Trade Implications of Transport Cost in the Philippines

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Declaration

I hereby declare that this thesis has not been and will not be submitted in whole or in part to another University for the award of any other degree.

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Summary

Trade costs play an important role in economic development. This is easily appreciated in the case of the Philippines, an archipelago of over 7000 islands that faces serious connectivity challenges. The Roll-on Roll-off (RORO) Terminal System (RRTS) introduced in 2003 presents an opportunity to study the effects of a transport system on trade costs, and how these in turn influence patterns of trade and pricing behavior. The design of the RRTS and its context are described in Chapter 2, which also outlines the process of building the historical data set on RRTS services by route. This data set is key to the empirical analyses in the subsequent chapters.

Chapter 3 estimates trade costs using province border effects, and examines how the RRTS affected them and their distribution. Results suggest that border effects are lower by a factor of 0.65 with the RRTS. However, this reduction is unevenly distributed, and limited to provinces that are near Metro Manila, the capital and the biggest demand center in the Philippines.

Chapter 4, which investigates the effect of the RRTS on trade patterns show that RRTS port-pairs trade 35% more compared to unconnected pairs with comparable characteristics. This gain comes from the intensive margins and more consistently through the extensive margins. Trade transactions are 7% to 9% more frequent in RRTS routes, suggestive of inventory management as an avenue of trade costs savings. High value and time-sensitive products systematically benefit more from the RRTS. These RRTS-associated gains do not come from displacing trade from competing non-RRTS ports. Instead, the RRTS complements trade in liner routes by supporting feeder traffic.

Finally, Chapter 5 uses an origin-destination mapped data set to evaluate how agricultural prices in supplying and destination provinces respond to changes in transport costs from the RRTS. Conditional on distance, price gaps as proportion of farmgate prices are on average 28% smaller in province pairs that have RRTS connection. The gap narrowing effect is driven by higher farm prices without the corresponding rise in consumer prices. During periods of positive price shocks, farmers in RRTS provinces retain a higher share of the rents from price increases, while changes in consumer prices are not significantly different in RRTS provinces compared to unconnected areas. The results are consistent with a reduction in markups from RRTS-induced competition in intermediation and shipping services.

Acknowledgments

Dedication:
To "What is Good, What is True, and What is Beautiful"

I have been interested in the topic of maritime transport costs in the Philippines for a long time. I saw firsthand how it affects local development when I was a civil servant with the Department of Agriculture in the Philippines. That I have the chance to study this topic in depth through a PhD owes much to the generosity of many individuals and institutions.

I am very grateful to my supervisors Ingo Borchert and L. Alan Winters for their attentive and thoughtful guidance. Every aspect of the supervision made it very clear that they are committed to providing me with the best education possible so that I develop the skills, habits, and the discipline to become a competent and independent researcher. Their pedagogy was responsive to my interests, priorities, strengths, and weaknesses. Communication with my supervisors has always been frank and open, and I regularly received timely and substantive feedback on my work. In particular, Ingo, my main supervisor thoughtfully explained what I did well and where I fell short at each stage of the thesis writing, and has been very earnest in turning my mistakes into learning opportunities. As a result, my interactions with him were always treasure troves for learning.

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Chapter 1

Introduction

Trade costs play an important role in economic development. They determine relative prices, and therefore patterns of production and trade. At their broadest, trade costs include all the resources required to get a product from one place to another – transport costs, trade policy, information costs, government procedures, contract enforcement, and marketing costs (Anderson and Van Wincoop, 2004). Obstfeld and Rogoff (2001) propose that all the major economic puzzles of international macroeconomics can be understood through the lens of trade costs.

Policy-induced trade costs such as tariffs and non tariff barriers alone are estimated to cost ten percent of national incomes. These have come down considerably over various rounds of multilateral and regional trade negotiations. Nonetheless, other trade costs remain high and even more binding, especially those that come from domestic infrastructure and institutions (Anderson and Van Wincoop, 2004).

Trade costs in domestic economies determine the distribution of surplus and adjustment costs of policies and shocks across regions within a country. And yet, intranational trade costs have received less empirical attention than their international counterparts. The earlier literature mostly assumed trade frictions within countries to be insignificant in the absence of trade barriers and other policy instruments such as exchange rates that hinder movement of goods and services between countries. Only more recently, subnational level data increasingly demonstrate that trade costs can also be substantial within countries even in developed economies such as Canada and the US (Coughlin and Novy, 2013; Agnosteva et al., 2019; Anderson and Yotov, 2010).

Importantly, the distribution of trade costs within a country affects the trajectory of regional development. Studies of rail and road network development demonstrate persisting effects of market access 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).

This thesis studies the effects of changes in trade costs in the Philippines and their subsequent impacts on trade patterns and pricing behavior. The Philippines presents a particularly 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).

It is against this backdrop that the government introduced the Roll on Roll off (RORO) Terminal System (RRTS) in 2003 with the aim of bringing down interisland domestic trade costs. By integrating 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 of 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 requirement 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.

The package of reforms in 2003 encouraged investments in RORO ships and the development of ports equipped for RRTS operations such as RORO berths, terminals, and other infrastructure. Documentary requirements for shipping were simplified and cargoes using the RRTS transport network were freed from burdensome regulations such as cargo handling fees and wharfage dues which previously prevented a broader take up. The details of the program, and the context in which the reforms were introduced are explained in the second chapter of the thesis, where the process of creating the historical RORO services database by route is also described. This database is central to the empirical analyses of the impacts of the RRTS, and forms a key contribution of this work.

The three empirical chapters of this thesis analyze the effects of the RRTS on different aspects of domestic maritime trade from 2000 to 2014. Chapter 3 investigates how the program influenced the evolution and distribution of agricultural trade costs among provinces as measured by border effects. Chapter 4 maps the different trade cost reducing components of the RRTS to patterns of domestic maritime trade. Chapter 5 evaluates the effects of the RRTS on price gaps between supplying and consuming provinces, and assesses impacts of the RRTS on markups of intermediaries and shipping companies. To the best of our knowledge, this thesis represents a first attempt at an empirical evaluation of the trade effects of the RRTS.

1.1 Overland and oversea: Domestic trade frictions in the Philippines

Chapter 3 analyzes the effects of the RRTS on trade costs. We use the gravity model to estimate province border effects in the Philippines, which indicate how much more a province trades with itself than with other provinces. The RRTS-associated changes to these border effects are then mapped across provinces, products, and time.

We focus on 14 agricultural products for which we can retrieve information on production and consumption by province, and match these to domestic maritime trade and international trade data. These pieces of information allow us to derive the volume of intraprovince and interprovince land trade, which are currently not monitored and recorded by the Philippine Statistical Authority (PSA).

Our results suggest that province border effects in the Philippines are substantial. On average, a province trades 28 ($e^{3.33}$) to 53 ($e^{3.97}$) times more with itself than with other provinces. By comparison, a review from Havranek and Irsova (2017) suggests that a developed country trades 1.72 ($e^{0.54}$) to 8.9 ($e^{2.19}$) times more with itself than with other countries, while emerging countries do so by a factor of 24.5 ($e^{3.20}$). Our estimates of domestic border effects are in the upper end. However, this is not entirely surprising in the context of an archipelago and the high minimum efficient scale in the shipping industry. Moreover, studies that bring international and domestic border effects into a unified framework show that it is not uncommon to find domestic border effects that dwarf those of international estimates (Anderson and Yotov, 2010; Coughlin and Novy, 2013; Fally et al., 2010).

Border effects are significant across the fourteen agricultural products ranging from $e^{2.4}$ for mangoes to $e^{5.8}$ for cabbage. To some extent, border effects decline with a product's value to weight ratio. However, other product characteristics also matter such as elasticity of demand, geographical specificity in production, and storage and handling requirements. Border effects also differ widely across the 54 provinces for which estimates could be made, with the largest border effects concentrated in the eastern seaboard of the Philippines where poverty rates are high, and where tropical cyclones that form in the Pacific Ocean usually make their first landfall in the country. The border effects have remained stable through time with point estimates that range from $e^{3.6}$ in 2000 to $e^{3.3}$ in 2014.

On average, RRTS is associated with a reduction of border effects by a factor of 0.65. In terms of products, the sharpest declines are for potatoes and onions, which reduced their border effects to nearly zero. These products exhibit high geographic specificity in production. On the other hand, RRTS does not appear to affect the border effects of products that require more specialized handling such as chicken and pork. The same can be observed for highly perishable products that have relatively small processing industries such as *calamansi* (calamondin or Philippine lime) and tomato. Finally, RRTS-associated border effect reductions are observed for bananas, rice, corn, and more substantially, for pineapple.

Over time, border effect reduction from RRTS is strongest between 2007 to 2011 coinciding with the opening of multiple RRTS routes in the central part of the Philippines. However, an assessment across provinces shows that only a handful of provinces near Metro Manila significantly reduced their border effects in response to the RRTS. Many other provinces did not experience discernible change in their border effects, and provinces that are remote from major sea ports even heightened them. For this latter set of provinces, their own trade to export ratio actually rose compared to others. This can be partly explained by the operational nature of the RRTS, which has the greatest comparative advantage in servicing short distances with high frequency.

1.2 Shipping technology, trade costs, and trade patterns in the Philippines

In chapter 4, we investigate how the RRTS influences patterns of maritime trade in the Philippines. This is typically an exercise beset with endogeneity because ports likely select into RRTS investment in the measure that they foresee benefits in doing so. We address endogeneity by controlling for time-invariant port-pair characteristics and exploiting the variation in the times at which pairs of ports became connected by RRTS, while others remained unconnected throughout.

With the exception of a few product groups that are not amenable to RORO transport such as arms and ammunition, cement, and fuels and minerals, we analyze all products traded within the Philippines.

RRTS-induced changes in trade costs are expected to have heterogeneous effects across products because they change the relative prices of goods, thereby influencing the volumes and kinds of products that can be exported to different destinations. At the same time, product characteristics also feed into the different trade cost reducing features of the RRTS. In the first instance, the ratio of transport costs to delivery price goes down with product value. Second, the extent to which trade costs and inventory costs can be traded off against each other depends on the physical characteristics and demand structure of products. Third, product characteristics interact with distance especially because RORO shipping is only superior to conventional liner shipping over short distances (JICA, 2007). Fourth, the importance of time savings from the RRTS likely varies with the time-sensitivity of products. Finally, the response of elastic and inelastic products to changes in trade costs manifests differently along the intensive and extensive margins (Chaney, 2008).

We rely on the gravity model to estimate the effects of the RRTS on trade patterns. The exercise is akin to investigations of trade responses to regional trade agreements (RTAs) in the international trade literature, which address the selection of country pairs into RTAs through pair fixed effects (Head and Mayer, 2013). In our context, this identification strategy partials out non-time varying characteristics that influence the likelihood of a port-pair investing in an RRTS connection. Controlling for time varying characteristics by product and province allows us to capture the variation that comes from RRTS access.

We find that port-pairs connected by RRTS increase trade by 35% more than what would otherwise have been without the infrastructure investment. This gain accrues from the combined expansion along the intensive and extensive margins. On average, RRTS-connected pairs trade 18% more of the same products, and 37% more kinds of goods. They also have a 1 percentage point greater likelihood of exporting to a new non-RRTS destination.

There is considerable heterogeneity in the distribution of RRTS-associated gains across the 21 product groups examined. Eight register overall increases in trade. The largest at more than 150% is for live animals. Meanwhile, only six product groups exhibit increases along the intensive margins, with the largest accruing to paper and pulp at 118%. The gains from the RRTS are overwhelmingly in terms of product variety with all product groups showing increases that range from 26% in fats and oils to 50% for machineries. Only ten product groups show greater probability of being exported to new non-RRTS markets. Finally, thirteen product groups increase trade frequency following RRTS connection. The increasing frequency of trade is a typical result of declining trade costs as the trade to inventory cost ratio goes down.

The RRTS confers more advantages on certain product groups. Consistent with predictions about the importance of time savings for perishable products, these products are traded with 60% more varieties on RRTS routes and have a 1.2 percentage points higher probability of being exported to new non-RRTS destinations. Moreover, perishable products are traded 80% more frequently between RRTS port-pairs.

The RRTS imposes freight charges based on the space that a cargo truck occupies in the RORO vessel, and by the distance that the ship travels. A practical consequence of freight charging by lane meter is that conditional on destination and storage requirements of products, it is cheaper to transport higher value goods through the RRTS because transport costs are fixed regardless of the cargo carried. Indeed, products in the highest quartile of the value distribution are traded with 45% more product variety on RRTS routes, have a 1.6 percentage points greater chance of finding a new market destination, and are traded 65% more frequently compared to similar non-RRTS pairs. The differential effects across products offer insights into the welfare implications of RRTS access.

The RRTS-associated gains that we uncover do not come from displacing trade in nearby non-RRTS ports, although neither do we find evidence of positive spillover effects to cities and municipalities. Finally, the short distance nature of RRTS that mostly cater to feeder traffic is strongly complementary to the long haul routes of liner services. The routes of liner services are fixed over time such that combined with pair fixed effects, we can examine the trade effects of RRTS access on liner services. We find that liner routes that have RRTS in both origin and destination trade 52% more compared to similar routes where RRTS is absent or is missing at one end.

1.3 Transport costs and pricing of agricultural products in the Philippines

Chapter 5 investigates how the RRTS changes pricing patterns and markup distribution of agricultural products in the Philippines. The price difference of a product between origin and destination provinces comprises transport costs, marketing and search costs, and finally, markups, which in the case of imperfect competition varies with product characteristics and trade costs (Hummels et al., 2009).

We anticipate that changes in trade costs from the RRTS translate into changes in pricing patterns between origin and destination markets as the fixed and variable costs of transport come down. Simplifying documentary requirements reduces fixed costs, while doing away with cargo handling procedures reduces both the fixed and variable components of transport costs. Secondly, lower transport costs can in turn foster greater competition in shipping and intermediation. RRTS introduced competition on routes that were previously serviced infrequently by few shipping companies (Austria, 2002). The smaller size of RORO vessels and the government support for purchasing ships also mean that the cost of market entry is lower. At the same time, lower transport costs reduce the fixed costs of entry for intermediaries who source and market agricultural products from one province and sell these to retail markets in other provinces. In the Philippines, intermediaries act as consolidators for small farmers, and are the primary means by which farmers market their produce (Intal and Ranit, 2001). These competitive effects of the RRTS are crucial. Without them, cost savings accruing to the RRTS would benefit neither producers nor consumers.

We trace the pricing pattern effects of the RRTS using an origin-destination mapped data set of 13 agricultural products and their monthly farmgate and retail prices. Our results show that conditional on distance, province pairs that are connected by RRTS on average exhibit a 28% narrower price gap as a proportion of farmgate prices compared to province pairs with similar characteristics but are unconnected. This is because RRTS supplier provinces enjoy higher farmgate prices without any differential changes in retail prices between RRTS and non-RRTS province pairs.

Localized weather shocks in a particular month-year t are sources of exogenous price increases that provide a setting for investigating RRTS associated changes in markups. We have three different scenarios for supplying provinces: (i) provinces supplying product k that are directly affected by the weather shock; (ii) suppliers of the same product k that are unaffected by the weather event, and are not connected by the RRTS; and (iii) suppliers that are unaffected by the weather event, and have access to the RRTS. Because all supplying provinces in our sample are major suppliers, a localized weather shock causes a general price increase. This presents an opportunity for provinces described in (ii) and (iii) to benefit from the exogenous price increase by raising prices for k. Nonetheless, we expect some differential effects by RRTS status premised upon greater competition in intermediation and shipping in RRTS routes.

We use deviations from long term monthly rainfall and wind velocity trends of each affected province as instrument for deviations in long term prices caused by extreme weather events in the unaffected provinces. This allows us to differentiate between movements that come purely from RRTS-induced changes in the marginal costs of trade which presumably remains constant, and RRTS-related changes in markups due to the price increase.

Our IV estimates suggest that RRTS connection leads to a distribution of surplus that is overall welfare enhancing. Provinces whose supplies are unaffected by the weather shocks and are RRTS-linked experience larger passthroughs of price increases to their farmgate prices compared to other unaffected supplying provinces that are not connected. This implies revenue gains for farmers in RRTS supplying provinces. Importantly, the higher farm prices in RRTS supplying provinces do not lead to price increases in their markets. Retail prices in RRTS markets are not significantly different from non-RRTS destinations. The farmer in an unaffected RRTS source province receives PhP 5.13 (USD 0.10) more per kilo on average across products than in non-RRTS sources. On the other hand, the markets of RRTS provinces only increase prices by an average of PhP 1.56 (USD 0.03), which is also not statistically different from zero. The combination of effects result in a reduction of average price gap levels by PhP 3.56 (PhP 1.56-PhP 5.13) in RRTS pairs, and translates into a price gap to farmgate price ratio that is 25% narrower. These findings suggest that the increase in farm revenues came from a squeezing of shipping or intermediary markups, consistent with a competition inducing effect of the RRTS.

1.4 Conclusion

The RRTS in the Philippines presents a unique opportunity to study the effects of trade costs within a country that faces serious connectivity challenges. The three empirical chapters of this thesis analyze the effects of the RRTS on different aspects of trade – trade costs as measured by border effects, patterns of domestic maritime trade, and spatial price patterns.

To the best of our knowledge, this thesis represents a first attempt at an empirical evaluation of the trade effects of the RRTS. The lack of empirical work on the subject can be explained by the absence of a data set that documents the sequential development of RRTS across routes and over time. This thesis fills the data gap by constructing a historical data set of RRTS services. This required the collection of information from various sources including a survey of RORO service providers, administrative records of shipping franchise permits, the list of ports equipped to handle RRTS operations, and reports from government and aid agencies.

Across the three different aspects examined empirically, our results consistently show that the RRTS contributed to the reduction of trade costs in the Philippines. First, RRTS is associated with lower average border effects, or the tendency of provinces to trade more with themselves than with other provinces. Second, port-pairs connected by RRTS trade more along the intensive and more strongly in the extensive margins compared to similar ports that are not connected. RRTS port-pairs also transact more frequently, consistent with expectations from declining trade to inventory cost ratio. Finally, the RRTS reduces price gaps between origin and destination provinces. Exploiting weather shocks as exogenous sources of price increases, we find that access to the RRTS is associated with higher farm revenues, and a reduction in markups that accrue to intermediary and shipping service providers.

