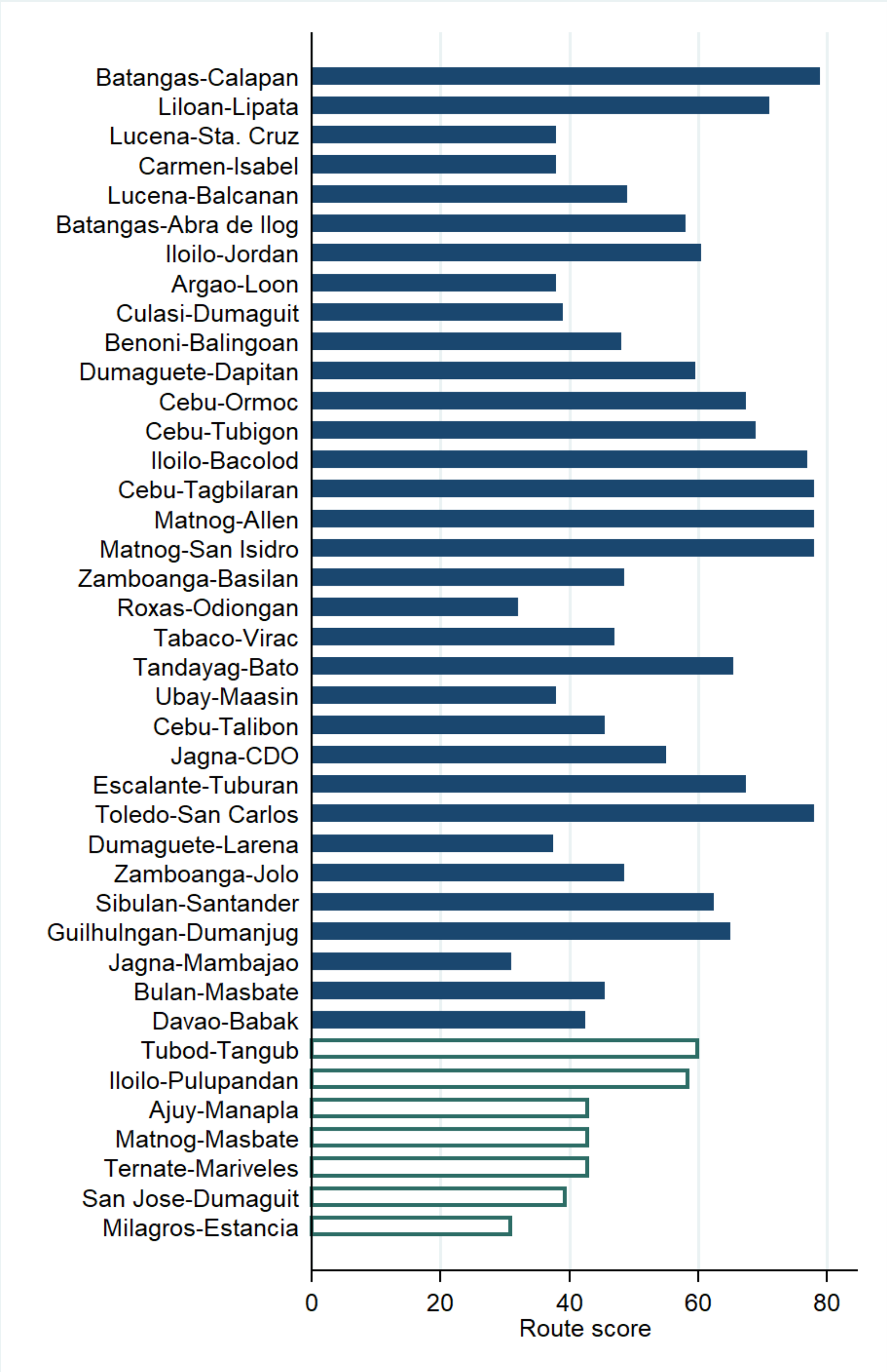


Source: Author

A government inter-agency committee identified the routes and the order of priority for RORO infrastructure development in 1992 using a point mark system that was based on inland road network and car ownership; maritime cargo and passenger traffic demand; cost of RORO terminal construction and development; and formation of RORO transport networks (JICA, 1992).[5] The actual sequence of route development exhibited substantial deviations from the prioritization plan. In Figure 5, the horizontal bars represent the scores which correspond to a route's priority, and the vertical ordering is the actual sequence of development. In 2014, there were 80 routes that had not been evaluated by the committee and yet are serviced by RORO. Moreover, seven of the 40 routes originally identified by the committee remained undeveloped and are shown as hollow bars at the bottom. In general, there is no systematic pattern between priority score and actual development sequence suggesting exogeneity in the order of service development.

[5]The Inter-Agency Technical Committee on Transport Planning (IATCP) comprised the different executive agencies of the Philippine Government. The routes were jointly evaluated with the Japan International Cooperation Agency (JICA) in 1992.

Figure 5: Planned prioritization of RORO route development



Source: Author and JICA(1992)

Trade cost changes from the RRTS are expected to influence domestic trade patterns as they alter relative prices. The impact of changes in trade costs on trade volumes are well-documented. A common example in the international trade literature involves Regional Trade Agreements (RTAs) or currency unions, and how these affect trade flows among member countries. Historically, a large shift in trade costs was introduced with container technology in global commercial trade. Containers streamlined the cargo handling process resulting to substantial savings given that port costs account for the largest share of ocean shipping costs. Bernhofen et al. (2016) find that containerization could explain as much as 68% of the growth in trade compared to the pre-adoption period.

Various aspects of the RRTS are expected to reduce maritime trade costs, and these are explained in detail below.

Improved land-sea interface. RORO improves the interface between land and sea transport by foregoing cargo handling. This represents substantial monetary and time savings that have large implications on the fixed component of trade costs.

The introduction of fixed costs in trade cost models in the last two decades revealed the quantitative importance of responses along the extensive margin – the variety of products being exported, and the number of establishments exporting (Helpman et al., 2008; Hummels and Klenow, 2005; Santos Silva et al., 2014). In a world with heterogeneous producers and fixed costs of trade, Chaney (2008) anticipates that products with high elasticity of substitution respond more along the intensive margin, whereas less substitutable products react more strongly in the extensive margin (number of exporters). This is because when trade barriers come down, new low productivity exporters are unable to gain substantial market shares when products are not easily substitutable.

Scale and service frequency. One of the main reasons for the large differential in the cost of domestic and international shipping in the Philippines is the shipping industry's sensitivity to scale. PSA (2017) data show that domestic maritime trade is at most 43% of the volume and 16% of the value of international maritime imports and exports.

The smaller size of RORO ships can alleviate the lack of scale in areas outside regional centers such as Metropolitan Manila and Cebu City. The median RORO ship in the Philippines has a capacity of 160 TEUs, while the median small container ship can handle over twice this volume. The smaller size of RORO ships means that they are able to make more frequent trips and ship in smaller batches, reinforcing savings in storage and warehousing, and other logistics-related costs for traders, and possibly small scale producers.

Aside from RORO, primary means of maritime transport include liners and trampers. Liners are large vessels that cater to long distance routes, while trampers can be any kind of ship, and can even be a RORO vessel hired on a contractual basis to transport bulky commodities (Austria, 2002). Trampers are potential alternatives to the RORO in terms of scale. However, they lack regularity and predictability in schedule, and are moreover only accessible to entities that can coordinate sufficient volumes. Specialized tanker vessels carry particular products such as cement, chemicals, and fuels. Areas where trade is minimal or infrequent tend to use small ferries.

The RRTS does not have a *de jure* distance limit. But RORO ships operating within the RRTS tend to serve short distances. Table 1 shows that the average distances serviced by RRTS are less than 80 kilometers compared to more than 180 km for other shipping services.

A practical consequence of the RORO ship sizes, cost of alternative transport modes, and the ideal turnaround time for delivery operations is that the competitiveness of ROROs declines with distance. JICA (2007) suggests a threshold of roughly 200 kilometers beyond which liners become at least as competitive as ROROs. The number of RORO links to be crossed also increases with distance and this complicates schedule coordination since the PPA maintains a first-come first-served policy for vehicles boarding RORO ships. Based on field interviews, it was not until 2017 that a RORO shipping company (Archipelago Philippine Ferries) committed to guaranteeing a coordinated passage across several RRTS links.

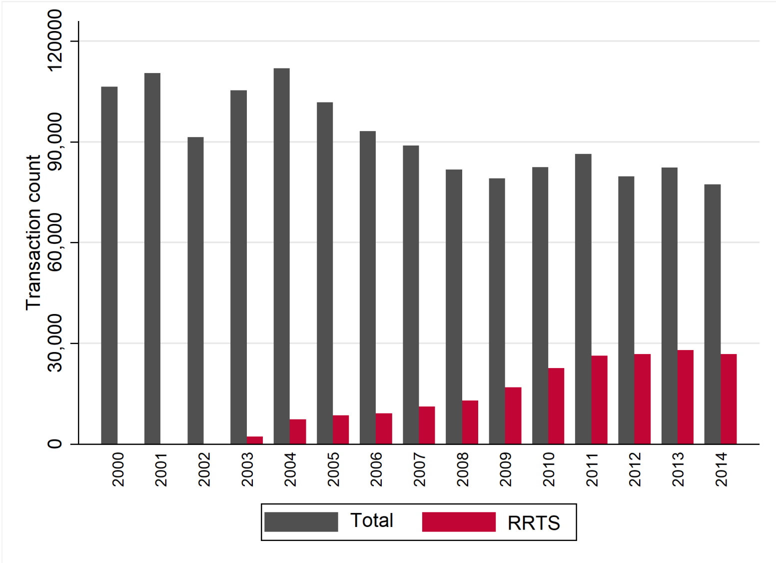
Trade-off between trade and inventory costs. A consequence of high fixed cost of trade is 'lumpy trade' whereby traders economize on per shipment cost by shipping less frequently with larger volumes, effectively trading off trade costs against inventory costs (Hornok and Koren, 2015). When fixed costs of trade are high as in most developing countries, firms stock up on inventories and do not order as frequently as they otherwise would (Alessandria et al., 2010). This is reflected in the asynchronous pricing and purchasing behavior of firms following exogenous devaluation episodes. Hornok and Koren (2015) also find evidence of lumpiness in US and Spanish trade transactions with the frequency-shipment size trade-off being more pronounced for products that are time-sensitive such as food and beverages and products involved in the parts and components trade.

The trade-inventory costs trade-off is reinforced by the possibility of direct delivery to institutional buyers. The savings can be substantial. The World Bank Logistics Performance Index (2018) documents that 50% of domestic freight forwarders in the Philippines perceive warehousing and trans-loading charges to be high, and an equal proportion deem the service quality very poor. The savings are foreseen to be largest for high value products where the opportunity costs of holding inventory are largest, and for products that are time-sensitive or require special storage facilities such as specialized machines, live animals, and dairy products.

There is anecdotal evidence that the RRTS altered delivery frequencies and inventory behavior. For example, Nestlè Philippines closed down 33 of its 36 distribution centers in the country and started making smaller, more frequent deliveries directly to its clients from its plants in Luzon in the north through RRTS routes. Universal Robina Corporation, also a large food manufacturing company, used to ship once a week from Metropolitan Manila to the provinces through a liner service but has increased delivery frequency to as often as 12 times a day through RRTS networks (Basilio, 2008). Since 2003, the share of transactions through RRTS-linked port-pairs, as measured by monthly frequency, has steadily increased even as the overall number of domestic maritime transactions has gone down (Figure 6).

RRTS and product characteristics. Product characteristics themselves feed

Figure 6: Count of monthly transactions by RRTS status



Source: Author based on PSA (2016)
Note: The following are excluded – arms and ammunition, fuel and by products, crude minerals, and cement.

into trade costs as they interact with the distance of trading partners, and available transport technologies (Harrigan, 2010). In the 1980s, air transport costs declined and air freight increasingly became a viable option for commercial trade even as it remained more expensive compared to surface transport by land or sea. This means that air will only be the modal choice of transport when the value of timely delivery is at least as large as the premium paid for air transport. Goods with higher value to weight ratios are more likely to be transported by air since transport cost forms a smaller share of their delivery price. At the same time, the value and the time-sensitive nature of a product interacts with distance. Shorter distances mean that the fixed cost per mileage of air travel is higher. In the US, Harrigan (2010) finds that more distant countries have larger market shares in lightweight goods that use air transport. Conversely, nearer countries like Mexico and Canada have greater market shares in heavier products that use surface transport.

The time savings in RRTS imply benefits for products that are time-sensitive such as those with short shelf-lives and those with high opportunity costs in inventory. The lane meter charging in the RRTS amplifies the gains for high value products by packing more value into a lane meter since transport cost per nautical mile does not vary with cargo type. Finally, pro-competitive effects of the RORO also means the absolute value of freight charge reduction should be larger for more expensive products (Hummels et al., 2009), which was found to be the case in Go (2020).

Spillover effects to other routes. The effects of the RRTS need not be localized to directly connected ports. Spillover effects can potentially be felt by neighboring ports and cities. The knock-on effects involve complementarities with other trading routes, trade displacement, and market access effects.

Trade displacement refers to a situation of nearby ports losing transactions to RRTS connected ports. Meanwhile, market access spillover effects is predicated on the literature on new economic geography, in which proximity to regional demand centers lead to concentration of economic activities and hence higher incomes (Hanson, 2005; Head and Mayer, 2011). Higher demand in RRTS connected cities could mean that ports and cities close to an RRTS linked locality effectively becomes closer to a market with enhanced demand, and as such are presented with expanded market access opportunities.

Finally, potential complementarities arise because trade flows typically involve a hub and spoke structure whereby large ships call on major ports, and smaller vessels transship products to smaller ports along shorter journeys (Bertho et al., 2016). RRTS can potentially alleviate cargo imbalance in liner routes, which is one of the key drivers of maritime freight costs (Brancaccio et al., 2019). High cargo asymmetry means shipping companies cross-charge one leg of the journey to subsidize for low back-hauls (Bertho et al., 2016).

Based on the channels of RRTS trade costs adjustments, predictions about how the RRTS affects trading patterns can be complex. If RRTS proves a cheaper alternative to conventional shipping, lower value products will find RORO to be a more viable mode of transport. This implies gains along the extensive margins, as products that were previously unable to surmount trade costs become tradeable. At the same time, higher value products have the advantage of lower fixed costs of trade because of lane meter charging. This charging modality implies that unit values influence the ratio of delivery to inventory costs, thus altering the frequency of transactions. In terms of product characteristics, the absence of cargo handling predicts an advantage for time-sensitive goods.

The effects of RRTS on trade costs and trading patterns have important development consequences because they influence the production and consumption patterns within a country. Many studies establish the empirical relationship between improved connectivity, market access, and incomes (Duranton, 2015). Among these, Donaldson (2018) link the phased and military-motivated development of the Indian rail network to increased trading activities of connected districts which also experienced higher real income growth. In the United States, market access from the railway expansion in the 19th century was capitalized into the agricultural land values, which in turn raised real incomes (Donaldson and Hornbeck, 2016). The stated goals of the RRTS include raising rural incomes and stimulating investments in the agricultural sector. Understanding how trading patterns respond to the RRTS is a first step in unpacking how changes in trade costs maps to the stated RRTS welfare objectives.

Various studies report positive impacts of the RRTS in terms of passenger and cargo traffic with increases of 300% and 500% respectively between 2003 and 2006, and reduction in cargo transport costs of as much as 20% to 68% over a range of routes and products (Basilio, 2008; Llanto et al., 2005; ADB, 2010). Nonetheless, the causal effects of RRTS on trade costs and trade outcomes have yet to be empirically established.

2 Methodology

The structural gravity model of Anderson and Wincoop (2003) is used as a framework for linking trade flows with observable and unobservable trade cost variables. As is standard in the gravity literature, bilateral trade flows are assumed to follow a Poisson distribution with the conditional mean of observed trade flows exhibiting an exponential form. This specification allows for a robust estimation in a context where zero trade flows take large shares of the observation and addresses concerns of heteroscedasticity in multiplicative models (Head and Mayer, 2013; Santos Silva and Tenreyro, 2006, 2011).

In equation 1, the value of exports of port i to port j in product k for year t, $X^k_{ij,t}$, is explained by a host of observable trade costs variables. $RRTS_{ij,t}$ is a dummy variable equal to one when a pair of ports becomes linked by RRTS. The RRTS effect is identified from pairs that are RRTS-linked and the variation in time when they become connected. $Lndist_{ij}$ is the log of the distance between a pair of cities (or municipality) where the ports are located. $Lang_{ij}$ is a binary variable that is equal to one if the majority of the population in the pair shares a common language.[6][7] $Liner_{ij}$ is a dummy variable that is equal to one for port-pairs that are served by liners. The multilateral resistance terms $\eta_{i,t}$ and $\theta_{j,t}$ correspond to city-year fixed effects. Cities and municipalities represent sufficiently disaggregated geographical units that account for localized economic trends, but also offer the advantage of a more parsimonious set of fixed effects compared to their port level counterparts.[8] $\kappa_{K,t}$ is a set of product group-year fixed effects which accounts for changes in demand and supply conditions.

$$X^k_{ij,t} = exp[\delta\, RRTS_{ij,t} + \beta_1\, Lndist_{ij} + \beta_2\, Lang_{ij} + \beta_3\, Liner_{ij} + \eta_{i,t} + \theta_{j,t} + \kappa_{K,t} + \epsilon^k_{ij,t}] \quad (1)$$

I employ pair fixed effects to address selection and potential endogeneity as is used to identify the effects of RTAs on trade flows (Baier and Bergstrand, 2007). This has become a standard identification strategy in gravity models in the absence of good instruments (Head and Mayer, 2013). Pair fixed-effects absorb the non-time varying characteristics between a pair that make them

[6]The analyses are at the port level but information on distance, language, and religion are only available at the municipal level.

[7]Religion was initially included as a gravity covariate. However, a variance inflation factor analysis reveals high collinearity with the distance variable.

[8]Port level fixed effects imply 725×15 port-year variables, compared to 365×15 city-year variables.

likely to invest in an RRTS connection. This includes combined market size, cultural affinity in terms of language and religion, and topographical characteristics that make RORO transport feasible along certain routes. This is captured by α_{ij} in equation 2. Figure 5 show that the actual sequence of RRTS route exhibit exogeneity from the original plans of the inter-agency team in 1992. Time-varying characteristics affecting product demand and supply are absorbed through interacted product group and year fixed effects. This leaves δ to identify the variation coming from RRTS connection.

$$X_{ij,t}^{k} = exp[\alpha_{ij} + \delta \, RRTS_{ij,t} + \kappa_{k,t} + \epsilon_{ij,t}^{k}] \tag{2}$$

Effects in the intensive and extensive margins, and heterogeneous impacts across product characteristics are examined by modifying equations 1 and 2. For example, the impact of RRTS on product variety is estimated by replacing $X_{ij,t}^{k}$ with $PCount_{ij,t}^{K}$, which corresponds to the number of products in the 5-digit Philippine Standard Commodity Classification (PSCC) traded between i and j in year t for product group K. In another exercise, $RRTS_{ij,t}$ is interacted with product value indicators to capture differential RRTS effects across the unit value distribution.

I investigate the RRTS effects on each component of annual trade flows through a decomposition method following Hornok and Koren (2015). This lends insights on lumpy trade and inventory response. For this exercise, an ordinary least squares (OLS) estimator is employed in place of the Poisson quasi maximum likelihood estimator (PQMLE) so that each trade value component adds up linearly to the total value.

In equation 3, $N_{ij,t}^{k}$ is the monthly frequency of bilateral shipments in a year; and $V_{ij,t}^{k}$, the average value of the shipment. $V_{ij,t}^{k}$ is further decomposed as the product of the average shipment quantity $Q_{ij,t}^{k}$, and average shipment price $P_{ij,t}^{k}$ as shown in equation 4. Each of these margins are then regressed on the gravity covariates in equations 1 and 2.

$$X_{ij,t}^{k} \equiv N_{ij,t}^{k} \times V_{ij,t}^{k} \tag{3}$$

$$X_{ij,t}^{k} \equiv N_{ij,t}^{k} \times Q_{ij,t}^{k} \times P_{ij,t}^{k} \quad (4)$$

Complementarities with other routes, trade displacement, and market access spillovers are examined by introducing indicators that capture these potential relationships. The exact specifications are detailed in Section 4.3.

3 Data

The PSA records more than 2.3 million monthly entries of domestic maritime trade flows from 2000 to 2014, covering 725 seaports in the Philippines. There was trade between 2,999 port-pairs, and 1,449 municipal pairs. Pairs that traded infrequently (traded less than ten months throughout the fifteen year period) are excluded. They account for 3% of the total sample.

Products are defined at the five digit PSCC code, and 1,964 products are covered by the trade data. This number excludes arms and ammunition, cement, fuels, metal ores, and minerals, which are mostly transported as bulk commodities and are not as amenable to RORO transport as other products.

Based on this slightly reduced sample, port-pair-product combinations that do not record trade for a particular year are assumed to be zero, and this makes up 73% of the total observations.

I build the data on RORO ports, routes, and their starting dates of service using various sources described in Go (2020). The primary source is through a survey of RORO shipping companies, which is then supplemented with other sources including the PSA Inventory of Ports; the MARINA inventory of RORO routes; information and annual reports from the PPA; aid agency reports, and newspaper articles. One hundred and fifteen port-pairs became part of the RRTS during some point in time. Finally, there are 248 liner-serviced routes in the sample, which were identified from Austria (2002).

Data on municipal characteristics such as language and religion come from the Philippine Census of Housing and Population 2000. Distances between municipal pairs are derived from the geographical coordinates in DIVA-GIS.

4 Results

4.1 Main results

The effect of the RRTS on trade estimated through equations 1 and 2 are summarized in Table 2. The first two columns use the full set of gravity covariates. The RRTS coefficient is positive and significant, suggesting that being connected by RRTS is associated with about 65% ($e^{0.498} - 1 = 0.6454$) more trade. In line with expectations, distance exhibits a negative effect on trade, with an elasticity of 0.10. Albeit only marginally significant, sharing a common language exerts a negative influence on trade. This is not entirely surprising in the context of maritime trade. Municipalities that share a common language are more likely to be contiguous by land, and therefore have alternative transport modes.[9] Finally, being served by a liner is associated with over 200% more trade, which is unsurprising given the larger vessels that service these major routes.

In the second column, RRTS effects are allowed to vary by distance thresholds to capture the short haul nature of the RRTS. $Short_{ij}$ is a dummy variable that is equal to one if a port-pair is not more than 185 kilometers apart, the median distance served by RORO ships in the sample. The results confirm that the positive effects of RRTS on trade flows is driven by short distance connections.

Results from the preferred specification with port-pair fixed effects are shown in columns (3) and (4). Time-invariant characteristics such as distance, language, and liner route designation are absorbed by the set of pair fixed effects. The RRTS coefficients remain positive and significant albeit with smaller magnitudes. Results in column (3) show that RRTS increased trade by 35% ($e^{0.300} - 1 = 0.35$) in connected pairs compared to unconnected port-pairs with similar characteristics. Taking off from the average value of trade prior to connection in Table 1, RRTS increased average trade from 3.2 to 4.3 million PhP per year for an RRTS port-pair. Column (4) shows that this gain is mainly driven by short distance RRTS connections, where trade

[9] The correlation between land contiguity and common language is 27% and is statistically significant at 1%.