Chapter 2

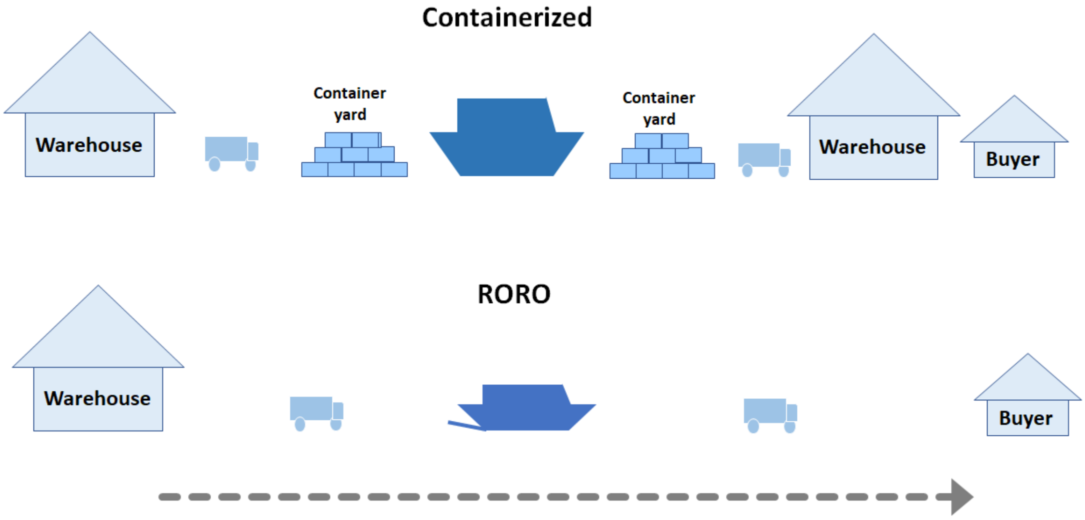
The Roll-on Roll-off Terminal System

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. The transport system is anticipated to have impacts on domestic trade in the country. The roll-on roll-off (RORO) as a shipping vessel is expected to 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 as demonstrated in Figure 2.1. Using RORO, firms can skip cargo handling procedures inherent in containerized shipping. The integration of land and sea transport also enables direct deliveries to institutional buyers.

This chapter introduces the RRTS and explains how its different features relate to the outcomes examined in the three empirical chapters – trade costs, trade patterns, and spatial price differences. The process of building the historical data set of RRTS services by route and time of connection is also described in Section 2.1.

The Philippines is an archipelago of over 7,000 islands and 83 provinces, and presents a unique setting for studying trade costs and their implications on trade patterns and pricing behavior. Distances between the major islands 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

Figure 2.1: The RRTS



Source: Author

of the domestic shipping industry, especially for the smaller islands where maritime transport is the only viable means of sustained trade. In 2017, the total value of domestic maritime trade was recorded at PhP 765 billion (roughly equivalent to 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. Moving a TEU from Davao, in the south of the Philippines to Manila, the capital in the north, cost USD 1.50 per nautical mile in the early 2000s compared to USD 0.50 from Bangkok, Thailand or Port Klang, Malaysia (Basilio, 2008). Llanto and Navarro (2014) document that 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.

To a large extent, the large differential in the cost of domestic and international shipping is explained by the shipping industry's sensitivity to scale. Calculations using PSA (2017) data show that domestic maritime trade is at most 43% of the volume and 16% of the value of combined international imports and exports conducted by sea.

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). In fact, there were RORO ships operating even before the RRTS. For example, the Batangas City-Calapan route in the northwest was already experiencing growth in RORO carried trade in the early 1990s. Nonetheless, RORO as a mode of transport could not fully take off. Its development was discouraged by government controls and bureaucratic delays, as well as by irrational cargo handling policies. RORO ships had to pay cargo handling fees even when this service was unnecessary. Moreover, truck "clearances" were required for interisland movement as if a cargo was moving from one country to another (USAID, 1994).

Llanto et al. (2005) also noted a conflict of interest between the Philippine Ports Authority (PPA) and the deployment of RORO ships. The PPA revenue generating structure was biased towards cargo handling operations. In 2001, domestic cargo handling fees accounted for 18% of the total revenues generated from port operations. At the same time, without clear support and priority from the national government, the PPA was reluctant to invest in RORO berths without the assurance of utilization (USAID, 1994).

The reforms that came with the RRTS are twofold. One group directly affected shipping activities – the waiving of cargo handling charges and wharfage dues; freight charging based on lane meter;[1] 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.

The effects of the first group of reforms 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. The second set of reforms are expected to reduce shipping costs in the longer term.

[1]Instead of commodity classification, freight is charged based on the space occupied by the cargo and the distance that the vessel traveled.

The empirical chapters focus on the first set of reforms as these have more immediate effects.

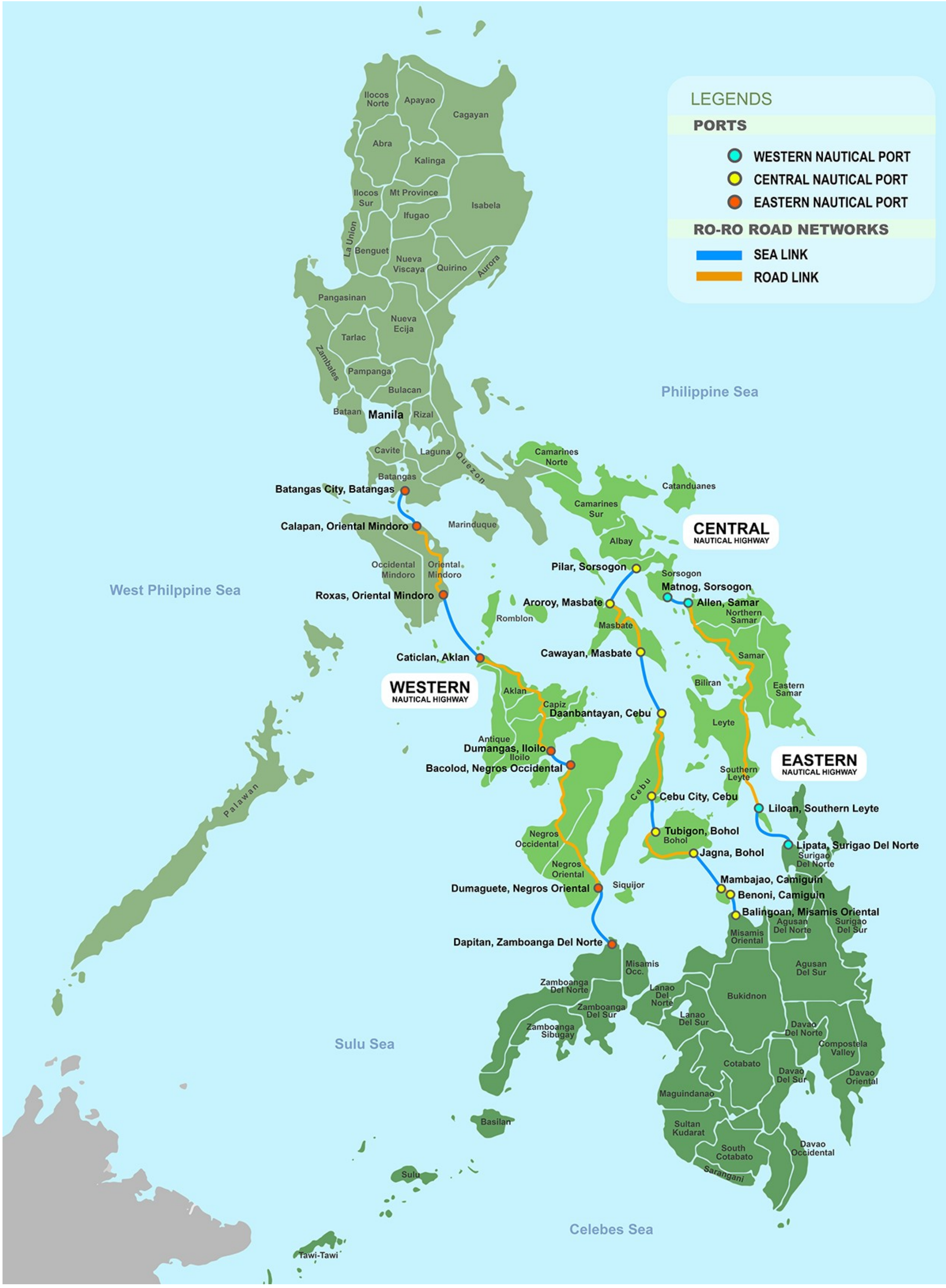
Figure 2.2 presents the major routes of the RRTS. A truck coming from Manila can board a RORO ship in Batangas City and can in principle drive all the way down south to Dapitan in the Zamboanga peninsula through various RRTS connections. The RRTS has three main trunks which are called 'nautical highways'. RORO operations in the Eastern Highway predate the RRTS; the Western Highway started operating as part of the RRTS in 2003; and the Central Highway was launched in 2008. However, the inauguration of these major vertical routes cannot be taken as the starting date of RRTS operations. There were RORO ships operating within the Western and Central highway as early as 2003, and there are also lateral links that are not captured by the three trunks that focus on vertical connectivity. Hence, we build a historical data set that tracks the development of RRTS services by route from 2003 to 2014.

The RRTS linkages at the start of the program in 2003 are presented in Figure 2.3. The number of RRTS routes grew from 36 in 2003 at an average of over 10% per year to cover 113 routes by 2014 as shown in Figure 2.4. The most dramatic growth occurred between 2005 to 2009 (see Figure 2.5) when several new links were introduced in the central islands of the Philippines. The plateauing of new routes from 2010 onward coincides with a change in government that did not promote the RRTS as a priority project.

The sequence of development of the routes within the RRTS deviated from the original intention of the inter-agency committee, which identified the routes and the order of priority for RORO infrastructure development (JICA, 1992).[2] Originally, routes were prioritized using a point mark system that was based on mobility in the hinterland (inland road network and car ownership); maritime cargo and passenger traffic demand; cost of RORO terminal construction and development; and

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

Figure 2.2: The RRTS in 2003



Source: Author

Figure 2.3: The RRTS in 2003

Source: Author

Figure 2.4: The RRTS in 2014

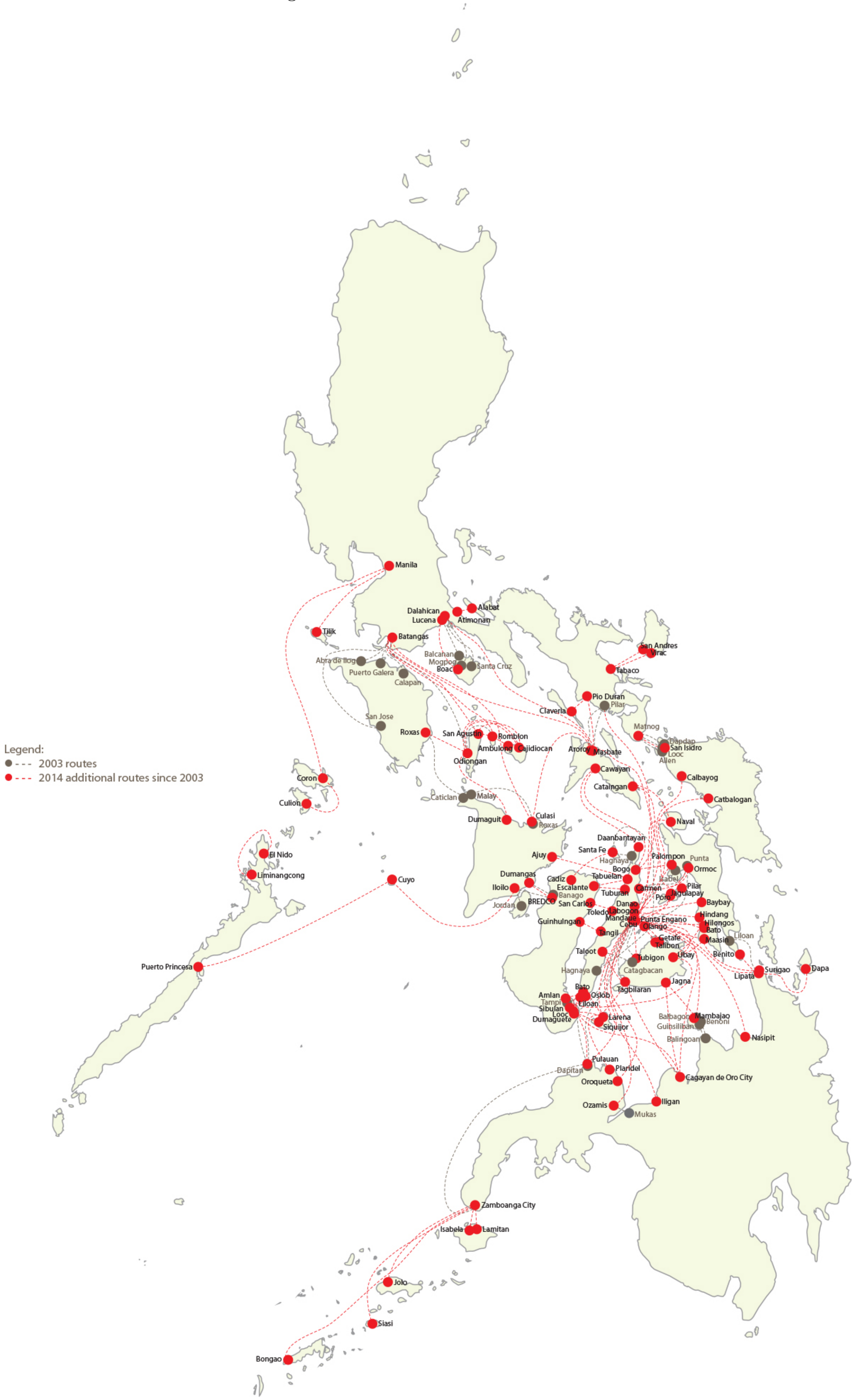


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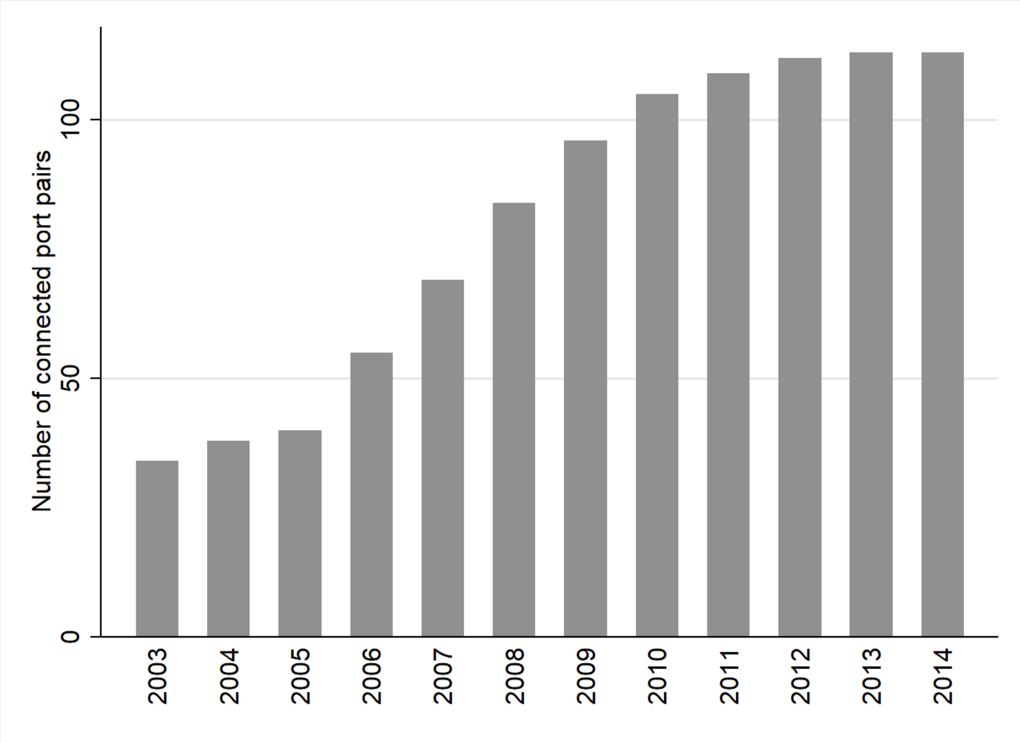
Figure 2.5: Number of RRTS linkages over time



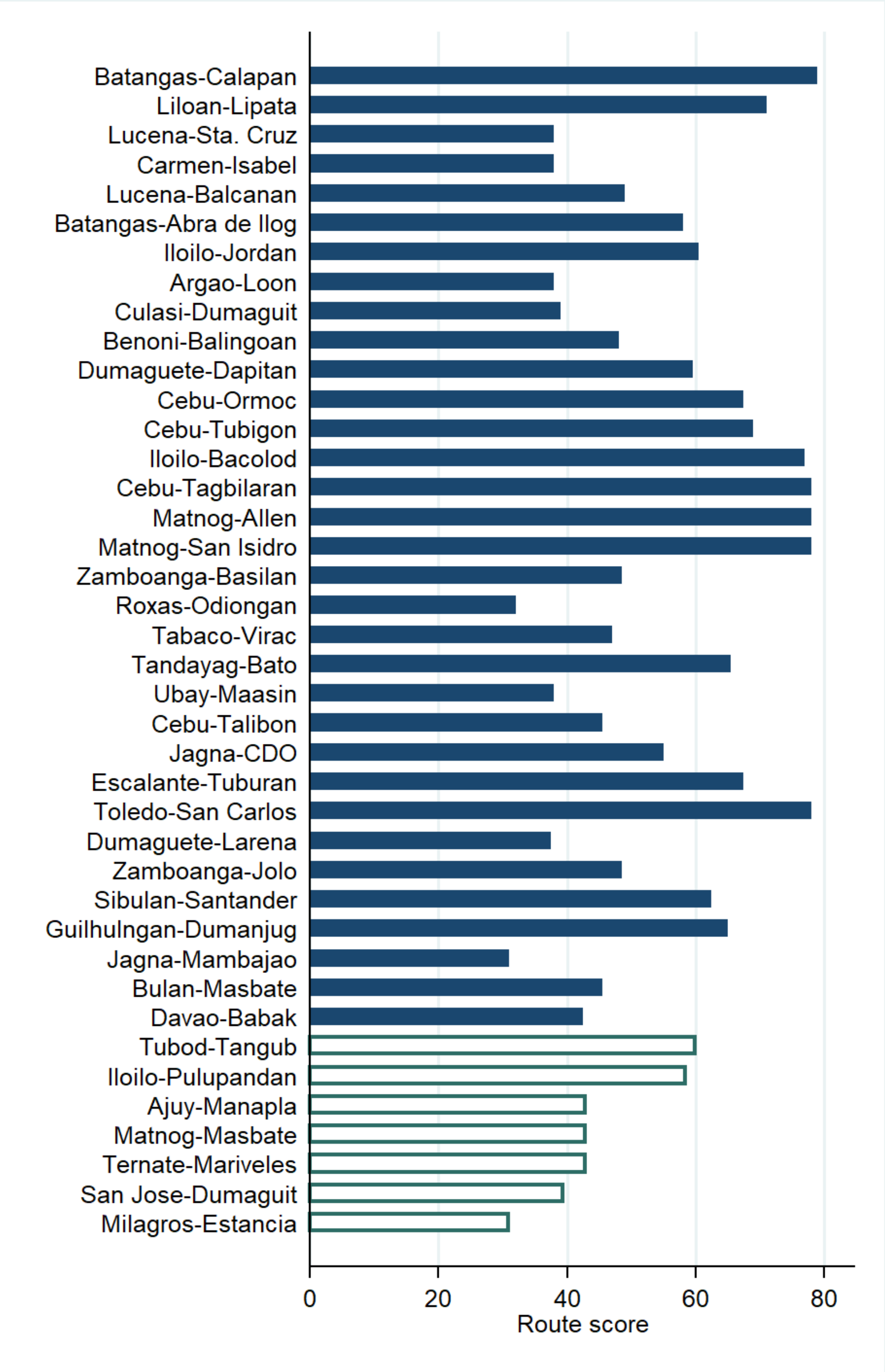
Source: Author

formation of transport networks across RORO routes.