Table 2: RRTS and domestic maritime trade

Dependent variable: Value of trade	(1)	(2)	(3)	(4)
RRTS	0.498***	0.131	0.300***	-0.002
	(0.189)	(0.369)	(0.112)	(0.215)
RRTS x short		0.393		0.330
		(0.361)		(0.240)
Log distance	-0.102**	-0.0982*		
	(0.0516)	(0.0522)		
Language	-0.332*	-0.328*		
	(0.190)	(0.190)		
Liner	1.243***	1.226***		
	(0.248)	(0.249)		
Observations	2,052,195	2,052,195	2,052,195	2,052,195
Origin-year FE	Yes	Yes	No	No
Dest-year FE	Yes	Yes	No	No
Product-year FE	Yes	Yes	Yes	Yes
Port-pair FE	No	No	Yes	Yes

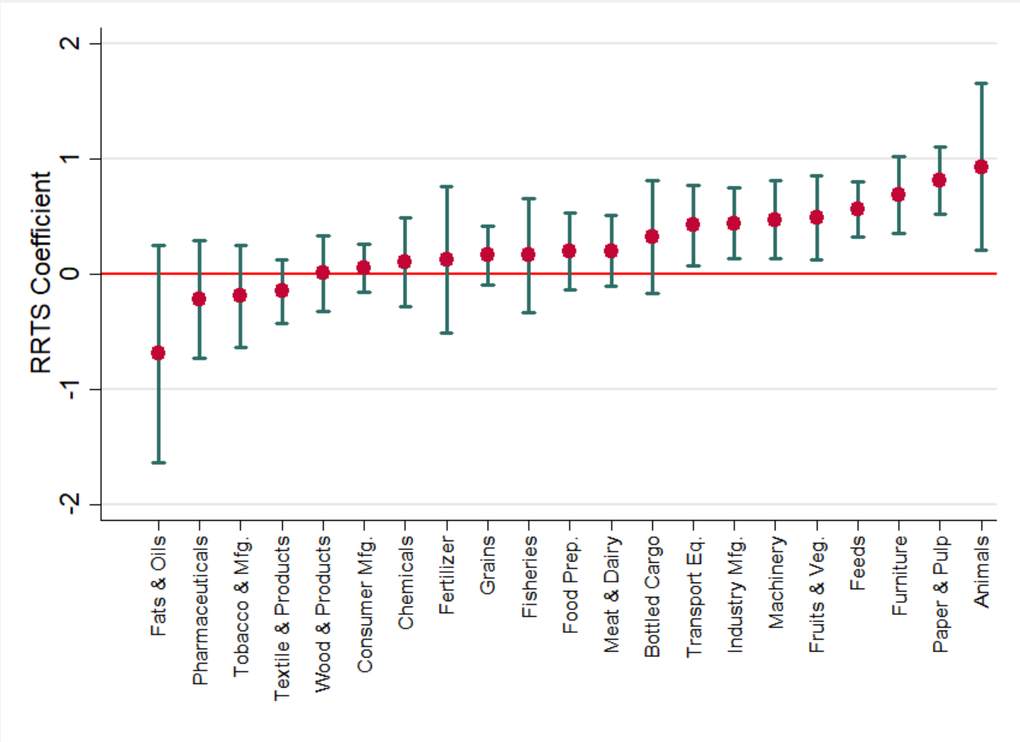
Robust standard errors in parentheses clustered at city pairs.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

is 39% more compared to similar but unconnected pairs.[10]

Figure 7 summarizes the RRTS effect by product group using the preferred specification in equation 2. The effect is positive for most product groups but only statistically significant for eight product categories. These are time-sensitive goods such as live animals, and fruits and vegetables; and high value products like machinery, industrial manufactures, and transport equipment. The regressions with distance threshold distinctions in Table A-2 in the Appendix reveal that the positive effects for live animals, and fruits and vegetables come from the short RRTS connections. Moreover, RRTS also

[10]Estimates using the volume of trade as regressand in Table A-1 confirm that the positive RRTS effects are not purely due to price effects. The overall results are largely in line with the value regressions. The effect on volume (albeit insignificant) largely comes from the longer haul RRTS routes, whereas the impact on value is driven by short distance RRTS services. This implies that bulkier goods tend to be shipped over longer haul RRTS journeys, which makes sense in light of their higher fixed costs in shipping.

Figure 7: RRTS effect on trade value by product group



Source: Author
Note: Whiskers represent 95% confidence intervals. All regressions include port-pair and product group (3-digit)-year fixed effects with robust standard errors clustered at city pairs. Actual estimates are presented in Table A-2.

increases trade in fishery products in short distance routes. A few groups of products – fats and oils, pharmaceuticals and medical instruments, tobacco and manufactures, and textile products – have negative coefficients although they are not statistically significant.

Intensive margins

The effects of the RRTS on the intensive margin is examined by limiting the sample to port-pair-product combinations that were being traded even before RRTS connections were introduced. The preferred specification in column (3) of Table 3 suggests that being RRTS-linked increases trade by 18% compared to similar pairs without RRTS. This is weaker than the overall effect found in the full sample and is also less precisely estimated. The results

Table 3: RRTS effect on the intensive margin

Dependent variable: Value of trade	(1)	(2)	(3)	(4)
RRTS	0.798***	0.0564	0.166*	-0.106
	(0.205)	(0.416)	(0.0903)	(0.188)
RRTS x Short		0.867**		0.296
		(0.430)		(0.200)
Short		-0.256		
		(0.201)		
Log distance	-0.112**	-0.146**		
	(0.0534)	(0.0591)		
Religion	-0.364*	-0.254		
	(0.193)	(0.204)		
Liner	1.230***	1.235***		
	(0.248)	(0.247)		
Observations	1,889,730	1,889,730	1,889,730	1,889,730
Origin-year FE	Yes	Yes	No	No
Dest-year FE	Yes	Yes	No	No
Product-year FE	Yes	Yes	Yes	Yes
Port-pair FE	No	No	Yes	Yes

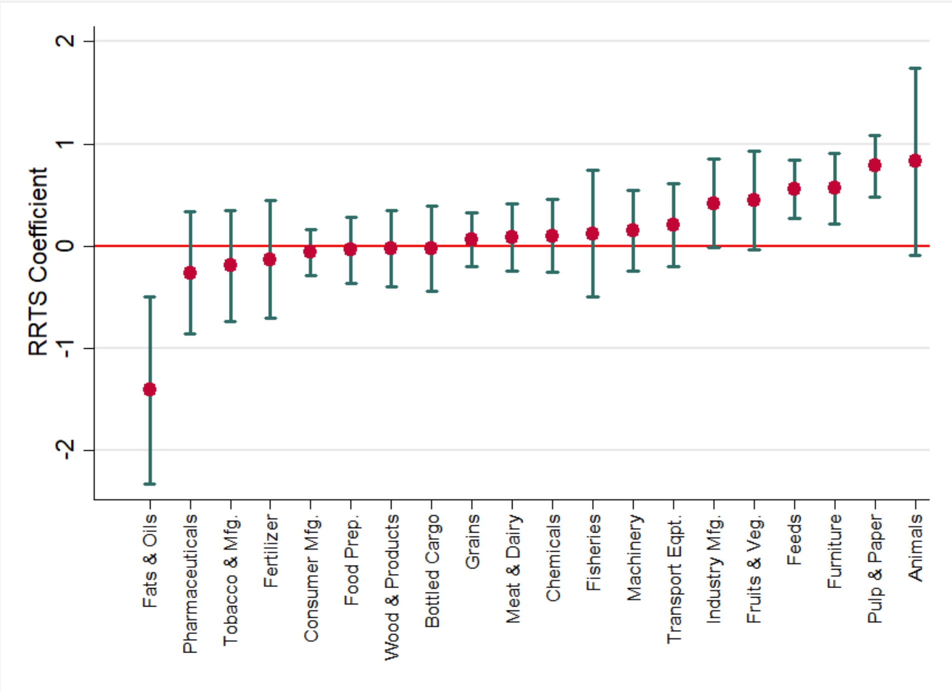
Robust standard errors in parentheses clustered at city pairs.
*** p<0.01, ** p<0.05, * p<0.1

in column (4) suggests that the intensive margin effects are stronger in short distance connections at 21% albeit only significant at 10%.

Results of the by-product regressions in Figure 8 provide insights to the weaker response in the intensive margin. Only a handful of product groups see more trade in RRTS port-pairs – feeds, furniture, pulp and paper. RRTS is also associated with large intensive effects in fruits and vegetables (87%), and live animals (160%) for short distance connections possibly due to the time-sensitive nature of these products (Table A-3). While mostly positive, the effects for other products are statistically insignificant. The results generally accord with the predictions that more substitutable products experience greater effects in the intensive margin (Chaney, 2008; Rauch, 1999). For example, feeds, furniture, and pulp and paper react more strongly compared to pharmaceuticals and consumer products.

The large and significant negative effect for fats and oils is notable. Domestic fats and oils trade largely pertains to coconut and palm oil, which

Figure 8: RRTS effect on intensive margin by product group



Source: Author.
Note: Whiskers represent confidence intervals of 95%. All regressions include port-pair and product group (3 digit)-year FEs with robust standard errors clustered at city pairs. Actual estimates are presented in Table A-3

has been increasing through RRTS routes, though not at the pace at which it has grown in liner and non-RRTS routes. Based on field interviews, fats and oils are increasingly shipped using food grade flexibags that are molded for twenty foot containers, which are handled in dedicated ports of big oil milling companies.

Extensive margins

The RRTS have features that largely impinge on the fixed costs of trade. The clearest examples include costs for cargo handling and inventory management which have substantial components in monetary and procedural terms that do not vary with the volume of trade. A significant reduction of fixed costs is therefore anticipated not only to increase the volume of products being traded, but also expand the range of products and export destinations available to a given area.

Extensive margin effects have potentially large welfare implications especially for remoter regions. The extensive margin as an avenue of trade cost adjustment is documented to be quantitatively important (Chaney, 2008; Hillberry and Hummels, 2008; Hornok and Koren, 2015; Santos Silva et al., 2014), and in some studies have proven to be the main driver of gains from trade (Hummels and Klenow, 2005).

Product diversity

Product diversity is measured as the count of the PSCC five digit level per product group for each bilateral route. $PCount^{K}_{ij,t}$ takes the place of $X^{k}_{ij,t}$ in equations 1 and 2.

Table 4 presents the RRTS effects on product diversity. The preferred specifications in columns (3) and (4) suggest substantial gains, with RRTS routes having 36.6% more product variety than their unconnected counterparts. In terms of product variety prior to connection in Table 1, RRTS increased the number of products being traded from 27 to 37, close to the breath of variety carried along the liner routes. The coefficient on long distance RRTS connection is insignificant in column (4), but the short distance coefficient is highly significant and close to the average effect at 37%.

Table 4: RRTS effect on product diversity

Dependent variable: Sector product count	(1)	(2)	(3)	(4)
RRTS	1.430***	1.724***	0.312***	0.260
	(0.138)	(0.252)	(0.0554)	(0.243)
RRTS x Short		-0.220		0.0571
		(0.278)		(0.244)
Short		-0.299**		
		(0.124)		
Log distance	-0.0510	-0.123***		
	(0.0338)	(0.0358)		
Language	-0.475***	-0.433***		
	(0.147)	(0.148)		
Liner	1.014***	1.104***		
	(0.170)	(0.172)		
Observations	271,545	271,545	271,545	271,545
Origin-year FE	Yes	Yes	No	No
Dest-year FE	Yes	Yes	No	No
Product-year FE	Yes	Yes	Yes	Yes
Port-pair FE	No	No	Yes	Yes

Estimator: Poisson quasi maximum likelihood.
Robust standard errors in parentheses clustered at city pairs.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

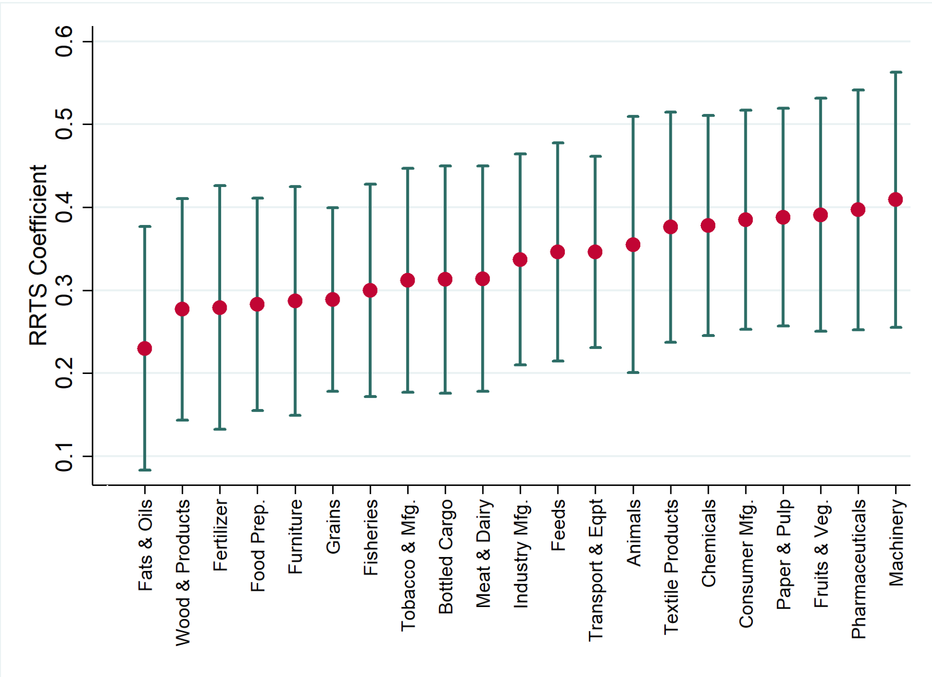
Figure 9 shows that the product diversity effect of the RRTS is positive across all product groups. Manufactured products appear to have gained the most. To some extent, this is an artifact of the number of products in each category. For example, there are 22 products under the 5 digit PSCC for grains, whereas there are 91 for transport equipment. This is controlled for in the pooled regression with product-year fixed effects in Table 4, but the product level regressions entailed summing across product groups and are therefore unable to account for this. Nonetheless, the differential effect of RRTS is strongly positive, ranging from 26% for fats and oils, to 51% for machinery. Consistent with the predictions of Chaney (2008), more differentiated products such as machinery and pharmaceuticals exhibit stronger effects along the extensive margins compared to more homogeneous goods such as fats and oils and wood products.

Exporting to new destinations

Linking a pair of ports by RRTS makes them part of a broader network of RORO-serviced routes. This expands the number of export markets accessible by RORO vessels. New markets can also come from outside the network of RRTS ports through 'learning by exporting'.

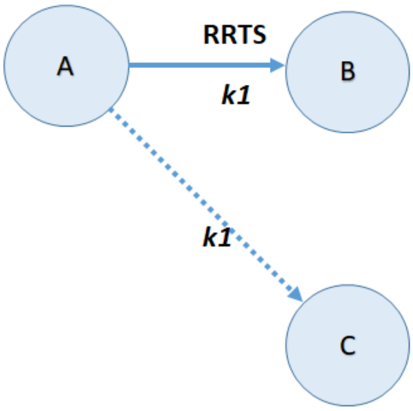
However, the RRTS effects on export destination expansion cannot be adequately addressed with pair fixed effects. Albeit unsatisfactory, it is more feasible to examine whether RRTS connection makes it more likely for the origin port to export the same set of products to a new non-RRTS market. In place of $X_{ij,t}^k$ in equations 1 and 2, $ProbX_{ij,t}^k$ is introduced as a binary indicator that is equal to one if the origin port in an RRTS port-pair begins exporting to a non-RRTS destination. Limiting the analysis to new non-RRTS markets reduces concerns about endogeneity since RRTS-enabled ports are more likely to connect with other RRTS ports to maximize network effects. Figure 10 illustrates. Suppose port A is exporting product $k1$ to port B, and they become linked by RRTS. Does this increase the probability of port A exporting $k1$ to a new destination port C even if pair AC is not linked by RRTS?

Figure 9: Product diversity effect by product group



Source: Author
Note: Whiskers represent confidence intervals of 95%. All regressions include port-pair and year FEs with robust standard errors clustered at city pairs. Actual estimates are presented in Table A-4.

Figure 10: RRTS and new markets



Source: Author
Note: Whiskers represent confidence intervals of 95%. All regressions include port-pair and year FEs with robust standard errors clustered at city pairs. Actual estimates are presented in Table A-5.

Estimates from a linear probability model in Table 5 show that in the preferred specification in column (3), linking a pair of ports by RRTS increases the probability of the origin port exporting to a new non-RRTS destination by one percentage point. This effect is potentially higher for short distance RRTS connections at 1.3 percentage points although the estimate is only significant at 10%.

Market expansion opportunities range from one percentage point for tobacco and manufactured products to around three percentage points for textile products. Exporters connected by short distance RRTS also exhibit greater probability of gaining new destinations for fertilizers. However, RRTS connections end up reducing the probability of new markets for pharmaceuticals and medical equipment, and furniture. The absence of other agricultural product groups, execpt for fisheries, among the beneficiaries is also notable. A potential explanation is that the time-sensitive nature of agricultural products limits the possibilities for market expansion outside of the RRTS network. Details of the results are in Table A-5.

Table 5: Probability of exporting to a new non-RRTS destination

Dependent variable: Probability of new export destination				
	(1)	(2)	(3)	(4)
RRTS	-0.00004	-0.000361	0.00954**	0.00781
	-0.00091	(0.00142)	(0.00458)	(0.00496)
RRTS x Short		2.90e-05		0.00209
		(0.00159)		(0.00623)
Short		0.00278***		
		(0.000969)		
Log distance	0.00028	0.00148***		
	-0.00024	(0.000324)		
Language	-0.00048	-0.000276		
	-0.00118	(0.00124)		
Liner	0.0054***	0.00448***		
	-0.00142	(0.00145)		
Observations	2,052,195	2,052,195	2,052,195	2,052,195
Origin-year FE	Yes	Yes	No	No
Dest-year FE	Yes	Yes	No	No
Product-year FE	Yes	Yes	Yes	Yes
Port-pair FE	No	No	Yes	Yes

Estimator: OLS, linear probability model.
Robust standard errors in parentheses clustered at city-pairs.
*** p<0.01, ** p<0.05, * p<0.1

The results from this subsection suggest significant extensive margin gains associated with RRTS for both product variety and market expansion. The stronger results in the extensive compared to the intensive margins makes intuitive sense. A substantial reduction in fixed costs confers savings even when exported volumes are held constant. The extent of intensive margin adjustment is dictated by how fast variable costs rises with the volume of exports. On the other hand, lower fixed costs of trade reduces the threshold for market entry across the board for all products and markets.

Lumpiness of trade - frequency of trade transactions

How do the different margins of trade adjust to changes in trade costs? A decomposition exercise answers this question. The exercise entails a shift from the exponential form of Poisson to a linear framework so that each component adds up to the total trade value. The log of $X^k_{ij,t}$, $N^k_{ij,t}$, $V^k_{ij,t}$, $Q^k_{ij,t}$, and $P^k_{ij,t}$, from equations 3 and 4 are each regressed as functions of the gravity covariates in OLS. By definition, this excludes zero flows.

The top panel of Table 6 presents the results with gravity covariates, whereas the lower panel shows the estimates with port-pair fixed effects. The direction of the estimates is broadly similar for both sets of estimates.[11] The preferred specification in the lower panel shows RRTS pairs increased their average transaction frequency by 7.7% (column 2). Using the pre-RRTS period as base, this implies that RRTS connection increased the number of transactions from 4.4 months to 4.7 months in a year. The stronger effects are in short distance connections, which trade 9.3% more frequently than they otherwise would without the RRTS as shown in column (7).

The higher transaction frequencies are not accompanied by significant reductions in average shipment value or volume as a clear story of trade-off

[11] Estimates of the decomposition elements add up closely with small discrepancies from rounding off. The ubiquity of single-frequency product-pair-year transactions comprising 40% of the observations also contributes to the discrepancies. Regressions without these observations bring down the discrepancies to the thousandths place. Finally, the demands of the fixed effects specifications also explain some of the divergences. Though base categories are held fixed across regressions, a larger set of fixed effects imply greater potential for perfectly collinear variables that need to be dropped.

between transport inventory costs predicts. Nonetheless, a zero-sum relationship is not necessary for inventory savings to materialize especially when accompanied by trade expansion. It is worth noting that the results in trade frequency represent a lower bound since zero flows are not included in this decomposition. The story of how RRTS affects inventory management is once again explored in the next sub-section in the context of lane meter charging and time-sensitive products.

About half of the 21 product categories exhibit significant increases in transaction frequency following RRTS services. The increases range from 9% for industrial manufactures to 14% for pulp and paper products. Consumer manufactures, fisheries, and live animals, also exhibit higher trade frequencies over short distance connections. The results are summarized in Table A-6.

Table 7 provides a summary of the estimated RRTS effects for the product groups across the aspects examined in this sub-section. The strongest and most significant results across products are observed along the extensive margins in terms of product variety, followed by higher frequency of trade transactions, and a greater probability of exporting to new non-RRTS destinations. The intensive margin gains are limited to a few sets of products, and in the case of fats and oils, is associated with slower trade growth.

Table 6: RRTS effect of trade components - lumpiness

Dependent variables: Log of trade value, frequency, average value, average quantity, and average price										
	log value	log freq	log avalue	log aquant	log aprice	log value	log freq	log avalue	log aquant	log aprice
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
RRTS	0.622	0.252***	0.370	0.249	0.121	0.139	0.317***	-0.178	-0.162	-0.0152
	(0.387)	(0.0415)	(0.371)	(0.296)	(0.0799)	(0.364)	(0.0927)	(0.347)	(0.331)	(0.0536)
RRTS x Short						0.499	-0.0627	0.562	0.432	0.130**
						(0.385)	(0.101)	(0.358)	(0.335)	(0.0596)
Short						0.753***	-0.00481	0.757***	0.532***	0.225***
						(0.178)	(0.0281)	(0.169)	(0.140)	(0.0446)
Log distance	0.151	-0.00125	0.153	0.117	0.0359	0.497***	0.0009	0.496***	0.371***	0.125***
	(0.109)	(0.0106)	(0.105)	(0.0845)	(0.0230)	(0.118)	(0.0116)	(0.112)	(0.0886)	(0.0257)
Language	0.283	-0.0197	0.303	0.158	0.145**	0.419**	-0.0155	0.435**	0.269	0.166***
	(0.287)	(0.0439)	(0.279)	(0.234)	(0.0600)	(0.211)	(0.0427)	(0.200)	(0.178)	(0.0414)
Liner	0.504***	0.169***	0.334***	0.322***	0.0119	0.111	0.170***	-0.0588	0.0344	-0.0932***
	(0.112)	(0.0297)	(0.107)	(0.110)	(0.0253)	(0.139)	(0.0304)	(0.135)	(0.125)	(0.0325)
Origin-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dest-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
					With pair fixed effects					
	log value	log freq	log avalue	log aquant	log aprice	log value	log freq	log avalue	log aquant	log aprice
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
RRTS	0.110	0.077***	0.018	0.061	-0.043	-0.214	-0.073	-0.150	-0.039	-0.111*
	(0.070)	(0.028)	(0.053)	(0.049)	(0.029)	(0.207)	(0.050)	(0.164)	(0.134)	(0.057)
RRTS x Short						0.358*	0.166***	0.185	0.111	0.075
						(0.215)	(0.056)	(0.168)	(0.139)	(0.061)
Product-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	545,052	545,052	545,052	545,052	545,052	545,052	545,052	545,052	545,052	545,052

Estimator: OLS

Robust standard errors clustered at city pairs.

*** p0.01, ** p0.05, * p0.1

Table 7: Summary of RRTS effect by product

Product group	Overall	Intensive	Prod. count	New partner	Frequency
Animals	✓	✓	✓		✓
Bottled Cargoes			✓		
Chemicals			✓		✓
Consumer Mfg.			✓	✓	✓
Fats & Oils		×	✓		
Feeds	✓	✓	✓		
Fertilizer			✓	✓	
Fisheries			✓	✓	✓
Food Preparations			✓		✓
Fruits and Veg.	✓	✓	✓		✓
Furniture	✓	✓	✓	×	✓
Grains			✓		
Industrial Mfg.	✓	✓	✓	✓	✓
Machinery	✓		✓	✓	
Meat & Dairy			✓		✓
Paper & Pulp	✓	✓	✓	✓	✓
Pharma.& Med.Inst.			✓	×	✓
Transport Eqpt.	✓		✓	✓	✓
Tobacco & Mfg.			✓	✓	✓
Textile & Products			✓	✓	
Wood & Products			✓	✓	

Note: ✓refers to positive effects in overall/short distance. × refers to negative effects. A blank denotes effects that are statistically insignificant.

4.2 Mechanisms

Lane Meter Charging

Lane meter charging in RRTS implies that conditional on vehicle size, storage requirements, and route, the same freight cost applies regardless of the cargo carried. This means that freight charges can be minimized by packing more value into a shipment, hence benefiting higher value products. In equation 5, $Quval_q^k$ is a dummy variable, where q indicates the quartile distribution of the average unit value of product k over fifteen years. Unit values range from PhP 3.73 to PhP 612.55 per kilogram (kg) with quartile thresholds at PhP 39, PhP 52, and PhP 73 per kg.

$$X_{ij,t}^k = exp[\alpha_{ij} + \delta_1 \, RRTS_{ij,t} + \delta_q \, RRTS \times Quval_q^k + \gamma \, Quval_q^k + \kappa_{K,t} + \epsilon_{ij,t}^k] \quad (5)$$

Table 8 summarizes the differential RRTS effects by product value on various aspects of trade patterns. Overall, the results provide evidence that higher value products benefit more from the RRTS. The relative gains are not strong in the overall sample and along the intensive margins as shown in columns (1) to (4). In these regressions, only products in the highest quartile exhibit more trade along short distance RRTS connections.

On the other hand, the effects on the extensive margins show clear patterns of progressively stronger RRTS effects as product value increases. In column (5), RRTS connections are shown to increase product types between pairs by 35% for the base quartile. Products in the second quartile of the distribution have 2 percentage points greater variety on top of the base gain, and products in the third and fourth quartiles have 2.1, and 3.4 percentage points greater product variety respectively. In column (7), products in the third quartile have a 0.27 percentage point higher probability of gaining new markets compared to products in the bottom of the distribution. The probability increases by 0.51 percentage points for the highest value products.