Figure 2.6 shows that the actual order of development exhibited departures from the prioritization plan. The horizontal bars represent the scores which correspond to a route's priority, and the vertical ordering is the actual sequence of development. The scores for each of the routes are summarized in Table A-1. Technical reports by JICA (2007) mostly point to geological and topographical factors as causes for the deviation. In 2014, there were 80 routes that had not been evaluated by the committee and yet are serviced by RORO ships. Moreover, seven of the 40 routes originally identified by the inter-agency committee remained undeveloped and are shown as hollow bars at the bottom of the figure. In general, a clear pattern between priority score and actual development sequence cannot be discerned. Nonetheless, the choice of routes followed a general guiding principle that suggests potential selection of ports into RRTS investment.

It is important to distinguish between RORO, which is a vessel type, and the RRTS which is a transport system. There are RORO ships that do not function

Figure 2.6: Planned prioritization of RORO route development



Source: Author and JICA(1992)

within the RRTS. For example, a number of liner companies use RORO ships to load containers (mounted on chassis) in lieu of container cranes. But these chassis-mounted containers require unloading by a truck head at the port of destination.

Other primary means of maritime transport are liner shipping 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). Finally, there are specialized tanker vessels that carry particular products such as cement, chemicals, and fuels. Areas where trade is minimal or infrequent tend to use small ferries.

The RRTS was hailed to be such a success that the Philippines and Indonesia were designated to shepherd the implementation of the Association of Southeast Asian Nations RORO (Faustino and Morales, 2010). The first RORO service plying between Davao-General Santos City in the Philippines and Bitung in Indonesia started in April 2017. Domestically, 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.

2.1 Data: Starting dates of RORO services

Empirical analyses of the effects of the RRTS require information on maritime routes – whether they are serviced by RORO ships, and if so when the service commenced. Building this data set involved using several data sources and a careful process of geographical mapping and verification, which is described below:

1. There were 39 RORO shipping companies servicing around 150 distinct routes in 2017 according to the Maritime Industry Authority (MARINA) inventory of RORO routes. Thirty-five of the companies have operations that span the

period of study and were requested to supply information on the starting dates of operation for each of the routes they service. Twenty companies responded with the requested data, while two companies could not be tracked down.

2. The certificates of public convenience (CPC) and their amendments specify the route and schedule franchise of a shipping company. We accessed the CPCs of ten shipping companies registered with the MARINA central and Region IV offices.[3] The historical records of CPCs only go as far back as 2008 (earlier records are either lost, as in the fire in the central office, or could not be located after being warehoused).[4]

3. The information obtained from the shipping companies were verified against the information provided by the PPA on the operation dates of RORO ports. There are RORO-equipped ports that do not have actual operations. As such, it is important to verify that a route is actually being serviced by a RORO ship.

4. A number of reports and feasibility studies of institutions and international aid agencies have information on the starting dates of RORO services for some routes. Among them, the following sources were used: ADB (2010), JICA (1992, 2007), accomplishment reports of the PPA, USAID (1994, 2014). Local news articles were also used to verify and complete the database. Less formally, information from the Philippine Ship Spotters Society was also used to check that a route is actually serviced by a RORO ship.

5. Finally, the information from different sources were compared with each other. Among the sources, only the PSA employs a universal port classification system that directly links a port of origin and destination to trade flows. Hence,

[3] These records are not digitized, and are physically distributed across the 13 MARINA regional offices in the Philippines.

[4] CPC issuance changed from being vessel-based to company-based in 2004. This means that CPC as a means of establishing starting dates of service can only be used for routes where services started from 2005 onward.

substantial effort was expended in ensuring geographical accuracy in identifying RRTS ports.

2.2 RRTS and trade costs

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

Improved land-sea interface

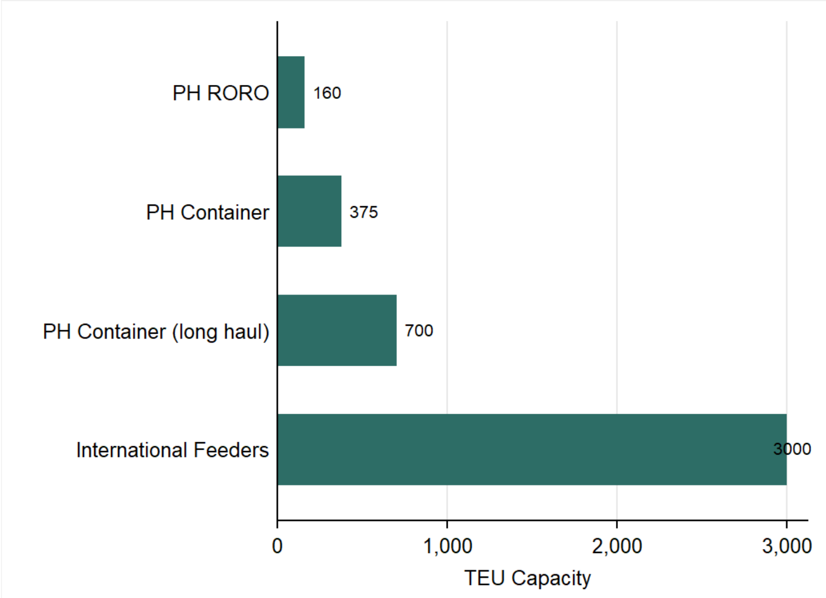
Cargo handling is one of the most time consuming and labor intensive processes in maritime trade (Brancaccio et al., 2019). The use of RORO shipping leads to substantial financial and time savings because cargo-bearing trucks can arrive at a port, load directly into a RORO ship, and continue to drive off to their final destinations.

The time savings imply benefits for products that are time-sensitive such as those with short shelf-lives. Moreover, the possibility of direct delivery implies savings in inventory costs. This is a potentially important source of savings. 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.

Scale and service frequency

The shipping industry has a high threshold of minimum efficient scale. The smaller size of RORO ships can alleviate the lack of scale in areas outside regional centers such as Metropolitan Manila and Cebu City, thereby opening new trading outlets for areas that do not have the scale for regular container-carrying ships. RORO ships typically have capacities of 100 to 200 TEUs, while container ships inevitably require large consolidation with the smallest vessels having a capacity of 250 TEUs. This biases cargo transport towards long-haul international shipping centered on hubs like Singapore, Hong Kong, and Taiwan (Faustino and Morales, 2010). Figure 2.7 shows that the median RORO ship in the Philippines has a capacity of 160 TEUs,

Figure 2.7: Median TEU capacity of Philippine ships



Source: Philippine Liner Shipping Association, 2017

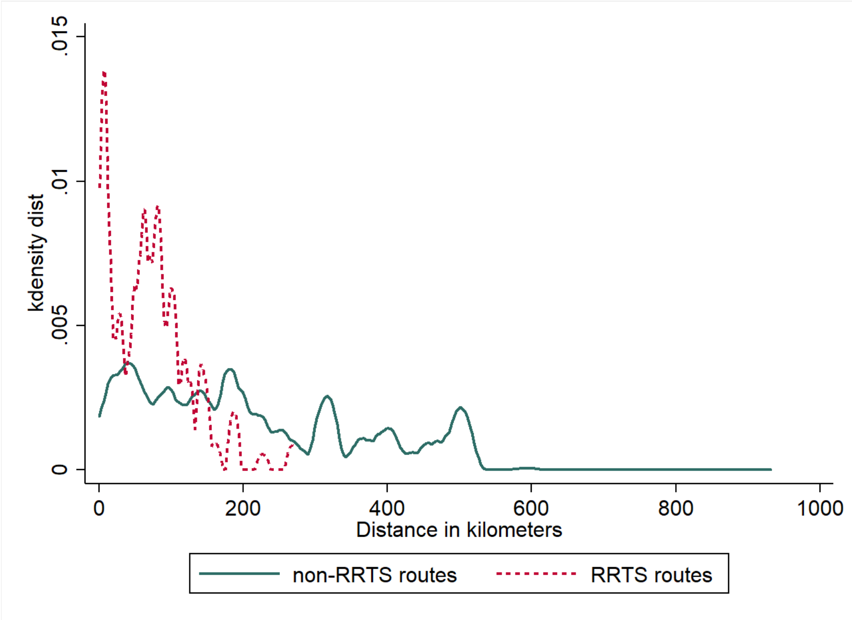
while the median small container ship can handle over twice this volume.

Trampers are potential alternatives to the RORO in terms of scale. However, trampers lack regularity and predictability in schedule, and are moreover most accessible to entities that can coordinate sufficient volumes to hire their services.

The smaller size of RORO ships means that they are able to make more frequent trips and faster turnarounds. Being able to ship in smaller batches and greater frequency reinforces savings in storage and warehousing, and other logistics-related costs for traders, and possibly small scale producers.

The RRTS does not have a *de jure* distance limit. But RORO ships operating within the RRTS tend to serve short distances as can be seen from Figure 2.8. This is a practical consequence of the cost of alternative transport modes and the ideal turnaround time for delivery operations. The competitiveness of ROROs against liners declines with distance. In particular, JICA (2007) suggests a threshold of roughly 200 kilometers beyond which long haul liners become at least as competitive as the RORO. At the same time, the number of RORO linkages to be crossed 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

Figure 2.8: Distance distribution of maritime routes



Source: Author

Philippine Ferries) committed to guaranteeing a coordinated passage across several RRTS links.

Increased competition in intermediation and shipping services

Trade costs can also come down through increased competition in the routes serviced by the RRTS, many of which are feeder routes with limited services prior to the program (Austria, 2002). At the same time, the trade costs reduction from the RRTS encourages competition as the fixed costs of entering the intermediation market come down.

Spillover effects to other routes

Non-RRTS routes may also benefit from the trade costs reduction from the RRTS. In particular, by improving the efficiency of cargo traffic in feeder routes, RORO can complement liner vessel operations and potentially alleviate cargo imbalance, which is a main determinant of shipping charges (Brancaccio et al., 2019).

2.3 RRTS and trade patterns

Trade cost changes from the RRTS alter relative prices across products and space, and thus affect patterns of trade. Trade patterns in turn have important development consequences because they influence production and consumption decisions throughout the country.

Various studies find that connectivity raises real incomes through increased market access (Duranton, 2015). Donaldson (2018) show this to be the case with the railway expansion in India in the 19th and early 20th century, and Donaldson and Hornbeck (2016) observe the same with the growth of the railway network in the United States in the 19th century. In Ghana, the railway lines that were constructed to access inland mines had positive effects on the production of cocoa, a main export crop (Jedwab and Moradi, 2016). This in turn increased agricultural productivity and promoted urbanization with effects on spatial distribution of economic activities that persist to the present times.

Ratio of transport costs to delivery price

The RRTS charges freight by lane meter and this means that shippers pay freight based on the space occupied by their cargo and the distance that the RORO ship traveled. Holding other factors constant, this fixes the transport cost per nautical mile regardless of the cargo type. The implication is that transport costs can be minimized by packing more value into a lane meter, thus favoring higher value goods.

In imperfectly competitive markets, shipping companies also optimize revenues by charging higher markups for higher value products because freight fees form a smaller share of their delivery price (Hummels et al., 2009). A pro-competitive effect from the RRTS thus also means that the absolute value of freight charge reduction should be larger for more expensive products.

Trade-off between trade and inventory costs

Trading activities are known to have high fixed cost components (Hornok and Koren, 2015). This leads to 'lumpy trade' whereby traders economize on per shipment cost by shipping less frequently with larger volumes, trading off fixed costs of trade against inventory costs. Trade costs reduction is therefore expected to manifest in terms of more frequent transactions.

Many of the reforms in the RRTS impinge on the fixed component of trade costs. The most straightforward example is the simplification of documentary requirements for RORO ship operators. The lane meter charging modality also reduces the fixed costs of trade albeit to varying degrees depending on product value. Finally, the time savings from not having to go through the process of cargo handling has a large part that does not vary by trade volume.

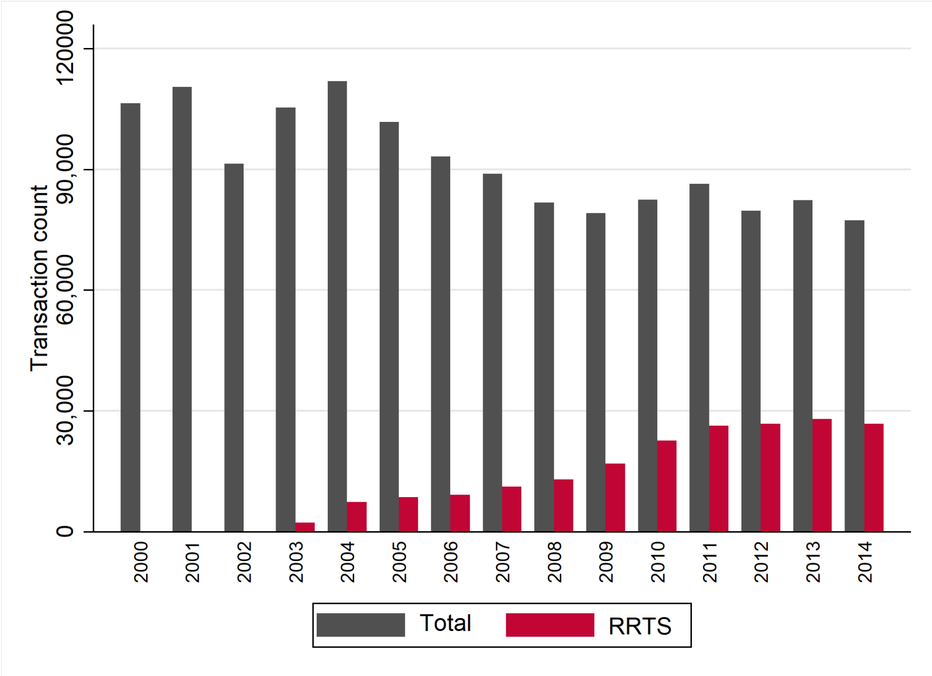
The trade-inventory cost trade-off is reinforced by the possibility of direct delivery to institutional buyers. The savings are foreseen to be largest for high value products where the opportunity costs of holding inventory are largest, and for products that are time-sensitive or require special storage 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 2.9).

Product characteristics

Product transport and storage requirements also dictate amenability to the RRTS. Some products are inherently not configured for RORO transport. For example, cement, chemicals, and fuels tend to be shipped in specialized tankers with dedicated ports for their handling (Rodrigue et al., 2017).

Figure 2.9: Count of monthly transactions by RRTS status



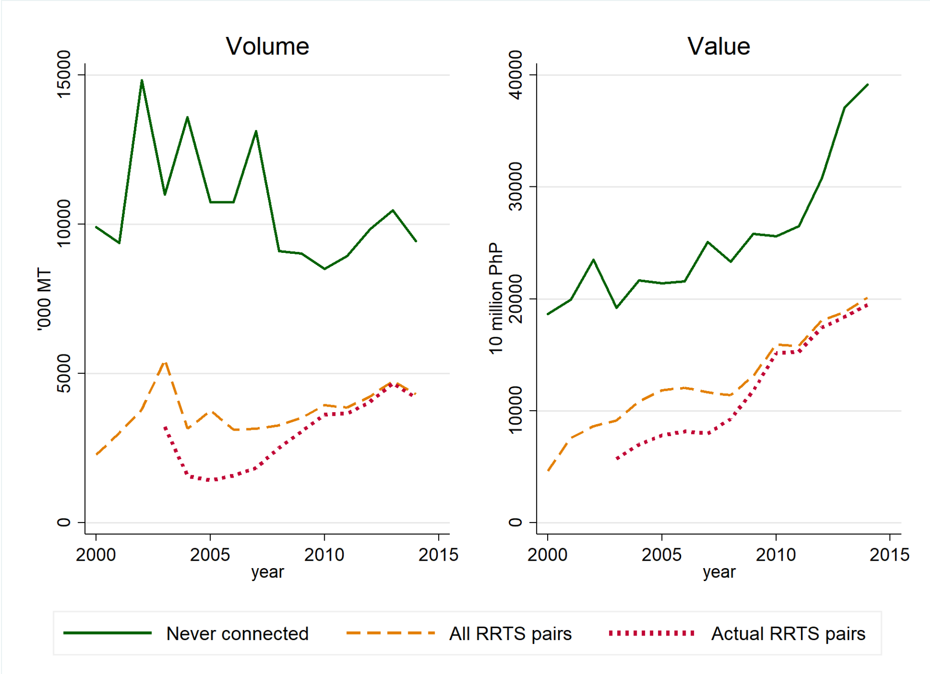
Source: Author based on PSA (2016)
Note: The following are excluded – arms and ammunition, fuel and by products, crude minerals, and cement.

RORO transport accounted for 14% of average domestic throughput in 2015 and 2016.[5] 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 are shown to have substantial shares of RORO cargo throughput. Finally, fuels, minerals, coconut products, and cement are shown to use RORO the least.

Figure 2.10 shows that since the RRTS started, the volume and value of trade among RRTS pairs have generally increased over time. On the other hand, the volume of non-RRTS trade has generally been declining. The volume and value increases in non-RRTS routes from 2012 to 2014 are due to the expansion of trade along liner routes. To a certain extent, the growth in RRTS trade is an artifact of the increasing number of linked pairs over time. Nonetheless, regardless of the time of connection, trade in RRTS pairs has also generally risen over time as shown by

[5]The PPA only started compiling RORO inbound and outbound cargo statistics in 2015.

Figure 2.10: 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.

the long-dashed lines in the figure.[6]

2.4 RRTS and pricing patterns

The price difference between a pair of locations is explained by transport costs, marketing costs, and markups in the case of imperfect competition. Markups also tend to vary with transport and marketing costs. The RRTS is expected to reduce spatial price differences as it brings down transport costs, and facilitates arbitrage by promoting competition.

Transport costs. The RRTS reduces the fixed and variable costs of transport, which typically forms an important component of trade costs. This is especially true for low value products for which transport costs form a larger share of the final delivery price. The fixed cost comes down from simplified documentary requirements, while the sidestepping of cargo handling procedures impinges on both the fixed and variable

[6]The 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.

costs.

Increased competition in shipping and intermediation services. The price gap between origin and destination also includes markups, which are affected by the market structure of intermediary and shipping services. Trade costs play a key role in enabling firms to price-to-market (Atkeson and Burstein, 2008). In a low trade costs world, competition eats excess margins away, making discriminatory pricing unviable.

In reducing trade costs, RRTS can foster greater competition on two fronts. First, RRTS caters to routes that previously had infrequent service from few shipping companies (Austria, 2002). The RRTS means more regular services and less reliance on trampers. In an international trade setting, Bertho et al. (2016) and Hummels (2007) show that the number of carriers servicing a route is a strong predictor of freight charges. The smaller size of RORO vessels and the support from the Government of the Philippines for purchasing ships also means that the cost of market entry is lower. At the same time, freight charging based on lane meter is a more transparent means of detecting excess profits in routes, thereby providing an additional mechanism for encouraging competition.

Second, lower transport costs reduce the fixed cost of entry for intermediaries who source and market agricultural produce from one province and sell these to retail markets in other provinces. In the Philippines, intermediaries act as consolidators for small farmers, and are the primary means by which farmers market their produce (Intal and Ranit, 2001). A more competitive intermediation sector can move products from surplus to deficit areas faster, more cheaply, and with lower markups. As part of this process, producers ought to benefit from higher factory or farmgate prices, and consumers from lower purchase prices (Bergquist, 2018). These competitive effects are crucial. Trade costs savings accruing to the RRTS will benefit neither producers nor consumers if the market structures in services that mediate between producers and consumers are highly concentrated.

Market integration and price volatility

The RRTS facilitates market integration, which means spatial price differences are more easily arbitraged away. The trade costs reduction from the RRTS potentially impinges on the different factors that lead to asymmetric transmission of price changes. Smaller producers are better able to surmount transactions costs by themselves or through cooperatives. The possibility for direct delivery to institutional buyers is also a means of hedging price volatility in an analogous way that US firms use faster air transport to smoothen the effects of international demand volatility (Hummels and Schaur, 2010). However, lower trade costs also mean greater transmission of external shocks to local markets and this may lead to greater income volatility as Allen and Atkin (2019) find in India following access to railways.

2.5 Conclusion

The RRTS was introduced in the Philippines with the aim of bringing down trade costs and improving interisland connectivity through the use of RORO ships. ROROs improve the interface between land and sea transport by dispensing with the need for cargo handling, which is one of the most labor-intensive and time-consuming processes in maritime shipping.

We create a historical data set that tracks the development of RRTS service by route, which enables the empirical examination of the trade effects of this transport system on different trade-related outcomes. This data set forms a distinct part of this work's contribution.

Aside from an overall reduction in trade costs, the different features of the RRTS are expected to affect the patterns of trade. For example, lane meter charging favors higher value goods whereas the time savings from RRTS are disproportionately important to time-sensitive products. The reduction in the fixed costs of trade is foreseen to significantly affect the trade-off between trade and inventory costs.

Finally, the RRTS-induced changes in trade costs can alter the pricing patterns in producer and consumer markets. In particular, lower trade costs can lead to greater competition in shipping and intermediation services implying welfare gains for producers and consumers alike. To the extent that RRTS deepens market integration, it also has implications on the volatility of producer incomes and consumer prices.

The RRTS-associated reduction in trade costs have potentially large welfare effects for an archipelago country like the Philippines, where some islands are remote, and where the lack of scale in demand and supply means that it is often more expensive for economic hubs like Metropolitan Manila to trade with other islands in the Philippines than with international trading partners.

Chapter 3

Over Land and Over Sea: Domestic Trade Frictions in the Philippines

The Philippine Government instituted the Roll-on Roll-off Terminal System (RRTS) in 2003 with the aim of bringing down interisland domestic trade costs. This chapter investigates the effects of this transport system on two fronts. First, the effect of RRTS on interprovincial agricultural trade flows is examined. This treats RRTS as a trade cost shifter that is available to some province pairs but not others. Second, provincial border effects as a metric of trade cost are obtained, and RRTS-associated changes to these border effects are mapped across provinces, product, and time. Aside from a historical database for the starting date of service of RORO by route, this investigation required the recovery of intraprovincial agricultural trade and interprovincial land trade, which are currently not tracked by the Philippine Statistical Authority (PSA).

We focus on agricultural products for which trade, production, and consumption data are available. The estimation of province border effects require these information by location. The agricultural focus is highly relevant in light of the sector's role as the main source of livelihood for the poorest provinces, and their sensitivity to trade costs because of their short shelf lives and lower value to weight ratio. In 2017, 6.6 million metric tons of food and live animals were transported by water, representing 30% of recorded volume of waterborne trade (PSA, 2017). Finally, the RRTS cites agricultural market linkage and food security as one of its primary motivations.

We find that trade costs in the Philippines, as measured by province border effects are substantial across all the 14 agricultural products examined. On average, provinces trade 28 to 53 times more with themselves than with other provinces. The RRTS reduced border effects by a modest average of 36 percentage points, equivalent to a factor of 0.65. The largest reductions occurred in 2009 and 2010 coinciding with the rapid expansion of the number of RRTS serviced routes in the central islands. However, the impacts are heterogeneous across provinces with areas nearer to Metro Manila, the political and commercial capital, exhibiting the largest border effect reductions.

To the best of our knowledge, this chapter represents the first attempt to estimate border effects within the Philippines and furthermore analyze how these frictions respond to changes in trade costs.

3.1 Related literature

Trade costs comprise all the costs of bringing a product from production to the final consumer (Anderson and Van Wincoop, 2004). They include transport and storage costs, administrative requirements, distribution and markups, exchange rate costs; and costs arising from distance and other cultural factors.

Approaches to measuring trade costs are generally grouped into three categories: direct measures, estimates from prices, and indirect measures from trade volumes (Anderson and Van Wincoop, 2004).

Direct measures of trade costs are sparse. In the international context, tariffs and non-tariff barriers (NTBs) are typically used as indicators of policy barriers. For transport costs, shipping and freight costs are ideal measures but are rarely available except in some developed countries. It has been common for studies to resort to matched partner cost, insurance, freight-free on board (CIF-FOB) ratios as proxy for *ad valorem* equivalents of transport costs. But comparisons with highly detailed data from the US and New Zealand reveal the ratios to be error-ridden, with little information that can be exploited for analyzing variations across time or commodities (Hummels and Lugovskyy, 2006).

Infrastructure and institutional indicators are considered as direct costs measures in some studies, where they are proxied by road networks, telephone density, ease of doing business and logistics performance indicators. However, outside of administrative records, these metrics are mostly derived from perception-based surveys with a select sample of respondents.

Working in the intranational context has the advantage of being freed from some factors of trade costs such as exchange rates, trade agreement memberships, tariffs, and NTBs. However, the data challenges can be just as difficult because trade barriers take less explicit forms, and locally disaggregated data are often not available.

A second approach infers trade costs from spatial price gaps. Agricultural products are frequently the subject of such studies as they are produced over extensive geographies and are expensive to transport (Fackler and Goodwin, 2001). In particular, the extent and speed of price passthroughs, the focus of the macro strand of the literature, are typically taken to be indicative of trade costs.

Atkin and Donaldson (2019) take the price gap analysis further using a data set of highly disaggregated products, combined with information on production location and trade destination data. They decompose observed price gaps between components that are due to markups and those that are due to trade costs. They find that the effect of distance on trade costs within Ethiopia and Nigeria are higher by four to five times than within the US.

In light of the practical difficulties involved in direct measurements and the data demands with the price gap approach, trade costs inference from trade volume is often the remaining option. Gravity models have been widely used to analyze the extent to which observable components of trade costs influence trade flows. Its properties can be used to estimate trade costs through an inverse gravity model, which derives trade costs from the ratio of internal trade within a pair of countries and their trade flows to each other (Arvis et al., 2016; Jacks et al., 2008). Arvis et al. (2016) estimate *ad valorem* equivalents of trade costs for 178 countries from 1995 to 2010 for agricultural and manufacturing products. The estimated value captures both direct costs such as shipping, documentary requirements, associated indirect costs such as storage requirements and time delays. Nonetheless, these estimates are not very informative for identifying the trade frictions that affect bilateral trade patterns.

Intranational trade can seem to face substantially less trade frictions than international trade. First, there are less trade policy barriers such as tariffs, exchange rates, and NTBs. Second, differences in culture and language are expected to play less prominent roles compared to the international setting. Indeed, while the size of estimates vary, studies consistently find strong bias towards domestic trade (Havranek and Irsova, 2017; Hillberry and Hummels, 2003). This home bias effect is measured as an international border effect in the pioneering work of Mccallum (1995) who found that Canadian provinces trade 22 times more among themselves than with the US. A recent meta-analysis by Havranek and Irsova (2017) confirms that international border effects remain sizable. Developed countries trade twice to eight times more with themselves than with other countries, while the factor is 24 for emerging economies.

Border effect estimates have also been derived for trade in services. Anderson et al. (2018) derive estimates for 28 countries in 12 services sectors. A key contribution of the work involves the projection of disaggregated services output data within countries which is often missing. Filling this data gap enabled the decomposition between costs that vary within a country, and those that vary across countries.

Home bias has also been observed in regional trade within a country. This is a parallel but smaller set of literature than its international counterpart. Interest in domestic border effects started with Wolf (2000) who found that states in the

US trade 3 to 4 times more with themselves than with other states. More recently, Agnosteva et al. (2019) estimate regional border effects using inter- and intraregional trade flows in Canada, and find these to vary widely, with a tendency of border effects to be larger for smaller and remoter regions.

Studies that bring domestic and international border effects into a unified framework bring richer insights by allowing for different levels of comparison. For instance, Anderson and Yotov (2010) find that provincial border effects in Canada are larger than the overall international border effect.[1] Coughlin and Novy (2013) find a similar pattern in the US, and Fally et al. (2010) in Brazil.

The large magnitudes of domestic and international border effects are one of the six major puzzles of international macroeconomics (Eaton et al., 2015). Nonetheless, the latest developments in gravity estimation has attenuated the border puzzle by about one-third. In particular, Havranek and Irsova (2017) conclude that the inclusion of zero flows, controlling for multilateral resistance, and consistent measurement of internal and external distance, lead to lower border effect estimates.

3.2 Methodology

We use the gravity model as the basis for evaluating the effect of the RRTS on trade flows and the estimation of domestic border effects. Gravity models provide a framework for linking trade flows with observable and unobservable trade costs variables, We adopt the the structural gravity system of equations from Anderson and Van Wincoop (2004).

$$X_{ij}^k = \frac{E_j^k Y_i^k}{Y^k} \left(\frac{\tau_{ij}^k}{P_j^k \Pi_i^k} \right)^{1-\sigma_k} \tag{3.1}$$

[1]In a goal parallel to this paper's in the context of RRTS, the authors also evaluate the effects of Canada's Agreement on Internal Trade (AIT) in 1995 which aimed to reduce interprovincial trade costs and encourage trade among Canadian provinces. The effects of the AIT are found to be negligible, but their simulations imply that a 30% AIT-induced reduction in trade costs will have tremendous positive welfare effects across Canadian provinces, with the remotest areas gaining the most.

$$(\Pi_i^k)^{1-\sigma_k} = \Sigma_j \left(\frac{\tau_{ij}^k}{P_j^k}\right)^{1-\sigma_k} \frac{E_j^k}{Y^k} \tag{3.2}$$

$$(P_j^k)^{1-\sigma_k} = \Sigma_i \left(\frac{\tau_{ij}^k}{\Pi_i^k}\right)^{1-\sigma_k} \frac{Y_i^k}{Y^k} \tag{3.3}$$

Where X_{ij}^k is the export of province i to province j of product k; E_j^k is expenditure of province j on product k; Y is national output; τ represents a host of trade barriers; P_j^k and Π_i^k are the inward and outward multilateral resistance terms which summarize trade resistance between a province and all its domestic partners. Finally, σ is the trade elasticity of substitution for product k across origin provinces.

A few notes are in order in using the gravity model as a methodological framework:

1. Equations 3.1 to 3.3 imply that estimates of trade costs necessarily have a relative interpretation. A change in trade costs between a pair of trading partners induces changes in trade flows of province i with other trading partners. At the same time, a change in trade costs within a province, τ_{ii} will also affect τ_{ij}. Supposing i to be a province, the decline in trade costs due to the RRTS is expected to tilt trade towards interprovincial trade and away from within province trade, leading to a reduction in home bias.

2. The gravity framework relies on an assumption of separability of trade flows, and production and consumption decisions within trading units. This implies the Armington assumption of product differentiation by source holds as captured by σ in gravity equations. However, estimates from gravity are sensitive to assumptions on the value of σ (Anderson and Van Wincoop, 2004). This presents a challenge in an intranational agricultural trade setting because σ is expected to be large for regularly consumed agricultural products. Nonetheless, the Armington assumption is still valid if demand is characterized by monopolistic competition and free entry; or supply is akin to a multiple producer homogeneous goods model based on Eaton and Kortum (2002). In the latter case, $1 - \sigma$ is alternatively interpreted as embodying comparative

advantage with a Frechet distribution (Anderson and Yotov, 2010).

3. Aggregation is known to introduce bias in gravity analyses even though its direction remains unclear (Anderson and Van Wincoop, 2004). Bias stemming from product aggregation is not a concern in our case since estimation is conducted at the four digit HS code level. Nonetheless, bias can also arise from spatial aggregation. Using symmetric micro regions in the US and systematically aggregating these into macro regions, Coughlin and Novy (2019) demonstrate that spatial aggregation influences the size of border estimates. Large states tend to exhibit lower border effects, a term they call 'spatial attenuation' because spatial expansiveness makes it relatively more expensive to trade within states. Unfortunately, the lack of subprovince trade and production data prevents us from examining spatial aggregation bias. However, the RRTS is still expected to bring down border effects to the extent that we use these as indicators of trade costs.

4. It is highly likely that for many provincial pairs, $P_j^k \neq \Pi_i^k$. Anderson and Yotov (2010) find that the proportion of trade costs borne by sellers, P_j^k, falls over time due to 'learning by selling', while that of the buyers', Π_i^k, remains constant and even rise. However, we have to abstract from issues of asymmetry since we do not have a universal product coverage required for its appropriate treatment.

As is standard in the gravity literature, bilateral trade is assumed to have a Poisson distribution with the conditional mean of observed trade flows following an exponential form. This specification addresses concerns about heteroscedasticity inherent in the log-linearization of multiplicative models, and allows for a robust estimation in a context where zero trade flows take large shares of the observation (Head and Mayer, 2013; Santos Silva and Tenreyro, 2006). The underlying data need not follow a Poisson distribution provided that the conditional mean is correctly specified. Equation 3.1 is therefore expressed as equation 3.4:

$$E(X_{ij}|Z) \equiv \exp(Z'\beta) = \frac{E_j^k Y_i^k}{Y^k}\left(\frac{\tau_{ij}^k}{P_j^k \Pi_i^k}\right)^{1-\sigma_k} \tag{3.4}$$

3.2.1 Evaluating the trade effects of the RRTS

In our set up, trade flows, $X_{ij,t}^k$ are explained by a host of observable trade costs variables such as distance, language, contiguity by land, and access to the RRTS.

$$X_{ij,t}^k = \exp[\beta_1 \, lnDist_{ij} + \beta_2 \, Lang_{ij} + \beta_3 \, Land_{ij} + \gamma RRTS_{ij,t} + \epsilon_{ij,t}^k] \tag{3.5}$$

In equation 3.5, $lnDist_{ij}$ is the log of distance between the centroids of provinces i and j. $Lang_{ij}$ takes a value of 1 if the majority of the population in a province pair share a common language and 0 otherwise.[2] $Land_{ij}$ is equal to 1 if a bilateral trade flow occurs by land rather than by sea. Finally, $RRTS_{ij,t}$ is a binary variable that takes the value of one when a province pair becomes serviced by a RORO ship.

However, equation 3.5 introduces potential endogeneity because: (i) provincial pairs that foresee trade potentials are more likely to invest in an RRTS connection; and (ii) $RRTS_{ij,t}$ is binary and does not capture the quality and capacity of the infrastructure in place, giving rise to measurement errors. These are analogous to the estimation issues involved in analyzing the impact of RTAs on bilateral trade flows. Baier and Bergstrand (2007) account for endogeneity of RTAs by introducing pair fixed effects, represented by α_{ij} in equation 3.6. α_{ij} captures all the time-invariant characteristics between provincial pairs that make them more likely to trade with each other, and therefore dispose them toward an RRTS connection. Origin-year fixed effects, η_{it}, and destination-year fixed effects, θ_{jt}, wash out year to year changes in origin and destination provinces. Finally, δ_{kt}, controls for changes in demand and supply conditions of products within the country. This leaves γ to capture the remaining variation coming from provincial RRTS linkage status.

[2] Religion could not be included in the specification because a variance inflation factor analysis reveals it to be highly collinear with distance

$$X^k_{ij,t} = \exp[\alpha_{ij} + \gamma RRTS_{ij,t} + \eta_{it} + \theta_{jt} + \delta_{kt} + \epsilon^k_{ij,t}] \tag{3.6}$$

3.2.2 Provincial trade frictions

Estimating province trade frictions through border effects requires information on intraprovince and interprovince trade. The former is not readily available and is derived using several data sources, which we detail in Section 3.3.

The province border effect is obtained by estimating equation 3.7:

$$\begin{aligned} X^k_{ij,t} = \exp[\beta_1\, lnDist_{ij} + \beta_2\, Lang_{ij} + \beta_3\, Land_{ij} + \psi\, Smprov^k_{ij} + \\ \lambda\, RRTS_{i,t} \times Smprov^k_{ij} + \eta_{it} + \theta_{jt} + \delta_{kt} + \epsilon^k_{ij,t}] \end{aligned} \tag{3.7}$$

$Smprov_{ij}$ is a dummy variable equal to 1 when trade is within the province, $i = j$, and 0 when $i \neq j$. If interprovince trade were frictionless, *Smprov* estimates should not be statistically different from zero.

Smprov is first estimated off a homogeneity assumption across observations. The influence of RRTS on province border effects is captured by letting *Smprov* vary according to a province's RRTS linkage status, $RRTS_{i,t} \times Smprov^k_{ij}$, where $RRTS_{i,t}$ is equal to one if the exporting province has at least one established RORO service. Later, we allow the impact of the RRTS on border effects to vary across the dimensions of product, provinces, and time.

3.3 Data

3.3.1 Provincial trade data

1. Maritime trade by origin and destination

   The PSA records monthly bilateral coastwise volume and value of maritime trade by port of origin and destination at the 5-digit Philippine Standard Commodity Classification (PSCC), which can be mapped to the SITC and HS codes at the 6-digit level.

However, the geographic configuration of the Philippines means that maritime trade data fall short of giving a comprehensive picture of provincial trade. Some provinces are islands in themselves such as Bohol, while others are contiguous by land such as those that make up most of Luzon and Mindanao.