Table 8: RRTS and lane meter charging

Dependent variables: Value of trade, product count, probability of exporting, frequency										
	Full		Intensive		No. of products		Prob. new partner		Frequency	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
RRTS	0.106	0.146	-0.0799	0.0448	0.298***	0.289	0.00760	0.00665	0.253***	0.0946
	(0.204)	(0.304)	(0.214)	(0.299)	(0.0579)	(0.252)	(0.00480)	(0.00727)	(0.0603)	(0.199)
RRTS x Q2	0.0385	0.00334	0.0157	0.0155	0.0197***	0.0256	0.000624	-2.52e-05	0.0627**	0.0356
	(0.173)	(0.346)	(0.175)	(0.380)	(0.00664)	(0.0197)	(0.000694)	(0.00182)	(0.0258)	(0.0804)
RRTS x Q3	0.375	-0.225	0.523	-0.236	0.0206***	-0.00215	0.00273***	0.00251	0.0678**	0.138
	(0.498)	(0.229)	(0.556)	(0.206)	(0.00754)	(0.0113)	(0.000821)	(0.00187)	(0.0319)	(0.0846)
RRTS x Q4	0.379	-0.413	0.467	-0.391	0.0336***	0.0195	0.00509***	0.00411**	0.115***	0.158**
	(0.361)	(0.399)	(0.391)	(0.403)	(0.00919)	(0.0229)	(0.000928)	(0.00204)	(0.0292)	(0.0738)
RRTS x Short		-0.0290		-0.119		0.0103		0.00109		0.174
		(0.319)		(0.313)		(0.253)		(0.00823)		(0.201)
RRTSxShortxQ2		0.0370		-0.00209		-0.00631		0.000709		0.0286
		(0.345)		(0.376)		(0.0211)		(0.00185)		(0.0819)
RRTSxShortxQ3		0.626		0.794		0.0245*		0.000239		-0.0746
		(0.519)		(0.566)		(0.0137)		(0.00195)		(0.0872)
RRTSxShortxQ4		0.825**		0.897**		0.0152		0.00109		-0.0447
		(0.332)		(0.356)		(0.0247)		(0.00214)		(0.0764)
Q1	1.128***	1.127***	-1.372***	-1.373***	-3.008***	-3.008***	0.0777***	0.0777***	-2.366***	-2.366***
	(0.192)	(0.192)	(0.287)	(0.287)	(0.0402)	(0.0402)	(0.00630)	(0.00630)	(0.0425)	(0.0425)
Q2	0.696***	0.696***	-1.881***	-1.882***	-3.004***	-3.004***	0.0767***	0.0767***	-2.695***	-2.695***
	(0.211)	(0.211)	(0.330)	(0.330)	(0.0404)	(0.0404)	(0.00630)	(0.00630)	(0.0471)	(0.0470)
Q3	0.652***	0.651***	-1.920***	-1.920***	-3.010***	-3.010***	0.0773***	0.0773***	-2.944***	-2.944***
	(0.206)	(0.206)	(0.315)	(0.315)	(0.0400)	(0.0400)	(0.00631)	(0.00631)	(0.0515)	(0.0515)
Q4	0.822***	0.821***	-1.744***	-1.745***	-2.993***	-2.993***	0.0740***	0.0740***	-3.207***	-3.207***
	(0.243)	(0.243)	(0.349)	(0.349)	(0.0401)	(0.0401)	(0.00631)	(0.00631)	(0.0504)	(0.0503)
Observations	2,052,195	2,052,195	1,889,730	1,889,730	505,800	505,800	2,052,195	2,052,195	2,052,195	2,052,195

Estimator: Poisson QMLE, LPM for columns (7) and (8).
Estimator: All regressions have port-pair and product-year FEs.
Robust standard errors in parentheses clustered at city-pairs.
*** p<0.01, ** p<0.05, * p<0.1

Finally, RRTS connection increases the frequency of trade by an average of 29%. This increases by 6.4, 7.0, and 12.2 percentage points moving from the second to the higher quartiles of the value distribution. Trading more frequently in RRTS routes allows firms to hold less inventory of expensive products, which have larger opportunity costs in terms of liquidity and cash flow management. The distinction between RRTS distance thresholds does not yield significant insights.

Time-sensitive products

The absence of cargo handling procedures combined with the possibility of more frequent transactions are foreseen to be valuable for products with sensitive shelf lives. Products such as fresh fruits and vegetables, fish and fish preparations, live animals, and meat and dairy, have greater chances of reaching their destination markets with less spoilage.[12]

The differential RRTS effects for trade in time-sensitive products are captured by interacting the RRTS variable with a dummy variable that is equal to one when a product is considered time sensitive, $RRTS_{ij,t} \times TS_k$.

The results in columns (1) and (2) of Table 9 suggest that compared to other product groups, time-sensitive goods are possibly traded less between RRTS pairs. This decline is also reflected in the intensive margins. In both cases, the magnitudes of the negative effects are large, although not very precisely estimated.

[12]Textiles, electronics, and auto parts and components, are considered time-sensitive in the context of a just-in-time inventory management system. However, the directory of the Philippine Economic Zone Authority indicate that garments and automotive and electronics manufacturing and assembly firms are all located in the Luzon mainland and Cebu, which directly export to international markets. Hence, there is no compelling reason to consider these products as time-sensitive for domestic trade.

Table 9: RRTS and time-sensitive products

Dependent variables: Value of trade, product count, probability of exporting, frequency										
	Full		Intensive		No. of products		Prob. new partner		Frequency	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
RRTS	0.348***	0.00562	0.232**	-0.0874	0.298***	0.249	0.00950**	0.00849	0.332***	0.178
	(0.127)	(0.226)	(0.111)	(0.205)	(0.0583)	(0.261)	(0.00468)	(0.00670)	(0.0635)	(0.230)
RRTS x TS	-0.563	-0.0724	-0.711*	-0.254	0.169***	0.159	0.00226**	-0.000738	0.115***	0.0880
	(0.346)	(0.325)	(0.402)	(0.374)	(0.0566)	(0.246)	(0.000925)	(0.00204)	(0.0362)	(0.0926)
TS	-0.546	-0.547	-0.0671	-0.482	-0.485***	-0.485***	-0.0459***	-0.0459***	0.153***	0.153***
	(0.487)	(0.487)	(0.237)	(0.358)	(0.0311)	(0.0311)	(0.00240)	(0.00240)	(0.025)	(0.0248)
RRTS x Short		0.371		-0.0923		0.0546	0.00116	0.00116		0.171
		(0.251)		(0.311)		(0.263)	(0.00764)	(0.00764)		(0.232)
RRTS x SH x TS		-0.513*		0.347		0.0107		0.00329		0.0287
		(0.302)		(0.214)		(0.253)		(0.00206)		(0.0978)
Observations	2,052,195	2,052,195	1,889,730	1,889,730	271,545	271,545	2,052,195	2,052,195	2,052,195	2,052,195

Estimator: Poisson quasi maximum likelihood; OLS for columns (7) and (8).
All regressions have port-pair and year FEs.
Robust standard errors in parentheses clustered at city-pairs.
*** p<0.01, ** p<0.05, * p<0.1

The positive effects of the RRTS on perishables are most apparent in the extensive margins. In column (5), results show that there are 18% more types of time-sensitive products in RRTS routes than in similar port-pairs. At the same time, the probability of exporting to new non-RRTS markets increases by 1.2 percentage points more than other product groups as shown in column (7). The result on export destination expansion is not exactly similar to the results in Section 4.1. Recall that among the perishable product groups, only fisheries had a greater probability of being exported to new destinations. That result is based on a more stringent set of product-year fixed effects, whereas the current specification excludes product fixed effects to capture the time-sensitive characteristics of these product groups. Moreover, the results in column (8) suggests that this higher probability mainly comes from the short distance connections. Finally, perishable products are transacted 12% more frequently compared to other products in the RRTS.

The positive RRTS effects on the extensive margins and transaction frequency for time-sensitive goods stand in contrast to the negative effect in the intensive margin. This combination of effects makes sense if substantial portions of shipments prior to RRTS comprise of insurance buffers against spoilage, pilferage, and storage. This, however, requires further validation.

4.3 Spillover effects

The RRTS alters the relative cost distribution between trading partners and can therefore have impacts beyond directly linked ports.

Interaction with liner routes

The nature of shipping transport networks mean that the RRTS does not operate in isolation from other routes. This is most easily appreciated when considering the interaction between liners and the RRTS. The former tend to serve major hubs that function as transshipment points where smaller vessels pick up cargo to forward to smaller destinations. This relationship is analyzed using the sample of liner routes in the data set, and by introducing an interaction term between liners and the RRTS, $Liner_{ij} \times RRTS_{ij,t} = RLineOD_{ij,t}$.

$RLineOD_{ij,t}$ is equal to one if a liner pair has an RRTS connection in both origin and destination. Liner routes are defined based on Austria (2002) and are time-invariant. In an estimation with pair fixed effects, the effect captured by $RLine_{ij,t}$ comes from the variation in timing when RRTS service in both ends of the liner route comes on. The analysis is performed at the city and municipal level since municipalities can have multiple ports that specialize in handling different types of vessels or cargoes. The complementary relationship between RRTS and liner routes is also treated as non-product-specific to reflect the practice in consignment consolidation.

The results are summarized in Table 10. In column (1), RRTS is shown to strongly complement liner trade with those that are serviced by RRTS in both origin and destination trading 55% more compared to liner port-pairs without RRTS. In column (2), the specification also distinguishes among liner routes that have RRTS connections only in their origin, $RLineO_{ij,t}$, and those that have them only in the destination city, $RLineD_{ij,t}$. Liner routes that have RRTS in their origin trade 32% more compared to those that do not have RRTS connection in either origin or destination. Columns (3) and (4) examine the possibility that volume may matter more in terms of the hub and spoke network structure of shipping routes. The results are of similar direction to the value estimates albeit with smaller coefficients.

By promoting trade among smaller ports, the RRTS facilitates the consolidation of cargoes, which can alleviate imbalance in liner routes. Imbalance between partners is defined as $\frac{|X_{ij,t}-X_{ji,t}|}{X_{ij,t}+X_{ji,t}}$. This takes the place of $X^k_{ij,t}$ in equation 2 with values closer to zero implying better balanced trade.[13]

The results in the lower panel of Table 10 suggest that the RRTS did not have significant impacts on liner trade imbalance. There is a suggestion of imbalance attenuation of about 13.8% in terms of volume when liner destinations are served by RRTS, albeit only marginally significant.

The combined results in Table 10 make up a consistent cargo consolidation story. Exporter cities with both liner and RRTS services are able to

[13] Zero flows are excluded from this set of analyses as a bi-directional zero flow will appear as balanced trade. This accounts for the difference in the number of observations between the top and bottom panel results.

Table 10: Interaction between liner and RRTS routes

Dependent variables: Value and volume of trade				
	Value	Value	Volume	Volume
	(1)	(2)	(3)	(4)
Liner O-D RRTS	0.437***	0.551***	0.386***	0.426*
	(0.105)	(0.190)	(0.111)	(0.233)
Liner O-RRTS		0.278*		0.193
		(0.167)		(0.181)
Liner D-RRTS		0.0260		-0.0274
		(0.152)		(0.234)
Observations	1,140	1,140	1,140	1,140
Dependent variables: Trade Imbalance in Value and Volume				
	Value	Value	Volume	Volume
	(1)	(2)	(3)	(4)
RLine O-D	0.0714	0.0499	0.0386	-0.0989
	(0.0511)	(0.0980)	(0.0513)	(0.102)
RLine O		-0.0225		-0.141
		(0.105)		(0.0913)
RLIne D		-0.0227		-0.149*
		(0.101)		(0.0905)
Obs.	1,130	1,130	1,130	1,130
Product-Year FE	No	No	No	No

All regressions include port-pair and year fixed effects.
Robust standard errors in parentheses clustered at city level.
*** p<0.01, ** p<0.05, * p<0.1

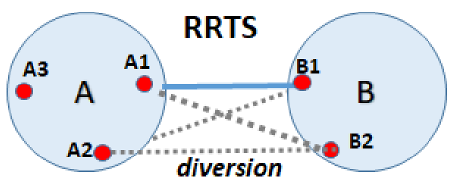
consolidate cargoes and therefore export more. On the other hand, routes where destinations have RRTS means that ships are less likely to be on ballast voyages – return voyages without cargoes – when destination cities have RRTS access. Admittedly, however, the imbalance reducing effects are not significantly realized in bilateral RRTS connection. As such, the results from this exercise are taken as suggestive. A thorough unpacking of the network relationships in shipping route is a subject of further study.