2. Interprovince land trade

   The PSA does not track commodities transported by land, and yet this is a key piece of information for estimating province border effects. Without this, derived intraprovince trade will be over-estimated because exports by land will be unaccounted for. We remedy the data gap by retrieving land trade flows from Marketing Cost Structure Studies (MCSS) of the Bureau of Agricultural Statistics (BAS). These studies identify the main supply and destination provinces for certain commodities for selected years. The difference between production and consumption of a supply province is assumed to be the amount available for export. A summary of the geographic flow for each commodity is described in Table A-2 in the Appendix.

3. Intraprovince trade is derived as follows:

$$X_{ii}^{k} = \begin{cases} Prod_i^k \times A^k - \Sigma_{i \neq j} X_{ij}^k, & \text{if } X_{ii}^k > 0 \\ Prod_i^k \times A^k, & \text{Otherwise} \end{cases} \tag{3.8}$$

   Where X_{ij}^k refers to exports of i to other provinces and international markets j of product k. X_{ij}^k also includes processed forms of bananas, mangoes, and pineapples which are exported in substantial volumes to international markets. For purposes of tractability, a one to one correspondence is used. For example, a kilo of fresh pineapple is assumed to be equivalent to one kilo of canned pineapple. This is clearly not the case. Inquiries with processors suggest a transformation rate of about 60% to 70%. However, international trade data is in units of gross kilograms and hence include the weight of packaging, and other additives. Information on international exports by province are sourced from the PSA. The PhP equivalent of USD FOB values were derived using the average monthly exchange rate from the *Banko Sentral ng Pilipinas* (BSP, 2016).

A^k is an adjustment factor from the Technical Notes on the National Agricultural Statistics of the PSA, which informs on the proportions of product k that are used as seeds, feeds, and waste. For provinces that are known to be main processing centers of certain products such as bananas in the Davao region, A_k also accounts for the share of products that are processed.

4. Transshipment

   The issue of transshipment is called the 'Rotterdam effect' in the international trade literature and is a typical feature of trade data. Majority of the products in our sample are domestically produced and consumed within the country. At most, chicken and pork have the highest share of imports in domestic consumption at 12.5% and 10.7% respectively (PSA, 2016). Hence, international transshipment is not a prominent concern.

   Nonetheless, transshipment remains an issue in domestic trade. The PSA trade data is sourced from the outward coasting manifests submitted by vessels, and does not identify the final destinations of the products on board. In the context of the RRTS in Figure 2.1, this means that a delivery truck from the port of Batangas, which passes through Mindoro may actually be destined for Aklan. Mindoro will appear as if it is increasing its exports to Aklan whereas it is actually Batangas that is shipping to Aklan. There is no systematic way of correcting this, but several points mitigate this concern.

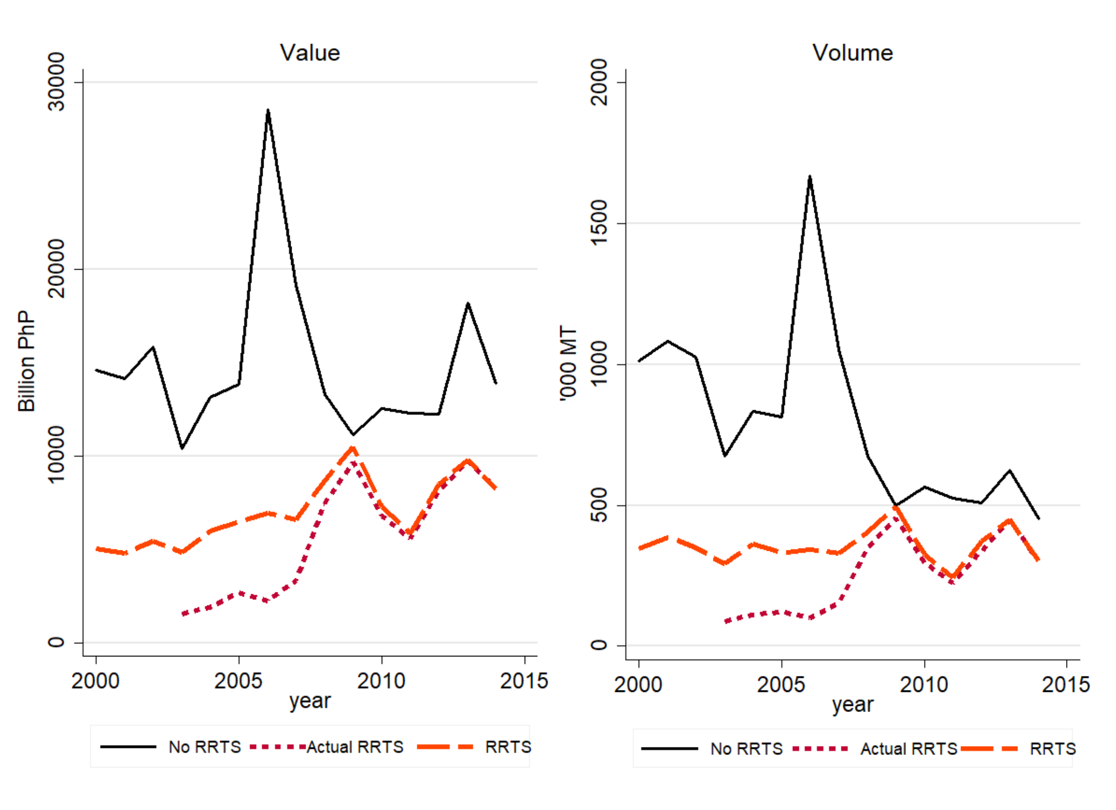
   First, cargo trucks tend to use only one or two chains in the RRTS at most (JICA, 2007). For example, in the Batangas to Aklan route, comprising two RRTS links, interviews with truckers reveal that 80% of those departing from Batangas are destined for Mindoro, and only 20% are moving further on to

Aklan. Second, RRTS loses its advantage vis-à-vis liner shipping as distance increases. The JICA (2007) report estimated the threshold to be around 200 kilometers. The fact that the boarding of RORO ships is on a first-come first-served basis complicates the coordination process as the number of links to be traversed increases. Based on field interviews, it was not until 2016 that a company - Archipelago Philippine Ferries Corporation - offered schedule guarantees for entire links of the main trunks of the RRTS.

Even outside of the RRTS, transshipment is a persistent feature of the trade data especially with regards to domestic trading hubs. The issue is most easily appreciated in the case of Metro Manila which does not produce commercial quantities of agricultural products and yet serves as an import and export hub to other provinces. This problem is overcome by mapping Metro Manila exports to their origin provinces using the MCSS as described in the Appendix, and summarized in Table A-3.

Figure 3.1 presents the agricultural maritime trade trends between province pairs by RRTS linkage status. In general, trade value between RRTS province pairs has grown faster. This is true even of the long-dash lines that pertain to pairs connected by RRTS regardless of the time of connection. This confirms that the trade increase is not a mere artifact of the increasing number of connections. However, this pattern is not observed for trade volumes which appear to have been stable throughout the period of study.

Figure 3.1: Agricultural trade by RRTS status



Source: Author based on PSA (2017)

3.3.2 Production and consumption

The PSA assembles production data of major crops and animals at the provincial level. Missing information are imputed using the production trend of the region to which a province belongs. Most production data are in annual frequencies, except for rice and corn that have quarterly production surveys.

The adjustment factors for the production data are sourced from the Technical Notes on the National Agricultural Statistics from the PSA (2016). This enables matching of production with consumption and trade data. For example, production data is in terms of paddy whereas trade is in both rice and paddy, and consumption is in terms of rice. Details of the adjustment factors are in Table A-4. The derivation for corn is also explained in detail in the Appendix.

Consumption patterns are assumed to change slowly, and hence not surveyed regularly. The per capita consumption figures for 2008 and 2012 are used to infer annual provincial consumption by multiplying per capita consumption with provincial population estimates from the Census on Population and Housing and the resulting projections for the intercensal years.[3]

3.3.3 Prices

We use annual provincial wholesale prices to derive the value equivalent of intraprovincial trade and land-based interprovincial flows. These are available from the PSA's Integrated Agricultural Marketing Information System and Agricultural Marketing News Services (AGMARIS-AMNEWSS). Gaps in price observations are imputed using the following sources in order of priority: (i) provincial retail price trends; (ii) regional wholesale price trends, and (iii) regional retail price trends.

Table A-5 shows the mapping of the consumption, production, price, and trade data sets.

3.3.4 Distance, Language, and RRTS

Geodesic distance between provincial trading pairs are derived from geographical coordinates provided in http://www.diva-gis.org/Data.

Transport costs or freight charges ideally take the place of distance as explanatory variable, but available sources are unreliable. The maritime trade data maintained by the PSA has a record of freight revenue along with the exported volume and value. However, these are not recorded consistently within ports and over time. Moreover, because the data refers to monthly flows, it cannot be ensured that the freight revenue reported corresponds to actual total shipments.

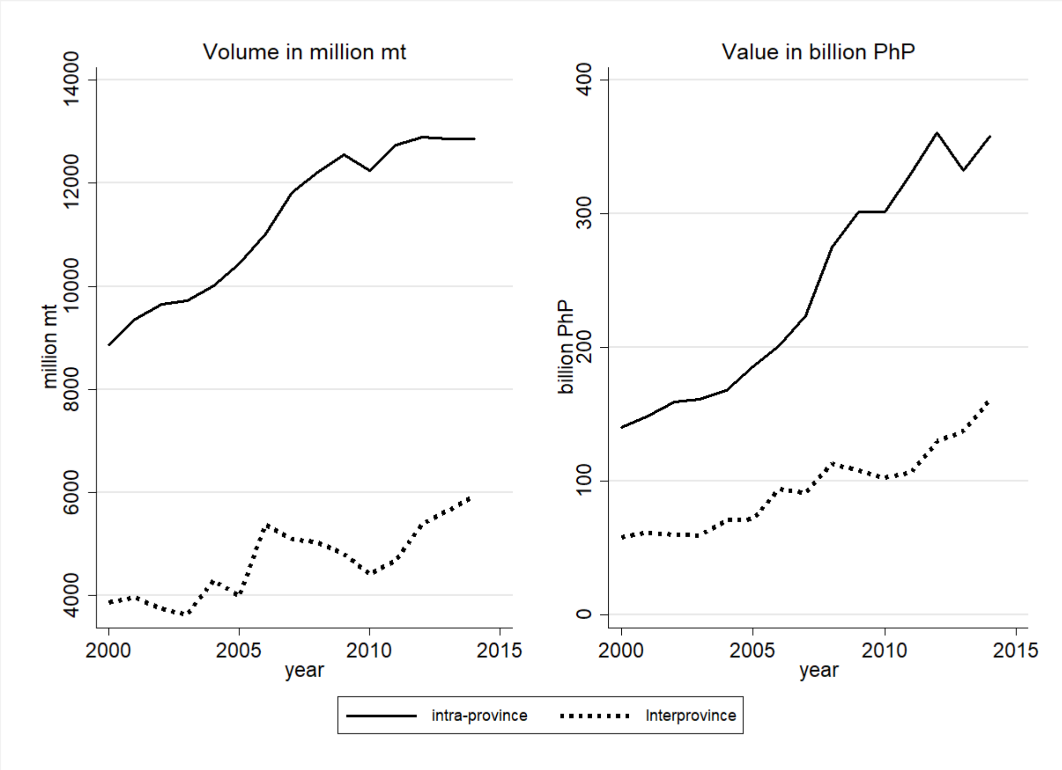
Information on language is obtained from the Philippine Census of Population and Housing 2000.

Finally, the process of building the data set for the starting dates of RRTS service by route is described in Section 2.1.

The resulting data set is a balanced panel of 40,650 observations, covering exports

[3] Consumption estimates are available for 1999. However, a change in sampling methodology implemented between 1999 and 2008 renders the series incomparable across time.

Figure 3.2: Inter- and intraprovincial trade in agriculture



Source: Author

from 60 provinces and bilateral trade between 822 province pairs. Four percent of the observations comprise land trade, and intraprovince flows account for 13% of the observations. 'Always zeroes' are not included in our observation. However, an unreported flow is assumed to be zero if a province pair-product has recorded positive trade in at least one year during the period of our study. Zeroes comprise 50.9% of the observations suggesting highly irregular trade flows between provincial pairs across products. Among seaborne interprovincial trade, 32% of the province pairs became linked by RRTS.

The information compiled from all the sources detailed above yields Figure 3.2, which shows the evolution of inter and intraprovince agricultural trade. Both are generally increasing, but intraprovince trade is at least twice as large as interprovince trade and has moreover increased faster. This is observed in both volume and value, and is suggestive of biting province border effects. Nonetheless, this figure belies heterogeneity across products and provinces. Table 3.1 provides a summary of the average intra- and interprovince trade by commodity.

Table 3.1: Average inter- and intraprovincial trade by product

Product	Interprovince		Intraprovince		Observations	
	Quantity (MT)	Value (million PhP)	Volume (MT)	Value (million PhP)	% Zeroes	Total
Banana	659.9	10.3	80912.3	1257.7	51.7	3930
Cabbage	10.7	0.2	4131.3	71.5	57.0	1440
Calamansi	38.6	0.7	780.3	17.5	58.9	1905
Carrots	18.7	0.6	2136.3	69.4	59.6	1605
Cassava	1695.2	21.3	20150.6	271.0	52.0	2250
Chicken	17.5	1.2	2093.7	133.0	54.5	1920
Corn	5961.9	74.6	50042.5	679.2	44.7	4410
Mango	1754.6	52.5	10050.8	321.7	44.0	3540
Onion	332.4	14.3	1487.6	70.2	45.8	3255
Pineapple	52.0	1.1	30415.6	649.3	52.1	3015
Pork	640.9	24.1	13920.7	951.3	52.6	1545
Potato	531.6	15.3	1150.7	37.1	56.9	1890
Rice	5134.6	124.2	106081.7	2475.0	51.3	7530
Tomato	343.1	6.3	1575.6	31.0	50.1	2415
Mean	2076.0	42.5	29890.6	640.0	50.9	40650

Source: Author

3.4 Results

3.4.1 Evaluating the trade effects of the RRTS

The effect of the RRTS on agricultural trade flows is first estimated by controlling for traditional gravity covariates, and accounting for year interacted with origin, destination, and product fixed effects as described in equation 3.5. The results in column (1) of Table 3.2 suggest that RRTS increased trade in connected provinces by close to 300% $[(e^{1.363} - 1) \times 100\%]$. Among the gravity covariates, only distance is a significant determinant of trade. A one percent increase in distance reduces trade values by 0.43%.

Results from the preferred specification with province pair fixed effects are in column (2). In this set of results, the RRTS coefficient is substantially smaller at 0.31 demonstrating the importance of controlling for unobserved pair characteristics that exert positive bias on the RRTS effect. The coefficient implies that province pairs connected by RRTS trade 36% more compared to similar pairs that are not linked. In column (3), origin and destination year fixed effects are added to pair fixed effects and this improves the precision of estimates. Finally, as a robustness test, columns (4) to (6) present the results for regressions with the volume of trade rather than value as dependent variable. Here too, the positive effect of the RRTS on trade flows is apparent.

In Table 3.3, the spillover effects of RRTS to adjacent provinces is examined by introducing a variable, $Spill_{ij,t}$ that is equal to one for a non-RRTS province that is trading with an RRTS-linked province. The results from the preferred specification in columns (2) and (3) suggest that effects on trade flows for neighboring non-RRTS provinces are insignificant. This confirms that the increase in trade flows between RRTS provinces do not come from displacing trade from unconnected provinces.

Table 3.2: RRTS and interprovincial maritime trade

Dependent variable: Value and volume of trade						
	Value	Value	Value	Vol	Vol	Vol
	(1)	(2)	(3)	(4)	(5)	(6)
RRTS	1.366***	0.311*	0.348***	1.556***	0.351*	0.437***
	(0.253)	(0.164)	(0.120)	(0.273)	(0.188)	(0.123)
Log distance	-0.430***			-0.0864		
	(0.114)			(0.139)		
Language	0.0144			0.314		
	(0.253)			(0.246)		
Observations	30,300	30,300	30,300	30,300	30,300	30,300
Origin-year FE	Yes	No	Yes	Yes	No	Yes
Dest-year FE	Yes	No	Yes	Yes	No	Yes
Product-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair FE	No	Yes	Yes	No	Yes	Yes

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

Table 3.3: RRTS spillover effects

Dependent variable: Value of trade			
	(1)	(2)	(3)
RRTS	1.300***	0.319*	0.343***
	(0.334)	(0.187)	(0.118)
Spillover	0.933***	-0.179	0.197
	(0.334)	(0.168)	(0.212)
Log Distance	0.290		
	(0.244)		
Language	0.705**		
	(0.292)		
Observations	30,270	30,270	30,270
Origin-year FE	Yes	No	Yes
Dest-year FE	Yes	No	Yes
Product-year FE	Yes	Yes	Yes
Pair FE	No	Yes	Yes

Robust standard errors in parentheses clustered
at province pairs; *** p<0.01, ** p<0.05, * p<0.1

3.4.2 Provincial trade frictions

This section estimates trade frictions between provinces and examines how the RRTS influenced their trajectory. Table 3.4 summarizes the results. Intraprovincial flows are first excluded in columns (1) and (2) as baseline comparisons. The distance coefficients exhibit the expected signs and magnitudes. The dominant role of trade by land is very apparent and reflective of its large share in domestic trade for the big island groups of Luzon and Mindanao.

The coefficient on language suggests that provinces sharing a common language trade 43% less with each other. One potential explanation is that provinces belonging to the same region and hence share similar languages also tend to produce the same agricultural products that are not traded with each other. For example, Benguet and Mountain Province both in the Cordillera Administrative Region share the Ilocano language and produce highland vegetables, which are marketed to other parts of the country. The negative language effect disappears when allowing for possible non-linear effects of distance in column (2). Distance is classified as short if province pairs are less than 402 kilometers apart. This represents the distance between Zamboanga del Sur and Tawi-Tawi, which is the second farthest province pair currently serviced by a RORO ship in the data set.[4]

The estimates in columns (3) and (4) include intraprovince trade but is limited to maritime flows. The distance elasticities are in line with expectations. The province border effect as captured by *Smprov* is positive and highly significant, although the effect is no longer significant under a non-linear distance specification. This points to possible collinearity in larger overlaps with *Smprov* and the short distance indicator in a reduced sample size. Finally, columns (5) and (6) present the results for the entire observation, showing province border effects to be positive and highly significant under both the linear and non-linear distance specifications.

The estimated trade friction coefficient ranges from 3.33 to 3.97. These estimates

[4] The farthest distance is over 500 kilometers between the centroids of Metro Manila and Palawan. But this represents a special case since RORO services in this route cater mostly to passengers and tourists rather than cargo operations.

Table 3.4: Province border effects

Dependent variable: Value of trade						
	Base	Base	Sea	Sea	Full	Full
	(1)	(2)	(3)	(4)	(5)	(6)
Log distance	-0.670***	-0.782***	-0.479***	-0.460***	-0.406***	-0.504***
	(0.0796)	(0.106)	(0.128)	(0.122)	(0.0826)	(0.0847)
Short dist		-1.121		2.216		-1.442
		(1.191)		(1.601)		(1.157)
Log dist x Sh.		0.0686		-0.484*		0.201
		(0.210)		(0.286)		(0.205)
Language	-0.599**	-0.298	0.292	0.261	0.199	0.278
	(0.259)	(0.246)	(0.245)	(0.288)	(0.186)	(0.188)
Land	3.799***	4.185***			4.370***	4.527***
	(0.222)	(0.280)			(0.190)	(0.239)
Smprov			3.218***	0.904	3.329***	3.970***
			(0.852)	(1.557)	(0.502)	(1.016)
Observations	35,040	35,040	39,105	39,105	40,650	40,650
R-squared	0.880	0.882	0.638	0.638	0.670	0.671

Robust standard errors in parentheses clustered at province pairs.
Regressions include origin and destination province-year, and product-year FEs.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

indicate that provinces trade 28 to 53 more times with themselves than with other provinces. These are large effects. Nonetheless, they are in the range of border effect estimates in the literature. In a survey by Havranek and Irsova (2017), international border effect estimates for developed countries are around 0.54 to 2.19, whereas coefficients for emerging countries are around 3.2. The border effects in Table 3.4 are larger and refer to domestic border effects. However, domestic border effects have been found to dwarf international border effects in some studies such as in Coughlin and Novy (2013) and Anderson and Yotov (2010). Moreover, the archipelagic geography of the Philippines presents a unique set of challenges for interprovince trade.

Border effects are not to be interpreted as trade cost per se. Rather, they capture a whole range of different frictions that prevent trade from freely flowing between provinces. Among others, they include transport and storage costs, product characteristics, marketing costs, information frictions, and government policies affecting movement of products such as quarantine restrictions.

Table 3.5: RRTS and province border effects

Dependent variable: Value of trade		
Variables	(1)	(2)
Log distance	-0.396***	-0.463***
	(0.0889)	(0.0852)
Short distance		-1.183
		(1.485)
Log dist x Short		0.173
		(0.265)
Language	0.429***	0.483***
	(0.163)	(0.186)
Land	4.553***	4.665***
	(0.216)	(0.288)
Smprov	3.926***	4.526***
	(0.566)	(1.341)
RRTS x Smprov	-0.443**	-0.437**
	(0.187)	(0.184)
Observations	36,600	36,600

Robust standard errors in parentheses clustered at province pairs
Regressions include origin and destination year, and product-year FEs
*** p<0.01, ** p<0.05, * p<0.1

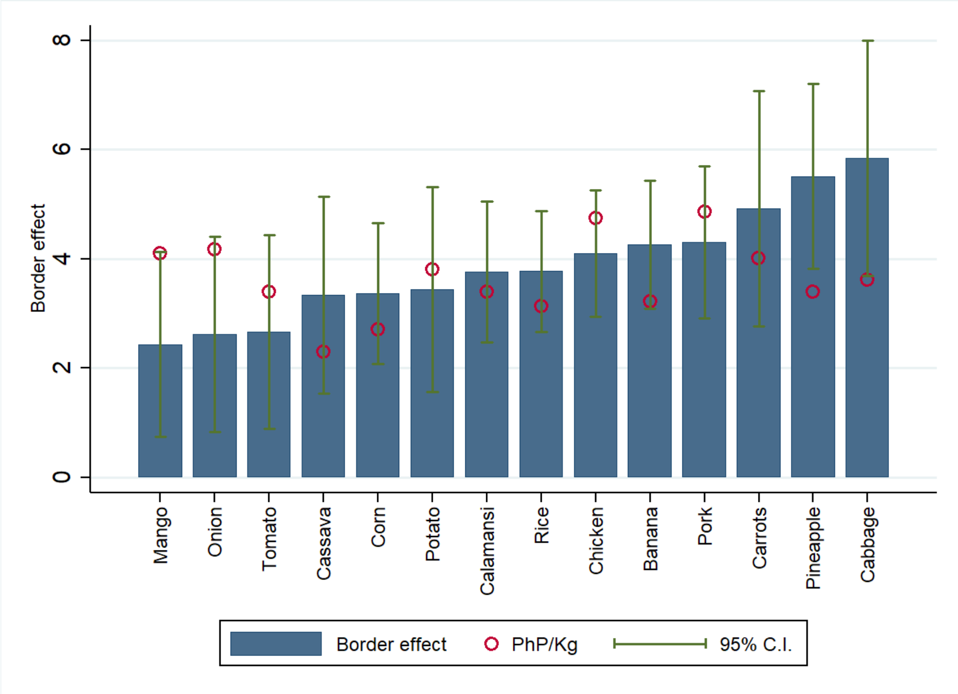
The impact of the RRTS on domestic border effects is estimated by interacting the same province dummy with the RRTS indicator, $Smprov_{ij} \times RRTS_{i,t}$. For this set of analysis, only provinces that can potentially be connected by RRTS are included, i.e. landlocked provinces are excluded. This reduces the number of provinces in the sample from 60 to 51. The results in Table 3.5 suggest that RRTS reduced overall trade frictions by 35 to 36 percentage points, equivalent to a factor of 0.64 to 0.65. This is consistent with the earlier set of results that RRTS raised interprovincial maritime trade flows.

Varying by product

Thus far, equation 3.7 has been estimated assuming homogeneous effects across provinces, time, and products. This assumption is now relaxed to let border effects vary by product, time, and provinces.[5]

[5] Non-linear distance specification do not work well with product, time and province varying border effects. Variance inflation factor analysis reveals a very high degree of collinearity when non-linear distance variables are included.

Figure 3.3: Border effect by product



Source:Author

Border effects by product are estimated by interacting $Smprov_{ij}$ with product dummies, δ^k. The resulting border coefficient for each product is presented in Figure 3.3. The regression returns positive and statistically significant border effects for the 14 products. The gravity covariates are collected in the first column of Table A-6 in the Appendix.

Setting aside product characteristics, lower value products ought to have higher border effects because low value to weight ratio means that the share of shipping costs in the delivery price is higher. To a certain extent, this is part of the story in Figure 3.3. But it is also apparent that other product characteristics play an important role in determining tradeability.

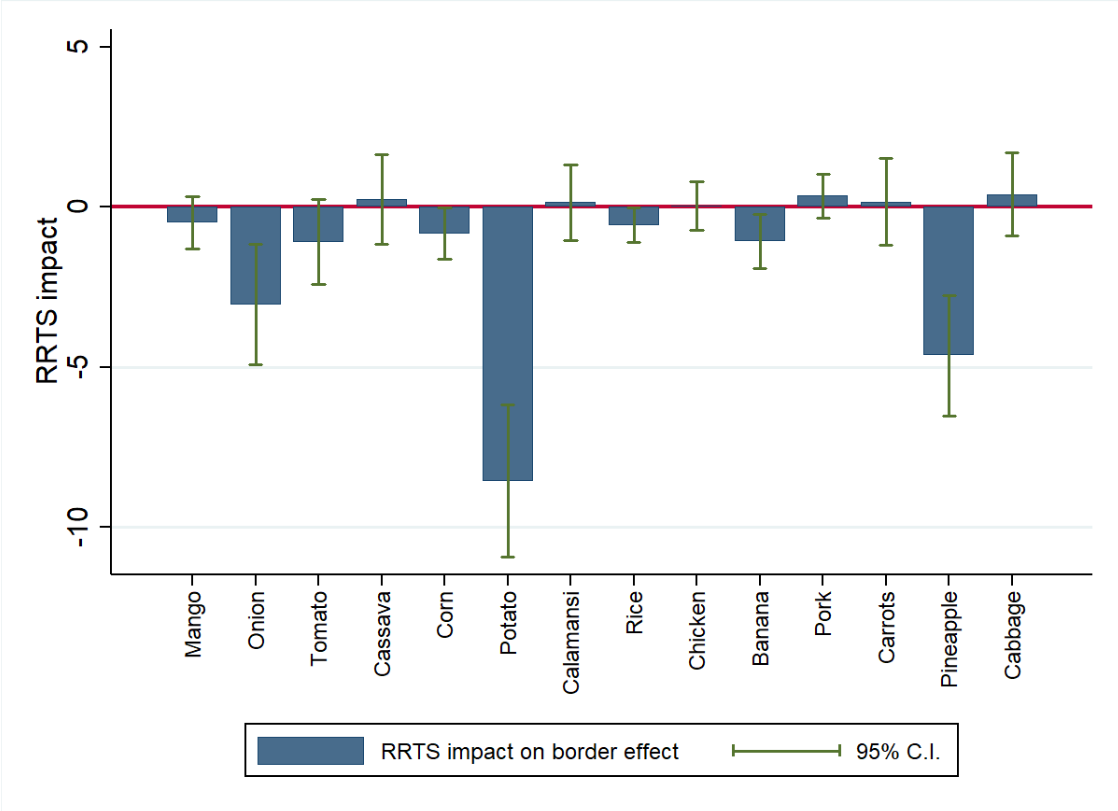
For example, chicken and pork, despite their higher value, require special handling in the form of refrigeration. Pork is also not consumed, and therefore barely traded in predominantly Muslim provinces. The border estimates likewise capture policies that apply to certain products. For instance, until 2015, pork from Luzon could not be transported to Mindanao and Visayas without quarantine clearance, the latter two regions being recognized by the World Organisation for Animal Health as free from foot and mouth disease (BAI 2015).

Bananas and pineapples, on the other hand, have post harvest losses averaging above 30%, and thus also require careful handling because of their high perishability (Andales, 2000). Both products are traded internationally in high volumes, and are mostly exported in their processed forms, with processing plants locating near the sources of raw materials. These exporting and processing activities are accounted for in the imputation of intraprovince and land based trade. Nonetheless, both products also exhibit heterogeneity in terms of the variety exported and those consumed locally. For example, Cavendish bananas are destined for exports whereas local consumption is more often that of sweet plantains and *lacatan*, which are of lower value.

Mangoes, onions, and tomatoes have the lowest border effects. This appears to be driven by a mix of higher unit values and geographic specificity in terms of production - tomatoes in Bukidnon, and onions in Nueva Ecija and Pangasinan. And yet, the geographic specificity of carrots and cabbage, both highland vegetables predominantly produced in Benguet and Bukidnon, did not translate to greater tradeability. A possible explanation could be that Philippine household consumption of some vegetables such as cabbages are highly price elastic at 1.9 compared to others such tomatoes at 0.78 (Mutuc et al., 2007).

Grains are widely produced throughout the country, and also widely traded at the same time. They comprise the majority of the volume traded among the 14 products, and yet still exhibit substantial border effects. On the one hand, the border effects can be thought of as lower than expected given the bulky and low value nature of grains and cereals. Nonetheless, three aspects may counter the transport cost effect: (i) they are staples. This is most apparent in the case of rice where the government's rice buffer stocking system directs about 5% of rice trade flows (NFA, 2017); (ii) cassava, and especially corn, aside from being staples, are also main feed ingredients for the livestock and poultry sectors; and (iii) they generally require a lesser degree of specialized handling and storage.

Figure 3.4: Reduction of border effects from RRTS, by product



Source: Author

Differences in product characteristics mean that the RRTS may have affected frictions across products heterogeneously. This is explored by letting $Smprov$ vary by product and RRTS connection status as captured by the coefficient from $Smprov_{ij} \times RRTS_{i,t} \times \delta^k$.

The border effect reductions by product are shown in Figure 3.4. Eight of the fourteen products reduced their border effects with RRTS access. Products that are produced in specific provinces such as onions and potatoes benefited the most from the RRTS bringing their border effects to almost zero. Bananas and pineapples, with their highly perishable nature also exhibited considerable reductions. Border frictions for the staples – rice and corn – also decreased modestly. The RRTS did not have any discernible impact on the border effect of carrots. Finally, there are four products for which the RRTS may have even increased border effects – cabbage, cassava, pork, and chicken. Coefficients on the gravity covariates are reported in Table A-7.

Varying over time

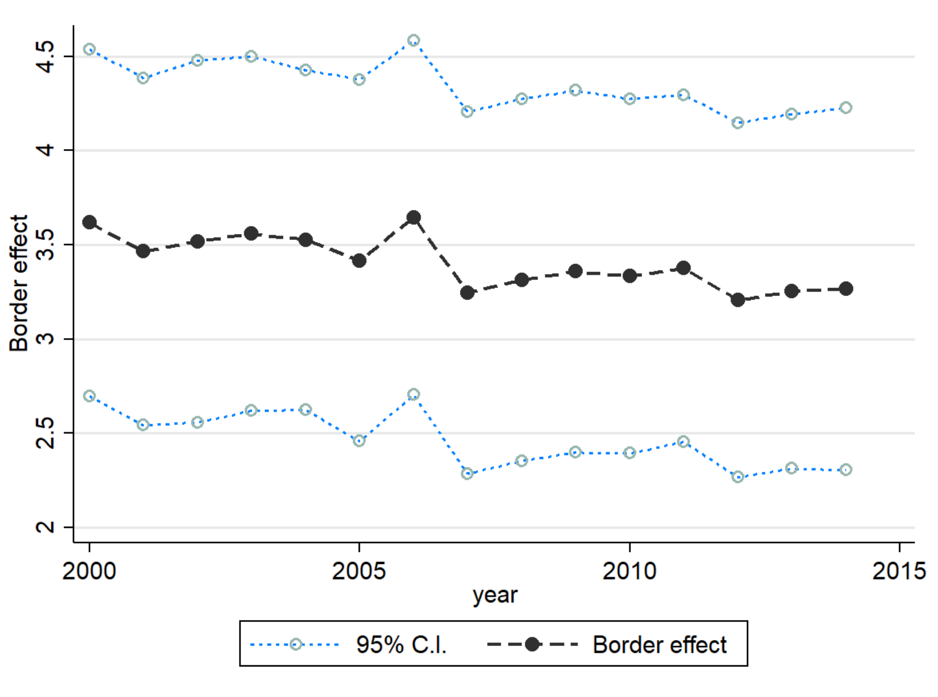
$Smprov_{ij}$ is interacted with year dummies to track the evolution of border effects over time. The evolution of province border effects over the years is illustrated in Figure 3.5.[6] Province border frictions remained stable over time with possible modest declines. The spike in friction in 2006 coincides with a sudden 15% increase in cargo handling charges for liner operations after having remained constant for the previous four years (ADB, 2010). However, the confidence intervals suggest that the border friction in 2014 is not necessarily different from the starting point in 2000.

The growing network of RRTS ought to translate to greater dampening of border frictions over time. The effect of RRTS on the evolution of province trade frictions is investigated by letting $Smprov_{ij}$ vary by RRTS linkage status and years, $Smprov_{ij} \times RRTS_{i,t} \times Yr_t$.

In Figure 3.6, RRTS is shown to reduce border effects for most years. However, the reduction is not continuous and cumulative as one would expect given the RRTS network expansion over time. The largest reductions are in 2009 and 2010, which coincide with the expansion of RRTS links in Batangas-Masbate, Capiz-Masbate, Cebu-Camiguin, Cebu-Masbate, Cebu-Misamis Oriental, Cebu-Surigao del Norte, and Lanao del Norte-Misamis Occidental.

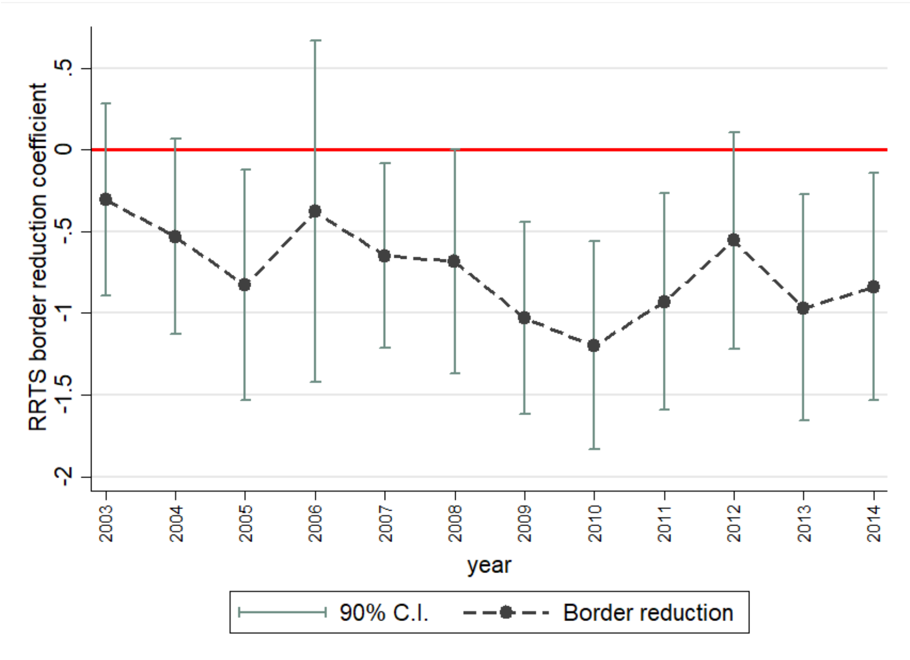
[6] Gravity covariates are in Table A-7.

Figure 3.5: Border effects through time



Source: Author

Figure 3.6: Reduction of border effects from RRTS by year



Source: Author

Varying by province

Province-specific border effects are estimated by letting $Smprov_{ij}$ vary by exporting province. Figure 3.7 visualizes the estimated border frictions in the Philippine map for 54 (out of 60) exporting provinces that can be retrieved. The estimates behind the figure are in Table A-8.