Trade displacement

Trade displacement describes a situation when the increase in trading activities in RRTS port-pairs arises from substitution away from ports that are not linked by the RRTS. This is illustrated in Figure 11. Suppose ports A1 and B1 become connected by RRTS, pairs A1-B2, and A2-B1 are identified as ports that are most likely to experience trade displacement, and are categorized with a dummy variable $TD_{ij,t} = 1$. Ports such as A3 that are unlikely to trade with ports in city B because of geographical location are excluded from the TD definition to ensure that they do not tend $TD_{ij,t}$ the coefficient toward zero.

Columns (1) and (2) of Table 11 show that the contemporaneous and $t + 1$ $TD_{ij,t}$ indicators are individually and jointly insignificant, confirming that the positive RRTS effects uncovered in previous analyses do not stem from mere substitution away from non-RRTS ports. This is consistent with

Figure 11: Defining trade displacement



Source: Author

Table 11: RRTS, trade displacement, and market access spillovers

Dependent variable: Value of trade				
	Trade displacement		Market access	
	(1)	(2)	(3)	(4)
RRTS	0.531***	0.317***	0.614***	0.386**
	(0.110)	(0.115)	(0.134)	(0.150)
Trade diversion	0.0491	0.535		
	0.300	(0.581)		
Trade diversion (t+1)		0.0649		
		(0.291)		
Market access			0.1593	0.103
			(0.100)	(0.0989)
Market access (t+1)				-0.0350
				(0.0705)
Observations	2,052,195	2,052,195	2,052,195	2,052,195

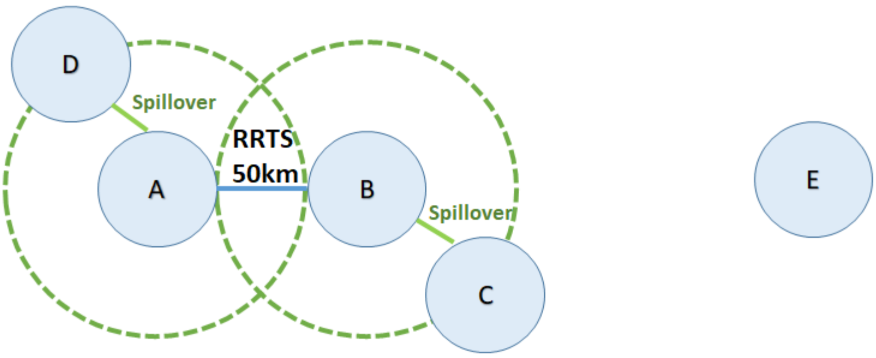
Regressions include port-pair and product-year FEs.
Robust standard errors clustered at city pairs
*** p0.01, ** p0.05, * p0.1

earlier findings on the extensive margin in terms of exporting to new non-RRTS destinations. Rather than displacing trade, RRTS promotes expansion to new markets.

Market access potential

Trade between an RRTS pair can generate activities in nearby areas because of increased demand within the linked pairs. A market access potential spillover indicator, $MA_{ij,t} = 1$, is assigned for cities that are not directly linked by RRTS but are at least as proximate to an RRTS-linked partner. For example, if cities A and B are linked by RRTS and are 50 kilometers apart, cities within the 50 kilometer radius of city A and city B are thought to potentially benefit from the A-B connection. In Figure 12, the 50 kilometer radius is represented by the dashed circle surrounding A and B. Following this, MA_{BC},and MA_{AD} are equal to one when A-B becomes RRTS-linked. Meanwhile, city E is assumed to be too distant to be affected by market access effects of the RRTS connection between A and B. The analysis is performed at the municipal level to differentiate from the port level analysis for

Figure 12: Defining market access spillovers



Source: Author

identifying trade displacement.

The results in columns (3) and (4) of Table 11 show that RRTS did not have significant contemporaneous or $t + 1$ market access spillovers to neighboring cities.

5 Conclusion

I analyze the trade cost reducing features of the RRTS, a transport program in the Philippines, and relate these to observed patterns of trade. The RRTS promotes the use of RORO ships in inter-island trade, which features a seamless interface between land and sea transport by dispensing with the need for cargo-handling.

Results show that RRTS is associated with greater trade flows, with connected port-pairs trading 35% more than similar unconnected pairs. These gains do not come from displacing trade from nearby ports.

Trade gains are observed along both the intensive and extensive margins. However, increases in the intensive margin are limited to 30% of the product groups. The extensive margin proves to be a stronger and more robust avenue of trade gains. RRTS pairs trade 36.6% more types of products than their unconnected counterparts. Moreover, all product groups exhibit greater trade variety with RRTS ranging from 26% for fats and oils to 51%

for machinery. RRTS is also associated with a one percentage point increase in the probability of exporting to new non-RRTS destinations. These findings strongly suggest the importance of fixed cost as an avenue of trade costs adjustment from the RRTS. The higher frequency of trade associated with RRTS further confirms this, and points to inventory management as a way of reducing trade costs.

The time savings from the RRTS is should greatly benefit perishable products. Along RRTS routes, trade in time-sensitive goods have 18% more product variety, have 1.2 percentage points greater chances of being exported to a new non-RRTS market, and are transacted 12% more frequently. These outcomes are in line with the goal of the RRTS of enhancing market access for agricultural products.

Lane meter charging dictates that higher value products would benefit more from the RRTS. The highest value products have 3.4 percentage points more product types, 0.6 percentage points higher probability of being exported to a new non-RRTS market, and are traded 12% more frequently along the RRTS than products in the lowest quartile of the value distribution.

Outside of directly connected ports, the RRTS plays a role in carrying feeder traffic for liner operations. Liner routes that have access to RRTS services in origin and destination have trade values that are 55% larger compared to routes without access in both ends of the journey. However, this fails to translate to a significant attenuation of trade imbalance in liner routes.

This work provides insights into how the RRTS affected trade flows, the types of product that benefit the most from the RRTS, and the mechanisms through which these gains are mediated. These form the foundations for understanding the welfare distribution implications of the RRTS. This study contributes to the literature that highlights the importance of trade costs in influencing regional development. Notwithstanding its domestic setting, the implications can inform policies in other archipelagic countries, or small island economies that face similar connectivity challenges to those in the Philippines.

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Appendices

Table A-1: RRTS and the volume of trade

Dependent variable: Volume of trade	(1)	(2)	(3)	(4)
RRTS	0.395**	0.644**	0.266**	0.313
	(0.170)	(0.317)	(0.116)	(0.215)
RRTS x short		-0.265		-0.051
		(0.297)		(0.234)
Log distance	-0.243***	-0.245***		
	(0.0421)	(0.0424)		
Language	-0.507**	-0.509**		
	(0.204)	(0.204)		
Liner	0.903***	0.909***		
	(0.214)	(0.215)		
Observations	2,052,195	2,052,195	2,052,195	2,052,195
Origin-year FE	Yes	Yes	No	No
Dest-year FE	Yes	Yes	No	No
Product-year FE	Yes	Yes	Yes	Yes
Port-pair FE	No	No	Yes	Yes

Robust standard errors in parentheses clustered at city pairs.
*** p<0.01, ** p<0.05, * p<0.1

Table A-2: RRTS effect on trade value by product group

Dependent variable: Value of trade							
	Port-pair FE			**Gravity covariates**			Obs.
Product Group	RRTS	RRTS	RRTSxSH	RRTS	RRTS	RRTSxSH	
Animals	0.932**	-0.798	1.849**	1.673*	1.355	0.477	26,400
	(0.439)	(0.633)	(0.740)	(1.010)	(1.978)	(1.903)	
Bottled Cargo	0.325	0.196	0.129	3.056	-0.548	4.952	71,910
	(0.300)	(0.224)	(0.409)	(2.429)	(2.234)	(3.537)	
Chemicals	0.101	0.283	-0.0866	0.364	0.184	0.350	103,605
	(0.235)	(0.260)	(0.278)	(0.270)	(0.451)	(0.526)	
Consumer Mfg.	0.0539	-0.377	0.444	-0.386	0.00998	-0.299	328,290
	(0.124)	(0.305)	(0.320)	(0.410)	(0.575)	(0.565)	
Fats & Oils	-0.699	-0.619**	0.0375	0.504	-0.191	0.472	21,390
	(0.575)	(0.261)	(0.618)	(0.549)	(0.690)	(1.016)	
Feeds	0.564***	0.722	-0.172	9.765***	5.020**	4.982*	34,140
	(0.146)	(0.482)	(0.484)	(1.893)	(1.993)	(2.818)	
Fertilizer	0.127	-0.117	0.300	2.648**	0.266	2.969**	20,520
	(0.385)	(0.295)	(0.415)	(1.059)	(0.531)	(1.397)	
Fisheries	0.167	-0.254	0.631*	1.125*	2.117	-1.631	55,050
	(0.301)	(0.324)	(0.365)	(0.681)	(1.436)	(1.685)	
Food Prep.	0.196	0.112	0.0721	0.456	-1.001	2.865	128,550
	(0.203)	(0.413)	(0.456)	(1.824)	(2.094)	(3.100)	
Fruits & Veg.	0.488**	-0.502***	1.149***	0.451	0.129	0.382	106,755
	(0.221)	(0.189)	(0.221)	(0.421)	(0.704)	(0.937)	
Furniture	0.692***	0.633**	0.0651	0.0791	0.0690	0.260	38,295
	(0.203)	(0.254)	(0.316)	(0.647)	(0.605)	(0.633)	
Grains	0.163	0.331*	-0.210	7.991***	5.109	2.261	59,145
	(0.155)	(0.169)	(0.190)	(2.951)	(4.115)	(4.395)	
Industry Mfg.	0.441**	0.354	0.0903	1.737	0.979	1.049	164,625
	(0.187)	(0.272)	(0.303)	(1.501)	(0.740)	(1.691)	
Machinery	0.475**	0.437	-0.120	2.985	0.730	2.957	288,210
	(0.205)	(0.326)	(0.361)	(2.057)	(0.692)	(2.152)	
Meat & Dairy	0.203	-0.610	0.851	-0.977	-3.128	3.130	62,565
	(0.187)	(0.854)	(0.869)	(1.097)	(2.658)	(2.591)	
Paper & Pulp	0.816***	0.405	0.453	-0.266	0.0776	-0.259	100,200
	(0.178)	(0.316)	(0.331)	(0.430)	(0.439)	(0.450)	
Pharmac.	-0.220	-0.258	0.0709	-1.787**	-1.655	0.540	34,065
	(0.309)	(0.468)	(0.558)	(0.780)	(1.219)	(1.182)	
Textile Products	-0.150	0.0270	-0.194	-0.497	-0.0715	-0.302	144,060
	(0.166)	(0.313)	(0.334)	(0.363)	(0.523)	(0.559)	
Tobacco & Mfg.	-0.191	-0.550**	0.425	-1.809**	-1.477	-0.0818	53,160
	(0.271)	(0.276)	(0.399)	(0.716)	(1.656)	(1.732)	
Transport & Eqpt.	0.427**	0.284	0.144	6.527***	-2.568	9.717	153,570
	(0.212)	(0.304)	(0.372)	(2.319)	(5.431)	(6.058)	
Wood & Products	0.00913	-0.0874	0.103	1.438***	3.509*	-2.217	57,690
	(0.199)	(0.165)	(0.259)	(0.508)	(2.125)	(2.428)	
Origin-year FE	No	No	No	Yes	Yes	Yes	
Dest-year FE	No	No	No	Yes	Yes	Yes	
Product-year FE	Yes	Yes	Yes	Yes	Yes	Yes	
Port-pair FE	Yes	Yes	Yes	No	No	No	

Estimator: Poisson QMLE.
Robust standard errors in parentheses clustered at city pairs.
*** p<0.01, ** p<0.05, * p<0.1