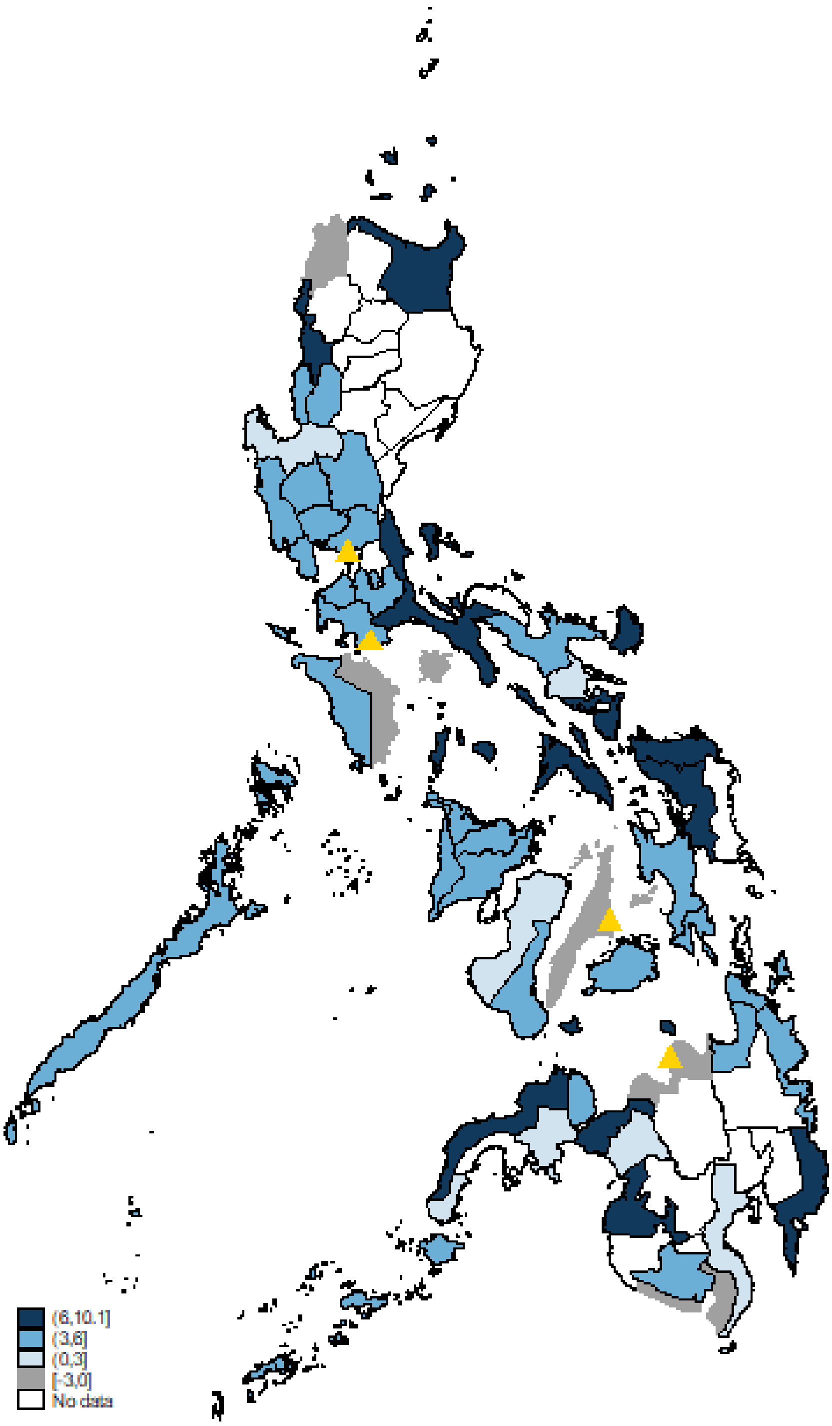
Border frictions vary widely across provinces. Darker shades represent higher border effects, and these tend to congregate in the Eastern seaboard. Aside from being some of the poorest provinces, and their geographic remoteness from major economic regions, they also tend to be where tropical cyclones forming in the Pacific Ocean frequently make their first landfalls.

With the exception of Batangas, provinces with large ports indicated by a triangle in the figure have zero or negative province border effects. These are Cagayan de Oro in Misamis Oriental, and Cebu City in Cebu. The significant border effect in Batangas despite its major port operations can be explained by several factors. First, it is a highly populated province which consumes a substantial portion of its own production. It is a net importer of 12 out the 14 products considered in this study. Second, the products in the data set comprise a small fraction of its outbound cargo operations – roughly 1% in 2000, rising to 5% in 2014 (PPA, 2017). In contrast, the proportions for the port in Cagayan de Oro are 7% and 25% respectively.

Provinces along the three main vertical trunks in Figure 2.1 do not necessarily coincide with having lower province border effects. A possible exception is the western trunk although the southern end of the link in Zamboanga del Norte has a high friction. On the other hand, Sorsogon, the northern tip of the central and eastern trunks, exhibits a high border effect.

A number of provinces surrounding Metro Manila exhibit moderately significant border effects. These provinces fall in the region of Central (Region III) and Southern Luzon (Region IV-A or CALABARZON). This may at first be surprising given their proximity to a large market. But while being large producers and exporters, these regions are also considerable markets in themselves with high urban populations and

Figure 3.7: Province border effects



Source: Author

light industry manufacturing firms that consume most of the agricultural products they produce. CALABARZON, in particular, is the most populous region of the country (PSA, 2015).

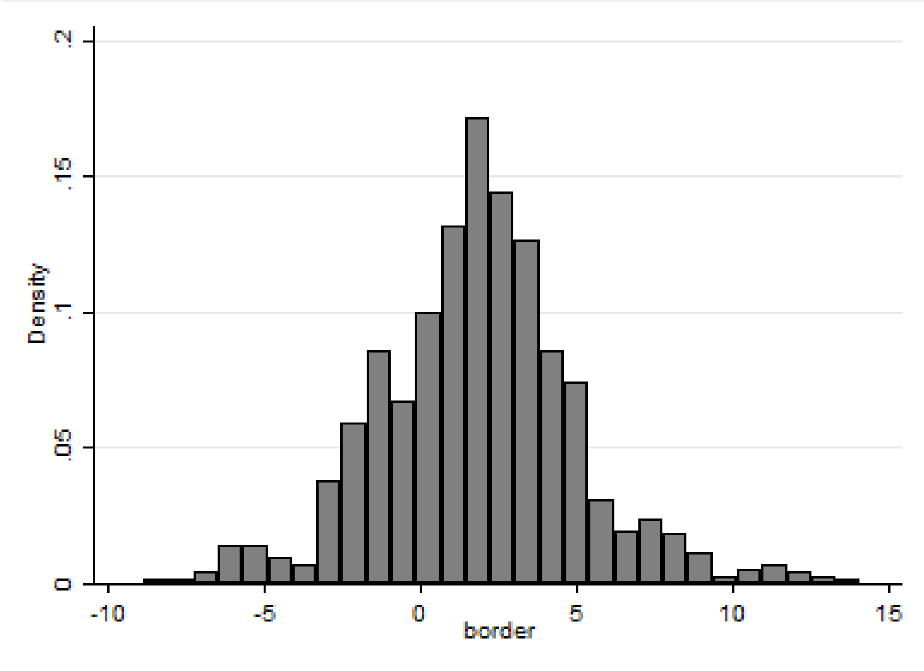
An examination of the relationship between the log of provincial land area size and province border effects suggest that the spatial attenuation bias alluded to by Coughlin and Novy (2016) is not a primary concern. The two variables are negatively correlated by about 10% to 12%, but this relationship is statistically insignificant. Potentially, the island geography of some provinces counters the biases arising from spatial aggregation.

The evolution of border frictions for each province can be examined by letting $Smprov_{ij}$ vary through time and provinces, i.e. $Smprov_{ij} \times \eta_i \times Yr_t$.

Figure 3.8 plots the distribution of the 900 time-varying province border effects. The majority of the estimates range between one and five, but there are also province-year combinations that exhibit negative border frictions, indicating that their internal trade is smaller than their interprovince trade. This is true and unsurprising for Cebu and Misamis Oriental, which are domestic shipping hubs, and may partly be caused by transshipment activities. But there are also a number of other provinces that exhibit negative borders such as Bukidnon, Davao Oriental, Ilocos Norte, Isabela, North Cotabato, Oriental Mindoro, Sarangani, and Sultan Kudarat. These provinces tend to export much of what they produce to more populous provinces.

In Figure 3.9, the starting border effect of provinces are plotted against their 2014 levels. For provinces that are linked by RRTS to other provinces, the earliest border effect estimates refer to the first year of RRTS connection. The dots represent provinces that have RRTS links whereas the crosses are provinces that were never linked (landlocked provinces are not included). The 45 degree line plots the starting border effect of each province. Provinces above the line increased their border frictions relative to their 2000 or RRTS starting year levels, whereas those below experienced decline. A larger share of non-RRTS provinces decreased their 2000

Figure 3.8: Distribution of province-year border effects



Source: Author

borders relative to their 2014 levels compared to those that are connected to the RRTS. Hence, the association between RRTS linkage and declining border effect is not clear.

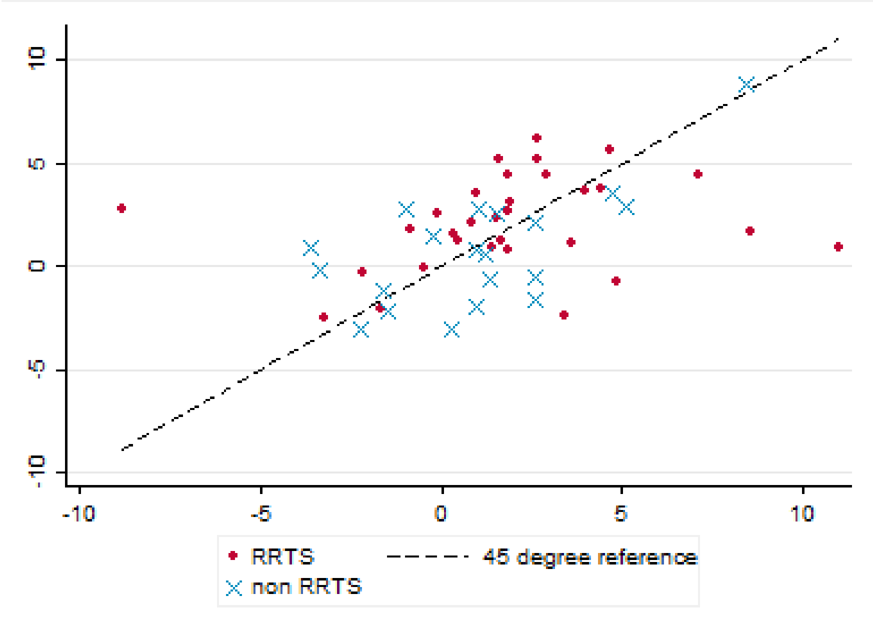
Formally, the impact of the RRTS on the border effect of each province is estimated by letting $Smprov_{ij}$ vary by province and RRTS linkage status, $Smprov_{ij} \times RRTS_{i,t} \times \eta_i$.

The change by province – increased, decreased, no change – is visualized in Figure 3.10. Estimates for each province is summarized in Table A-9.

The RRTS had widely different effects on the border effects of provinces. Batangas, Occidental and Oriental Mindoro, colored in green, reduced their border effects significantly. The same applies to Marinduque even though its border effect was negligible even prior to the RRTS. All four provinces are geographically proximate and linked by RRTS with each other. The proximity to Metro Manila is also easily appreciated in the figure.

Nonetheless, there are also provinces that heightened their border effects following RRTS connection. The increases are largest for Basilan (+3.6), Sorsogon (+3.2), and Tawi-tawi (+3.2). The small island of Camiguin (+2.9), albeit being

Figure 3.9: Pre and post RRTS border effects by province



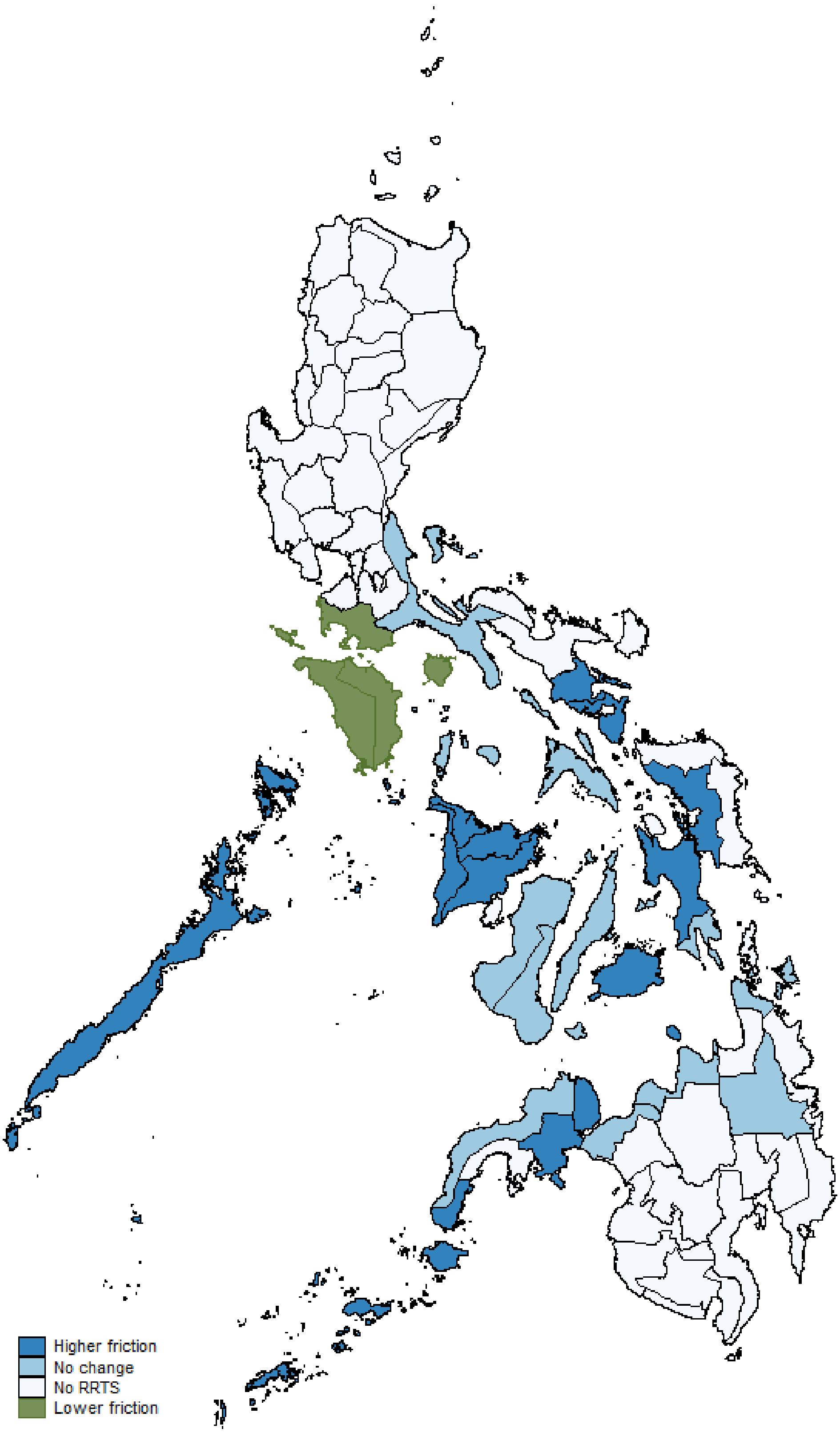
Source: Author

linked by RRTS to Bohol, Cebu, and Misamis Oriental heightened its border effect. Nonetheless, the Camiguin-Cebu RORO service only operates once a week, and that of Bohol-Camiguin once a day. As suggested by JICA (2007), service frequency is key to reaping the benefits of the RRTS.

It is notable that the RRTS linked group of provinces in the southwestern extremities of the Philippines – Basilan, Sulu, Tawi-Tawi, and Zamboanga del Sur – all heightened their border effects after RRTS linkage. The lack of gains from the RRTS can possibly be due to the long distances separating these islands from each other, and their remoteness from major sea ports such as Cagayan de Oro and Cebu. Provinces that lowered their border effects are concentrated to those that are near Metro Manila. Taken at face value, this suggests a reinforcement of the north to south trade imbalance that liner shipping operators allude to. In this sense, the goal of EO 170 of facilitating export of agricultural products from the poorer and more rural provinces to big demand centers was only realized to a limited extent. The welfare implications of these results are worthy of a separate in depth empirical inquiry.

Nonetheless, it is also important to keep in mind some limitations of our meth-

Figure 3.10: Change in border effects from RRTS, by province



Source: Author

odology. First, border effects only capture the exporting activities of provinces. Consider as example the RRTS-linked provinces of Cebu and Leyte. Suppose the RRTS caused Cebu's exports to Leyte to increase, but not vice-versa, then Cebu will show up as having lowered border frictions while Leyte's frictions may not change, or may even increase if its production is rising but it remains a deficit province. This is a potential explanation for the intensification of border effects for Albay, Bohol, and Leyte.

Second, in using provinces as unit of observation, connectivity issues within a province is implicitly assumed to be negligible. This can affect border estimates in several ways. A province may show up as increasing its border effect if municipalities within a province are becoming better connected with each other by land, and this is developing faster than the improvement of maritime links with other provinces. On the other hand, provinces may be too broad as a unit of observation if road networks within a province are poor, such that the benefits of the RRTS are only confined to the municipality linked by RRTS but do not trickle through to the rest of the province. Finally, RRTS can potentially increase border estimates if it improves connectivity within a province, since some provinces comprise several islands themselves. Nonetheless, an examination of within province maritime trade suggest this mechanism can be ruled out for our case.

3.5 Conclusion

The Philippine Government established the RRTS with the aim of bringing down domestic maritime trade costs in the country.

Estimated border effects suggest that conditional on distance and province characteristics, an province in the Philippines trades 28 to 53 times more with itself than with other provinces. The introduction of the RRTS reduced this home bias tendency by a factor of 0.64 to 0.65. This is confirmed with findings that link RRTS to enhanced interprovincial maritime trade flows of agricultural products. Province pairs that are connected by RRTS trade 36% more compared to similar province pairs that do not have access to the infrastructure. This does not stem from diverting trade from provinces without RRTS connection.

A closer examination reveals heterogeneity in the distribution of border effects along the dimension of product and provinces. Among products, tomatoes, onions, and mangoes have the lowest border effects, while cabbage and pineapples have the highest. This pattern is likely due to a mixture of product characteristics having to do with geographic specificity in production and income elasticity of demand. Majority of the products in the study saw decline in border effects following the introduction of RRTS. In particular, the border effect practically disappeared for onions and potatoes – products that are produced in limited locations in the Philippines.

Province border effects are lowest for major trading provinces such as Cebu (Cebu City) and Misamis Oriental (Cagayan de Oro), and highest for many provinces that are remote from main economic centers of their respective regions. The introduction of the RRTS decidedly reduced the border effects for a few provinces that are near Metro Manila – Batangas, Marinduque, Occidental and Oriental Mindoro – but did not change the border effects for most of the provinces. However, remoter provinces in Southwest Mindanao apparently heightened their border effects. The combination of results suggest a possible crowding out of trading activities in provinces that require longer distance RRTS connections and are remote from big demand centers. The implication is that to the extent that exports of agricultural products of remote provinces are concerned, RRTS in itself may not be a sufficient means of establishing sustained market access. Complimentary investments that enhance productivity such as post harvest facilities may be necessary for provinces to benefit from the xport enhancing opportunities that the RRTS offers.

Chapter 4

Shipping Technology, Trade Costs, and Trade Patterns in the Philippines

Changes in trade costs alter relative prices and therefore patterns of trade. In this chapter, we investigate how the RRTS influenced patterns of domestic maritime trade in the Philippines. We use the variation in the distribution of RRTS connections by route and the time of their introduction to identify effects along the intensive and extensive margins. We also relate specific features of the RORO ship and the transport system like smaller scale trade and lane meter charging to outcomes such as inventory management and the kinds of products that benefited the most from the RRTS.