Table A-3: RRTS effect on intensive trade value by product group

Dependent variable: Value of trade							
	Port-pair FE			**Gravity covariates**			Obs.
Product Group	RRTS	RRTS	RRTSxSH	RRTS	RRTS	RRTSxSH	
Animals	0.827*	-0.876	1.828**	1.999*	1.560	0.671	24,480
	(0.467)	(0.636)	(0.763)	(1.121)	(2.173)	(2.069)	
Bottled Cargo	-0.0236	0.118	-0.149	0.871	-0.430	2.059	67,380
	(0.212)	(0.202)	(0.281)	(1.236)	(2.278)	(2.491)	
Chemicals	0.102	0.00958	0.103	0.777**	0.109	0.877	92,505
	(0.181)	(0.146)	(0.167)	(0.338)	(0.564)	(0.657)	
Consumer Mfg.	-0.0673	-0.472	0.445	-0.358	0.0980	-0.393	302,610
	(0.114)	(0.291)	(0.301)	(0.500)	(0.658)	(0.653)	
Fats & Oils	-1.412***	-0.767***	-0.747	0.123	-0.104	-0.120	19,665
	(0.469)	(0.262)	(0.508)	(0.484)	(0.777)	(1.014)	
Feeds	0.553***	0.695	-0.154	14.97***	8.382**	7.030	31,845
	(0.146)	(0.477)	(0.479)	(2.746)	(3.794)	(4.790)	
Fertilizer	-0.136	-0.347	0.224	3.156**	0.896	2.663*	18,525
	(0.295)	(0.230)	(0.238)	(1.240)	(0.732)	(1.465)	
Fisheries	0.123	-0.227	0.449	1.495*	2.604*	-1.862	51,150
	(0.316)	(0.340)	(0.385)	(0.781)	(1.484)	(1.682)	
Food Prep.	-0.0491	-0.478*	0.465	1.374	-1.686	4.634	121,140
	(0.163)	(0.262)	(0.298)	(2.188)	(2.360)	(3.512)	
Fruits & Veg.	0.443*	-0.573***	1.179***	0.583	0.180	0.464	98,100
	(0.246)	(0.147)	(0.205)	(0.494)	(0.775)	(1.066)	
Furniture	0.564***	0.379*	0.202	0.146	0.0714	0.337	35,745
	(0.174)	(0.194)	(0.254)	(0.764)	(0.751)	(0.761)	
Grains	0.0627	0.285**	-0.234	9.732***	5.443	3.681	56,295
	(0.134)	(0.131)	(0.149)	(3.514)	(4.398)	(4.786)	
Industry Mfg.	0.418*	0.274	0.157	2.626	1.288	1.701	152,655
	(0.222)	(0.265)	(0.306)	(2.086)	(0.892)	(2.354)	
Machinery	0.149	0.258	-0.120	4.913	0.997	5.066	261,840
	(0.202)	(0.238)	(0.264)	(4.329)	(1.097)	(4.588)	
Meat & Dairy	0.0833	-0.691	0.832	-0.828	-3.871	4.093	56,535
	(0.169)	(0.846)	(0.856)	(1.419)	(3.250)	(3.108)	
Paper & Pulp	0.782***	0.240	0.594*	-0.0950	0.118	-0.131	91,935
	(0.156)	(0.294)	(0.309)	(0.517)	(0.525)	(0.546)	
Pharmac.	-0.264	-0.419	0.163	-1.518	-0.589	-0.307	29,715
	(0.307)	(0.356)	(0.466)	(0.931)	(1.459)	(1.502)	
Textile Products	-0.196	-0.0827	-0.120	-0.363	0.0466	-0.310	132,705
	(0.144)	(0.201)	(0.235)	(0.434)	(0.611)	(0.665)	
Tobacco & Mfg.	-0.194	-0.629**	0.488	-2.046**	-1.882	0.0425	48,825
	(0.276)	(0.281)	(0.403)	(0.849)	(1.935)	(2.021)	
Transport & Eqpt.	0.210	0.233	-0.0236	9.830***	-1.857	12.76*	142,245
	(0.206)	(0.275)	(0.348)	(2.779)	(6.065)	(7.015)	
Wood & Products	-0.0256	-0.0913	0.0884	2.412***	4.418*	-2.211	53,835
	(0.190)	(0.163)	(0.256)	(0.659)	(2.378)	(2.754)	
Origin-year FE	No	No	No	Yes	Yes	Yes	
Dest-year FE	No	No	No	Yes	Yes	Yes	
Product-year FE	Yes	Yes	Yes	Yes	Yes	Yes	
Port-pair FE	Yes	Yes	Yes	No	No	No	

Estimator: Poisson QMLE.
Robust standard errors in parentheses clustered at city pairs.
*** p<0.01, ** p<0.05, * p<0.1

Table A-4: RRTS effect on product diversity by product group

Dependent variable: Product count by sector							
	Port-pair FE			**Gravity covariates**			Obs.
Product Group	RRTS	RRTS	RRTSxSH	RRTS	RRTS	RRTSxSH	
Animals	0.355***	0.113	0.262	1.217***	1.500***	-0.0738	8,880
	(0.0787)	(0.235)	(0.236)	(0.111)	(0.359)	(0.375)	
Bottled Cargo	0.313***	0.754	-0.470	1.298***	1.710***	-0.221	13,845
	(0.0698)	(0.640)	(0.643)	(0.149)	(0.382)	(0.406)	
Chemicals	0.378***	0.666***	-0.310	1.468***	2.205***	-0.562	11,685
	(0.0677)	(0.229)	(0.232)	(0.199)	(0.384)	(0.439)	
Consumer Mfg.	0.385***	0.610	-0.242	1.573***	2.195***	-0.527	18,135
	(0.0673)	(0.434)	(0.437)	(0.237)	(0.360)	(0.410)	
Fats & Oils	0.230***	0.0717	0.173	0.368*	0.966**	-0.364	8,760
	(0.0748)	(0.230)	(0.235)	(0.201)	(0.405)	(0.439)	
Feeds	0.346***	0.494	-0.160	1.242***	1.716***	-0.268	14,505
	(0.0670)	(0.314)	(0.318)	(0.109)	(0.405)	(0.416)	
Fertilizer	0.279***	0.505	-0.246	0.898***	1.579***	-0.487	9,075
	(0.0749)	(0.312)	(0.314)	(0.163)	(0.368)	(0.394)	
Fisheries	0.300***	0.221	0.0868	1.241***	1.457***	-0.161	10,980
	(0.0653)	(0.285)	(0.290)	(0.136)	(0.311)	(0.310)	
Food Prep.	0.283***	0.615	-0.354	1.701***	1.995***	-0.186	23,715
	(0.0652)	(0.615)	(0.618)	(0.130)	(0.430)	(0.446)	
Fruits & Veg.	0.391***	0.666	-0.297	1.547***	2.480***	-0.894**	12,495
	(0.0715)	(0.585)	(0.589)	(0.148)	(0.381)	(0.404)	
Furniture	0.287***	0.293	-0.00676	0.878***	1.384***	-0.329	8,520
	(0.0704)	(0.274)	(0.278)	(0.159)	(0.363)	(0.380)	
Grains	0.289***	0.384	-0.102	1.484***	1.718***	-0.0535	19,740
	(0.0564)	(0.319)	(0.322)	(0.116)	(0.341)	(0.361)	
Industry Mfg.	0.337***	0.233	0.111	1.372***	1.582***	-0.000238	16,755
	(0.0649)	(0.435)	(0.438)	(0.154)	(0.442)	(0.458)	
Machinery	0.409***	0.451*	-0.0462	1.450***	2.593***	-1.007***	14,640
	(0.0785)	(0.259)	(0.266)	(0.172)	(0.281)	(0.318)	
Meat & Dairy	0.314***	0.740	-0.452	1.199***	2.128***	-0.885**	10,005
	(0.0694)	(0.535)	(0.537)	(0.176)	(0.399)	(0.418)	
Paper & Pulp	0.388***	0.605	-0.232	1.259***	1.849***	-0.397	10,665
	(0.0670)	(0.462)	(0.465)	(0.167)	(0.437)	(0.459)	
Pharmac.	0.397***	0.216	0.195	1.166***	1.571***	-0.311	7,260
	(0.0737)	(0.233)	(0.238)	(0.194)	(0.492)	(0.514)	
Textile Products	0.376***	0.510*	-0.143	1.055***	-0.693***	-0.440	10,995
	(0.0707)	(0.273)	(0.275)	(0.188)	(0.433)	(0.450)	
Tobacco & Mfg.	0.312***	0.278	0.0380	1.146***	1.600***	-0.269	9,525
	(0.0688)	(0.266)	(0.271)	(0.130)	(0.427)	(0.439)	
Transport & Eqpt.	0.346***	0.492	-0.157	7.085***	5.998***	1.101	17,610
	(0.0588)	(0.444)	(0.447)	(0.195)	(0.685)	(0.714)	
Wood & Products	0.277***	0.270	0.00707	1.245***	1.571***	-0.246	13,755
	(0.0680)	(0.533)	(0.536)	(0.117)	(0.244)	(0.267)	
Origin-year FE	No	No	No	Yes	Yes	Yes	
Dest-year FE	No	No	No	Yes	Yes	Yes	
Product-year FE	Yes	Yes	Yes	Yes	Yes	Yes	
Port-pair FE	Yes	Yes	Yes	No	No	No	

Estimator: Poisson QMLE
Robust standard errors in parentheses clustered at city pairs
*** p<0.01, ** p<0.05, * p<0.1

Table A-5: RRTS effect on probability of new export markets by product group

Dependent variable: Exporting to new non-RRTS destinations, 1 or 0							
	Port-pair FE			**Gravity covariates**			Obs.
Product group	RRTS	RRTS	RRTSxSH	RRTS	RRTS	RRTSxSH	
Animals	-0.007	-0.014	0.008	0.003*	0.003	-0.002	26,400
	(0.008)	(0.013)	(0.015)	(0.0016)	(0.0025)	(0.0034)	
Bottled Cargo	0.010	0.004	0.007	0.0009	0.0024	-0.0029	71,910
	(0.006)	(0.013)	(0.014)	(0.001)	(0.0034)	(0.004)	
Chemicals	-0.0036	-2.79e-05	-0.004	-0.001	-0.0008	0.0016	103,605
	(0.0046)	(0.0130)	(0.0134)	(0.0014)	(0.0038)	(0.00418)	
Consumer Mfg.	0.024***	0.024***	-0.00039	0.0016	0.002	-0.0008	328,290
	(0.0051)	(0.0081)	(0.008)	(0.001)	(0.0021)	(0.0024)	
Fats & Oils	-0.004	0.0036	-0.0088	-0.012***	-0.0088	-0.0035	21,390
	(0.008)	(0.019)	(0.021)	(0.0030)	(0.0071)	(0.0080)	
Feeds	0.0091	0.0048	0.0051	-0.003*	-0.0031	0.0005	34,140
	(0.0084)	(0.028)	(0.029)	(0.0018)	(0.0043)	(0.0048)	
Fertilizer	-0.0037	0.047**	-0.058**	-0.00079	0.0031	-0.0049	20,520
	(0.012)	(0.023)	(0.026)	(0.0021)	(0.0071)	(0.007)	
Fisheries	0.0176**	0.0135	0.0046	0.001	0.001	-0.0015	55,050
	(0.0081)	(0.0099)	(0.012)	(0.0011)	(0.0019)	(0.00266)	
Food Prep.	0.0045	0.0099	-0.006	-0.004***	-0.004	-0.0001	128,550
	(0.0068)	(0.0082)	(0.010)	(0.001)	(0.003)	(0.0032)	
Fruits & Veg.	0.011	0.019	-0.0088	-0.0011	0.001	-0.0043*	106,755
	(0.0073)	(0.014)	(0.015)	(0.0011)	(0.0017)	(0.0024)	
Furniture	-0.016***	-0.013	-0.0039	0.0006	0.005	-0.0065*	38,295
	(0.006)	(0.019)	(0.020)	(0.0015)	(0.0034)	(0.0038)	
Grains	-0.0075	-0.013	0.0059	-0.002	0.00034	-0.0024	59,145
	(0.0072)	(0.018)	(0.019)	(0.0013)	(0.0019)	(0.0025)	
Industry Mfg.	0.016**	0.017*	-0.0014	-0.0017*	0.0018	-0.005**	164,625
	(0.0069)	(0.0087)	(0.011)	(0.00095)	(0.0017)	(0.0021)	
Machinery	0.025***	0.018***	0.0077	0.0022*	0.0016	-0.00065	288,210
	(0.0052)	(0.005)	(0.0067)	(0.0012)	(0.0023)	(0.0027)	
Meat & Dairy	0.0014	0.023	-0.024	-0.0033**	-0.0028	-0.00078	62,565
	(0.0077)	(0.016)	(0.017)	(0.0014)	(0.0035)	(0.0039)	
Paper & Pulp	0.013**	0.0073	0.0069	-0.0008	-0.0043**	0.004*	100,200
	(0.0062)	(0.0085)	(0.010)	(0.00083)	(0.0017)	(0.0021)	
Pharmac.	-0.0217***	-0.005	-0.019	-0.0012	-0.005	0.0015	34,065
	(0.0065)	(0.021)	(0.022)	(0.0018)	(0.0036)	(0.0043)	
Textile Products	0.033***	0.022***	0.012	-0.0017	-0.0026	0.0012	144,060
	(0.0058)	(0.0074)	(0.0081)	(0.0011)	(0.0023)	(0.0026)	
Tobacco & Mfg.	0.014**	-0.0022	0.018	0.0009	-0.0019	0.0045	53,160
	(0.0053)	(0.011)	(0.012)	(0.0012)	(0.0028)	(0.0035)	
Transport & Eqpt.	0.017*	0.0048	0.011	0.00058	0.0015	-0.0021	153,570
	(0.009)	(0.008)	(0.0094)	(0.001)	(0.002)	(0.0023)	
Wood & Products	0.022***	0.0067	0.018	0.0045*	0.0099	-0.0071	57,690
	(0.007)	(0.015)	(0.016)	(0.0023)	(0.008)	(0.0084)	
Origin-year FE	No	No	No	Yes	Yes	Yes	
Dest-year FE	No	No	No	Yes	Yes	Yes	
Product-year FE	Yes	Yes	Yes	Yes	Yes	Yes	
Port-pair FE	Yes	Yes	Yes	No	No	No	

Estimator: OLS - Linear probability model.
Robust standard errors in parentheses clustered at city pairs.
*** p<0.01, ** p<0.05, * p<0.1

Table A-6: RRTS and lumpiness, by product group with port-pair fixed effects

Dep var Product group/	log value (1)	log freq. (2)	log A.Val. (3)	log. A. Quant (4)	log A. Price (5)	log value (6)	log freq. (7)	log A.Val. (8)	log. A. Quant (9)	log A. Price (10)	Obs
Animals											
RRTS	-0.171	0.059	-0.227*	-0.157	-0.0718	-0.540	-0.256	-0.288	-0.339	0.0710	7,065
	(0.157)	(0.0563)	(0.125)	(0.123)	(0.0731)	(0.638)	(0.162)	(0.504)	(0.462)	(0.118)	
RRTS x Short						0.410	0.349**	0.0682	0.203	-0.159	
						(0.648)	(0.166)	(0.513)	(0.477)	(0.122)	
Bottled Cargoes											
RRTS	0.149	0.078	0.065	-0.001	0.0657*	0.193	0.093	0.096	0.056	0.043	21,574
	(0.120)	(0.0490)	(0.0905)	(0.0804)	(0.0371)	(0.138)	(0.0678)	(0.129)	(0.125)	(0.0459)	
RRTS x Short						-0.0486	-0.0172	-0.0346	-0.0629	0.0252	
						(0.178)	(0.0815)	(0.151)	(0.148)	(0.0472)	
Chemicals											
RRTS	0.044	0.066**	-0.037	-0.115	0.081**	0.089	0.050	0.028	0.059	-0.024	24,313
	(0.0967)	(0.0300)	(0.0848)	(0.0829)	(0.0352)	(0.184)	(0.0700)	(0.126)	(0.0958)	(0.0698)	
RRTS x Short						-0.049	0.018	-0.070	-0.189**	0.114	
						(0.183)	(0.0715)	(0.121)	(0.0910)	(0.0711)	
Consumer Manufactures											
RRTS	0.004	0.0689*	-0.079	-0.001	-0.075**	-0.301	-0.128**	-0.182	-0.083	-0.099	89,017
	(0.0853)	(0.0360)	(0.0657)	(0.0620)	(0.0339)	(0.211)	(0.0606)	(0.179)	(0.131)	(0.0671)	
RRTS x Short						0.338	0.218***	0.115	0.091	0.026	
						(0.221)	(0.0670)	(0.183)	(0.138)	(0.0710)	
Fats & Oils											
RRTS	-0.190	0.003	-0.183	-0.326**	0.143**	-0.794	-0.024	-0.767**	-0.810**	0.046	4,512
	(0.184)	(0.0520)	(0.167)	(0.158)	(0.0685)	(0.496)	(0.168)	(0.359)	(0.398)	(0.156)	
RRTS x Short						0.695	0.031	0.673*	0.557	0.112	
						(0.524)	(0.176)	(0.390)	(0.421)	(0.166)	
Feeds											
RRTS	0.167	0.037	0.121	0.105	0.020	0.658**	0.156	0.489**	0.455*	0.045	9,420
	(0.111)	(0.0465)	(0.0790)	(0.0825)	(0.0320)	(0.289)	(0.137)	(0.211)	(0.251)	(0.0794)	
RRTS x Short						-0.545*	-0.132	-0.409*	-0.388	-0.028	
						(0.293)	(0.141)	(0.214)	(0.253)	(0.0829)	
Fertilizer											
RRTS	0.100	-0.014	0.104	-0.046	0.162***	-0.475	-0.175*	-0.328	-0.429*	0.139	4,599
	(0.179)	(0.0680)	(0.141)	(0.139)	(0.0569)	(0.296)	(0.102)	(0.283)	(0.227)	(0.154)	
RRTS x Short						0.636**	0.178	0.478	0.424*	0.026	
						(0.318)	(0.117)	(0.294)	(0.243)	(0.155)	
Fisheries											
RRTS	0.084	0.068	0.011	0.023	-0.013	-0.763**	-0.157	-0.607**	-0.354	-0.256	14,965
	(0.123)	(0.0466)	(0.0962)	(0.0832)	(0.0569)	(0.349)	(0.106)	(0.257)	(0.262)	(0.228)	
RRTS x Short						0.962***	0.256**	0.703***	0.428	0.277	
						(0.346)	(0.112)	(0.253)	(0.264)	(0.234)	

Robust standard errors in parentheses clustered at city-pairs
*** p<0.01, ** p<0.05, * p<0.1

Dep var Product group/	log value (1)	log freq. (2)	log A.Val. (3)	log. A. Quant (4)	log A. Price (5)	log value (6)	log freq. (7)	log A.Val. (8)	log. A. Quant (9)	log A. Price (10)	Obs
Food Preparations											
RRTS	0.250***	0.139***	0.102	0.044	0.057	0.081	0.052	0.030	0.068	-0.039	34,050
	(0.0954)	(0.0375)	(0.0733)	(0.0743)	(0.0348)	(0.255)	(0.114)	(0.163)	(0.148)	(0.0565)	
RRTS x Short						0.184	0.0959	0.0786	-0.0261	0.105*	
						(0.269)	(0.119)	(0.171)	(0.161)	(0.0589)	
Fruits & Vegetables											
RRTS	0.137*	0.102***	0.0280	0.0575	-0.0276	-0.474**	-0.125***	-0.347*	-0.285*	-0.0622	35,697
	(0.0821)	(0.0357)	(0.0674)	(0.0612)	(0.0303)	(0.199)	(0.0471)	(0.178)	(0.170)	(0.0512)	
RRTS x Short						0.682***	0.253***	0.418**	0.382**	0.0386	
						(0.205)	(0.0544)	(0.180)	(0.172)	(0.0541)	
Furniture											
RRTS	0.158	0.122**	0.0289	0.212**	-0.185***	-0.369	-0.070	-0.307	0.012	-0.325*	11,815
	(0.119)	(0.0491)	(0.0866)	(0.0990)	(0.0675)	(0.424)	(0.105)	(0.321)	(0.371)	(0.171)	
RRTS x Short						0.585	0.214*	0.373	0.221	0.156	
						(0.435)	(0.112)	(0.328)	(0.384)	(0.181)	
Grains											
RRTS	0.100	0.022	0.073	0.020	0.054	-0.019	-0.088	0.061	0.059	-0.005	17,033
	(0.106)	(0.0377)	(0.0829)	(0.0726)	(0.0341)	(0.298)	(0.132)	(0.182)	(0.192)	(0.0943)	
RRTS x Short						0.134	0.123	0.0132	-0.0434	0.0661	
						(0.311)	(0.135)	(0.193)	(0.202)	(0.0964)	
Industrial Manufactures											
RRTS	0.168*	0.0975**	0.0571	0.131*	-0.072*	-0.116	-0.0481	-0.076	0.191	-0.265***	44,218
	(0.0990)	(0.0382)	(0.0714)	(0.0704)	(0.0379)	(0.331)	(0.101)	(0.246)	(0.218)	(0.0539)	
RRTS x Short						0.311	0.160	0.145	-0.0656	0.211***	
						(0.347)	(0.107)	(0.255)	(0.227)	(0.0620)	
Machinery & Equipment											
RRTS	-0.0841	0.0400	-0.170***	0.0153	-0.186***	-0.291	-0.048	-0.275*	-0.0631	-0.212***	66,071
	(0.0725)	(0.0279)	(0.0601)	(0.0594)	(0.0433)	(0.208)	(0.0455)	(0.166)	(0.144)	(0.0592)	
RRTS x Short						0.231	0.0976*	0.117	0.087	0.030	
						(0.217)	(0.0499)	(0.170)	(0.151)	(0.0670)	
Meat & Dairy											
RRTS	0.293***	0.122***	0.159*	0.276***	-0.118**	0.001	-0.092	0.084	0.235*	-0.152**	17,123
	(0.107)	(0.0405)	(0.0829)	(0.0761)	(0.0502)	(0.184)	(0.0800)	(0.119)	(0.134)	(0.0665)	
RRTS x Short						0.319	0.233***	0.0817	0.0448	0.0375	
						(0.195)	(0.0842)	(0.128)	(0.146)	(0.0628)	

Robust standard errors in parentheses clustered at city-pairs.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Dep var	log value	log freq.	log A.Val.	log. A. Quant	log A. Price	log value	log freq.	log A.Val.	log. A. Quant	log A. Price	
Product group/	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	Obs
Paper & Pulp Products											
RRTS	0.307***	0.143***	0.153**	0.159**	-0.003	-0.485	-0.101**	-0.391	-0.292	-0.0974	28,345
	(0.0976)	(0.0417)	(0.0773)	(0.0733)	(0.0372)	(0.382)	(0.0464)	(0.357)	(0.235)	(0.152)	
RRTS x Short						0.871**	0.269***	0.598*	0.495**	0.104	
						(0.392)	(0.0578)	(0.362)	(0.237)	(0.157)	
Pharmaceuticals & Medical Equipment											
RRTS	-0.0618	0.140***	-0.215*	-0.0474	-0.162**	-0.749***	-0.130	-0.629***	-0.0907	-0.536***	8,461
	(0.143)	(0.0490)	(0.118)	(0.109)	(0.0658)	(0.280)	(0.145)	(0.183)	(0.176)	(0.129)	
RRTS x Short						0.753***	0.295*	0.453**	0.0473	0.409***	
						(0.283)	(0.151)	(0.177)	(0.180)	(0.134)	
Textile & Textile Products											
RRTS	-0.103	0.055	-0.175**	-0.053	-0.121***	-0.406**	-0.065	-0.354*	-0.280**	-0.074	35,332
	(0.102)	(0.0449)	(0.0759)	(0.0719)	(0.0420)	(0.195)	(0.0668)	(0.197)	(0.120)	(0.0961)	
RRTS x Short						0.333	0.132*	0.197	0.250**	-0.0522	
						(0.213)	(0.0792)	(0.202)	(0.126)	(0.102)	
Tobacco & Manufacturing											
RRTS	0.200**	0.103***	0.0906	0.128*	-0.0414	-0.119	-0.0465	-0.072	0.132	-0.204	13,612
	(0.102)	(0.0380)	(0.0799)	(0.0767)	(0.0516)	(0.399)	(0.0690)	(0.341)	(0.263)	(0.137)	
RRTS x Short						0.364	0.170**	0.186	-0.00416	0.186	
						(0.411)	(0.0746)	(0.348)	(0.268)	(0.146)	
Transport Equipment											
RRTS	0.261**	0.126***	0.121*	0.218***	-0.102**	-0.0553	-0.0347	-0.0291	0.209*	-0.248*	42,428
	(0.102)	(0.0384)	(0.0715)	(0.0800)	(0.0437)	(0.167)	(0.0908)	(0.107)	(0.119)	(0.134)	
RRTS x Short						0.353*	0.179*	0.168	0.0105	0.163	
						(0.195)	(0.0975)	(0.126)	(0.144)	(0.137)	
Wood & Wood Products											
RRTS	0.137	0.054	0.075	0.077	-0.002	-0.313	-0.107	-0.205	-0.267	0.062	15,402
	(0.115)	(0.0379)	(0.0943)	(0.0927)	(0.0443)	(0.376)	(0.0994)	(0.282)	(0.210)	(0.136)	
RRTS x Short						0.501	0.179*	0.312	0.383*	-0.072	
						(0.393)	(0.104)	(0.294)	(0.225)	(0.142)	

Estimator: OLS.

Robust standard errors in parentheses clustered at city-pairs

*** $p<0.01$, ** $p<0.05$, * $p<0.1$