Table 4.1 presents average trade figures based on the different types of shipping services. The average volume and value of trade are largest for a typical liner route, which also ship the greatest variety of products in a given year. In comparison, the value and volume of trade for the average RRTS route are small. Nonetheless, among the routes that eventually became connected by RRTS, there has been a doubling of average trade value and a 70% increase in average trade volume. Albeit, less dramatically, the average number of product types and the monthly frequency of

Table 4.1: Average trade indicators by shipping service, 2000-2014

	Liner	RRTS		Others	All
		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.

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.

Our 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 37% in the types of products traded, and a 1% point increase in the probability of exporting to a new non-RRTS destination. Average transaction frequency along RRTS routes also increased by 7%, suggesting inventory management as an important avenue of trade costs savings from the RRTS. Time-sensitive and high-value products systematically gained from the RRTS in terms of product variety and transaction frequencies. These gains do not come from displacing trade from non-RRTS ports. Finally, we also uncover evidence of the complementary role of the RRTS to other routes. On average, liners that have RRTS connections in both origin and destination have 52% larger trade values than liners without RRTS connections or where the connection is missing in one end.

To the best of our knowledge, this is the first empirical study that relates the RRTS to changes in patterns of trade. This is a first step in answering bigger questions about welfare distribution effects of the RRTS and how related policies can be designed to optimize development goals.

4.1 Related literature

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 the advent of container technology in global commercial trade. Exploiting the variation in timing, and 'containerizability' of particular products, Bernhofen et al. (2016) find that containers explain as much as 68% of the growth in trade compared to the pre-adoption period. Containerization reduced trade costs by streamlining the process of cargo handling which resulted in time and money savings, and minimized cargo damage. In particular, the efficiency gains can be traced to the improved interface between sea and land-based transport given that port costs account for the largest share of ocean shipping costs (Bernhofen et al., 2016).

In the last two decades, the introduction of fixed costs in trade cost models 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. However, the effects on the extensive margins dominate when the productivity of exporters approximates a Pareto distribution. Consistent with this prediction, a cross country study finds that the impacts of trade barriers on the trade volumes of homogeneous products are milder than for more differentiated ones (Rauch, 1999). In a sample of Swedish firms, Andersson (2007) also documents that changes in fixed costs manifest more strongly along the extensive margin (number of exporters). At the same time, the effect on the extensive margin is also stronger for more differentiated products.

The fixed costs of trade have important consequences for trade patterns. High fixed cost leads to 'lumpy trade' whereby traders economize on per shipment cost by shipping less frequently with larger volumes, effectively trading off fixed costs against inventory costs (Hornok and Koren, 2015). Alessandria et al. (2010) demonstrate that 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. This is reflected in the asynchronous pricing and purchasing behavior of firms following exogenous devaluation episodes. Hornok and Koren (2015) examine the effects of fixed costs as proxied by the monetary costs and number of days involved in processing imports in US and Spanish export destination countries. They find evidence of lumpiness across all product groups, but the frequency-shipment size trade-off is more pronounced for products that are time-sensitive such as food and beverages and products involved in the parts and components trade.

Aside from substitutability, product characteristics themselves feed into trade costs. Harrigan (2010) demonstrates this by analyzing the relationship among product value, the distance of trading partners, and the modal choice of transport. In the 1980s, air transport costs declined and air freight increasingly became a viable option for commercial trade. Nonetheless, 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 because air transport is unlikely to be more economical than surface transport along short distances. Shorter distances mean that the fixed cost per mileage of travel is higher. Indeed, countries more distant from the US have larger market shares in lightweight goods that use air transport. Conversely, countries nearer to the US like Mexico and Canada have greater market shares in heavier products that use surface transport.

Based on the studies cited, predictions about how the RRTS affects trading patterns can be complex. If RRTS proves a cheaper alternative than conventional shipping, lower value products will find RORO to be a more viable alternative. This implies gains along the extensive margins, as products that were previously unable to surmount trade costs become tradeable. The same applies to cities and municipalities that could not export their products prior to the RRTS. At the same time, higher value products have the advantage of lower fixed costs of trade because of the lane meter charging modality. Lane meter charging in RRTS 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. These product characteristics include their demand and substitution elasticity, which respond differently along the intensive and extensive margins. Finally, product characteristics also interact with distance, as RORO is only superior to conventional liner shipping in short distances (JICA, 2007).

The trade pattern implications of the RRTS have yet to be empirically studied. However, there is anecdotal evidence that RRTS altered delivery frequencies and inventory behavior. Following the RRTS launch, Nestlè Philippines closed down 33 of its 36 distribution centers in the country and started making smaller and more frequent deliveries directly to its clients from its plants in Luzon through RRTS routes. Universal Robina Corporation, also a large food manufacturing company used to ship once a week from Manila to the provinces through a liner service but has increased its delivery frequency to as often as 12 times a day through RRTS networks (Basilio, 2008).

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. 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). This is reflective of the relationship between liner and RRTS routes. Seen in this context, 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).

The possible trade displacement from the RRTS refers to a situation of nearby ports losing transactions to RRTS connected ports. Meanwhile, the idea of market access spillover effects is based on the literature on new economic geography, in which proximity and linkage 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 potentially means that ports and cities close to an RRTS linked locality effectively becomes closer to a market with enhanced demand, and as such face an expanded market access opportunity.

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 increased connectivity, market access, and incomes (Duranton 2010). Among these, Donaldson (2018) link the phased and military-motivated development of the rail network in India during the 20th century to increased trading activities of connected districts which also experienced higher real income growth. In the United States, connectivity brought about by the railway expansion in the 19th century increased market access of linked counties (Donaldson and Hornbeck, 2016), which was capitalized into the agricultural land values and in turn raised real incomes.

One of the stated motivations of the RRTS is to raise rural incomes and stimulate investments in the agricultural sector by connecting rural areas to larger demand centers. Understanding how trading patterns change in response to the RRTS is a first step in unpacking how changes in trade costs maps onto welfare distribution.

4.2 Methodology

We use the structural gravity model of Anderson and Wincoop (2003) 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 on heteroscedasticity in multiplicative models (Head and Mayer, 2013; Santos Silva and Tenreyro, 2006, 2011).

In equation 4.1, 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.[1,2] $Liner_{ij}$ is a dummy variable that is equal to one for port-pairs that were served by liners as of 1998. The multilateral resistance terms $\eta_{i,t}$ and $\theta_{j,t}$ correspond to city-year fixed effects that absorb trends in a city and municipality. 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.[3] $\kappa_{K,t}$ is a set of product group-year fixed effects which accounts for changes in demand and supply conditions within the country.

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

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

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

$$X^k_{ij,t} = exp[\delta\, RRTS_{ij,t} + \beta_1\, Lndist_{ij} + \beta_2\, Lang_{ij} + \beta_3\, Liner_{ij} + \\ \eta_{i,t} + \theta_{j,t} + \kappa_{K,t} + \epsilon^k_{ij,t}] \quad (4.1)$$

However, equation 4.1 does not account for possible selection of port-pairs into RRTS investment. In Chapter 2, we explained that the actual sequence of RRTS route development departed substantially from the original plans of the inter-agency team in 1992. Nonetheless, there are potential ways in which selection comes into play. For example, developments could have occurred after the feasibility study such as rapid growth in particular municipalities. To address selection and issues that lead to potential endogeneity, we adopt the strategy of Baier and Bergstrand (2007) of using pair fixed effects to identify the effects of RTAs on trade flows. This method has become a common identification strategy in the gravity literature in the absence of good instruments (Head and Mayer, 2013). Pair fixed-effects absorb the non-time varying characteristics between a pair of ports that make them 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 4.2. 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.

$$X^k_{ij,t} = exp[\alpha_{ij} + \delta\, RRTS_{ij,t} + \kappa_{k,t} + \epsilon^k_{ij,t}] \quad (4.2)$$

Trade patterns such as effects along the intensive and extensive margins, and heterogeneous effects across product characteristics are examined by modifying equations 4.1 and 4.2. For example, the impact of RRTS on product export variety is estimated by replacing $X^k_{ij,t}$ with $PCount^K_{ij,t}$, which corresponds to the number of products traded between i and j in year t for product group K measured at the 5-

digit level Philippine Standard Commodity Classification (PSCC). In investigating whether higher value products benefited more from the RRTS, $RRTS_{ij,t}$ is interacted with product value indicators to capture differential RRTS effects across the distribution of unit values of products. 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 the discussion of results in Section 4.4.

Finally, the effect of RRTS on the lumpiness of trade is examined through a decomposition method following Hornok and Koren (2015). This allows for an examination of how RRTS affected each component of annual trade flows, lending insights on 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 its composite element.

$$X^k_{ij,t} \equiv N^k_{ij,t} \times V^k_{ij,t} \tag{4.3}$$

In equation 4.3, $N^k_{ij,t}$ is the monthly frequency of bilateral shipments in a year; and $V^k_{ij,t}$, the average value of the shipment. In equation 4.4, $V^k_{ij,t}$ is further decomposed as the product of the average shipment quantity $Q^k_{ij,t}$, and average shipment price $P^k_{ij,t}$.

$$X^k_{ij,t} \equiv N^k_{ij,t} \times Q^k_{ij,t} \times P^k_{ij,t} \tag{4.4}$$

Each of these margins are then regressed on the gravity covariates in equations 4.1 and 4.2.

4.3 Data

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

The 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.

We build the data on RORO ports, routes, and their starting dates of service using various sources described in Section 2.1. These include the PSA Inventory of Ports; the MARINA inventory of RORO routes; information from the PPA; aid agency reports, newspaper articles; and a survey of RORO shipping companies. 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.

4.4 Results

4.4.1 Main results

The effect of the RRTS on trade is estimated through equations 4.1 and 4.2, and the results are summarized in Table 4.2. 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 for trade.[4] 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. $Short_{ij}$ is a dummy variable that is equal to one if a port-pair is not more than 185 kilometers apart, the median distance serviced by RORO ships in the sample. This time, only the short distance RRTS coefficient is significant suggesting 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 coefficient remains positive and significant albeit with a smaller magnitude. On average, results in column (3) show that RRTS raised 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 being connected in Table 4.1, RRTS increased average trade from 3.2 to 4.3 million PhP for an RRTS port-pair. In column (4), we see that this gain is mainly driven by short distance RRTS connections, which trade 39% more compared to similar but unconnected port-pairs.

In the bottom panel, the volume of trade is used in place of trade value as regressand to ensure that the RRTS effect we uncover is not purely due to price effects. The overall results are largely in line with the value regressions, although 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 the higher fixed costs of shipping them.

Figure 4.1 summarizes the RRTS effect by product group using the preferred specification corresponding to equation 4.2. Only eight product categories exhibit overall trade gains with RRTS connections. These are time-sensitive goods such

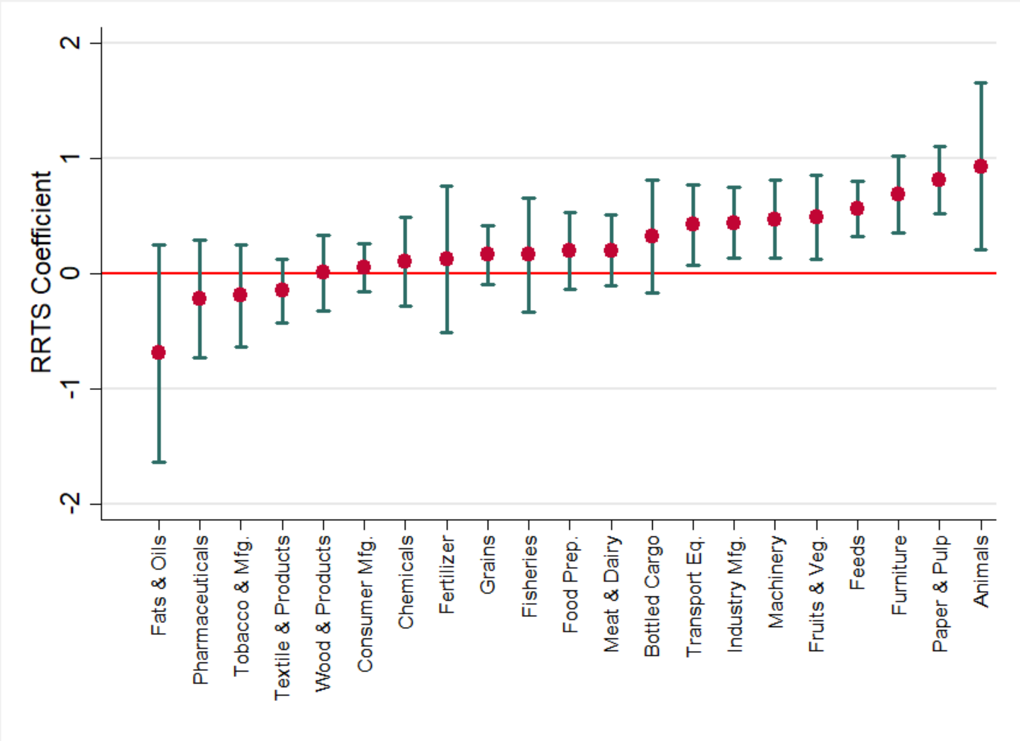
[4] The correlation between land contiguity and common language is 27% and is statistically significant at 1%.

Table 4.2: 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)		
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

Figure 4.1: 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.

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-10 in the Appendix reveal that the positive effects for live animals, and fruits and vegetables are mostly driven by the short RRTS connections. Moreover, RRTS also increases trade in fishery products in short distance routes.

For most product groups, the effect is positive but not statistically significant. 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

Having established an overall positive effect from the RRTS, we examine the effects on the intensive margin by limiting the sample to port-pair-product combinations that were being traded even before RRTS connections were introduced. The pre-

Table 4.3: RRTS effect on the intensive margin

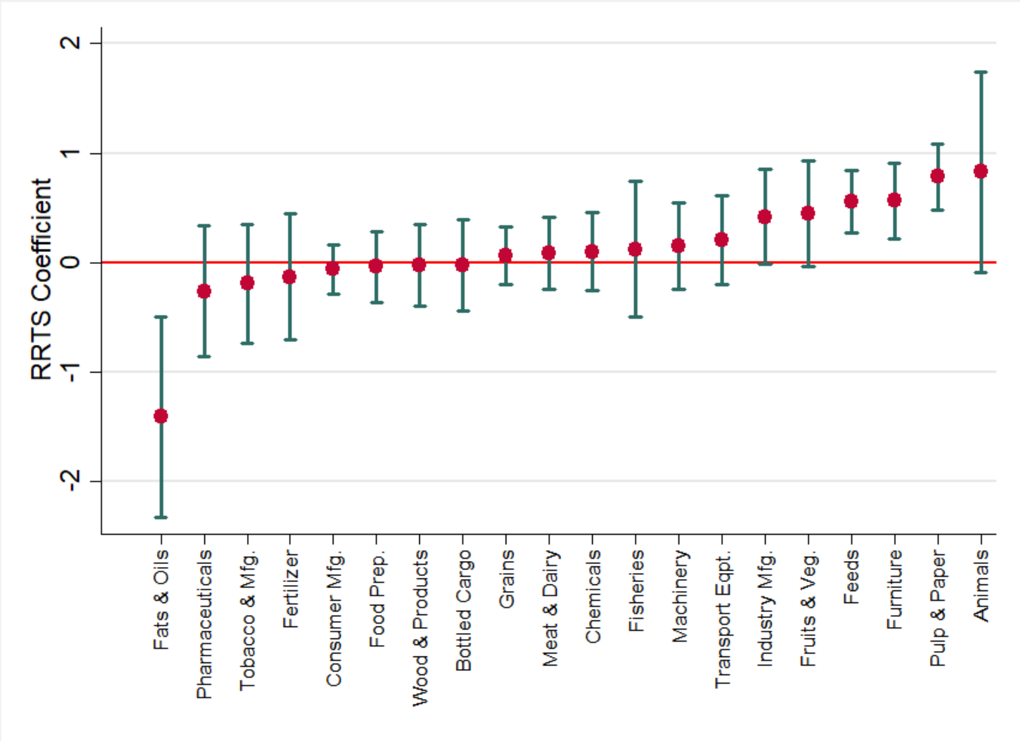
Dependent variable: Value of trade	(1)	(2)	(3)	(4)
RRTS	0.798***	0.0564	0.166*	-0.106
	(0.205)	(0.416)	(0.0903)	(0.188)
RRTS x Short		0.867**		0.296
		(0.430)		(0.200)
Short		-0.256		
		(0.201)		
Log distance	-0.112**	-0.146**		
	(0.0534)	(0.0591)		
Religion	-0.364*	-0.254		
	(0.193)	(0.204)		
Liner	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

ferred specification in column (3) of Table 4.3 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 in column (4) suggests that the intensive margin effects are stronger in short distance connections at 21% albeit only significant at 10%.

An examination of the by-product regressions presented in Figure 4.2 provides insights for 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%). However these are confined to the short distance connections possibly due to the time-sensitive nature of these products. While mostly positive, the effects in other categories are small and statistically insignificant. While lacking information about the elasticity of substitution for each product group, the results generally accord with the predictions of Chaney (2008) and Rauch (1999) of more substitutable products experiencing greater effects in the intensive margin. For example, feeds, furniture, and pulp and paper react more strongly compared to

Figure 4.2: 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 **??**

pharmaceuticals and consumer products.

The large and statistically significant negative effect on the intensive margin for fats and oils is notable. Shipments of fats and oils within the Philippines largely pertain to coconut and palm oil. Actual RRTS trade in fats and oils is actually increasing, though not at the pace at which it has grown in liner and non-RRTS routes. A potential explanation is that big oil milling companies have dedicated ports that handle their own oil shipments, which export directly to foreign markets. Based on field interviews, fats and oils are also increasingly shipped using food grade flexibags that are molded for twenty foot containers.

Extensive margins

The RRTS is also expected to expand the number of products and the number of export destinations as trade costs decline. Lower trade costs mean that some products that could not be traded previously can now surmount the trade costs and be exported. At the same time, products that are currently being exported can be sold to new markets. Moreover, the sidestepping of cargo handling procedures and lane meter charging modality of the RRTS impinges on the fixed costs of trade, which in turn is expected to manifest more strongly along the extensive margins.

The extensive margin as an avenue of adjustment for trade costs changes is documented to be quantitatively important (Chaney, 2008; Hillberry and Hummels, 2008; Santos Silva et al., 2014), and in some studies had proven to be the main driver of gains from trade (Hummels and Klenow, 2005). Changes in the extensive margins have potentially large welfare effects especially for remoter provinces that have very limited markets within reach because of high transport costs.

Product diversity

The effect of the RRTS on diversity in product exports is measured using counts 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 4.1 and 4.2.

Table 4.4 presents the effects of RRTS on product diversity. The preferred specifications in columns (3) and (4) suggest substantial gains, with RRTS routes having 36% more product variety than their unconnected counterparts. In terms of average product count prior to connection, RRTS increased the number of products being traded from 27 to 37, close to the breath of variety carried along the major liner routes. Although the coefficient on long distance RRTS connection is insignificant in column (4), the short distance coefficient is highly significant and close to the average effect in column (3) at 37%.

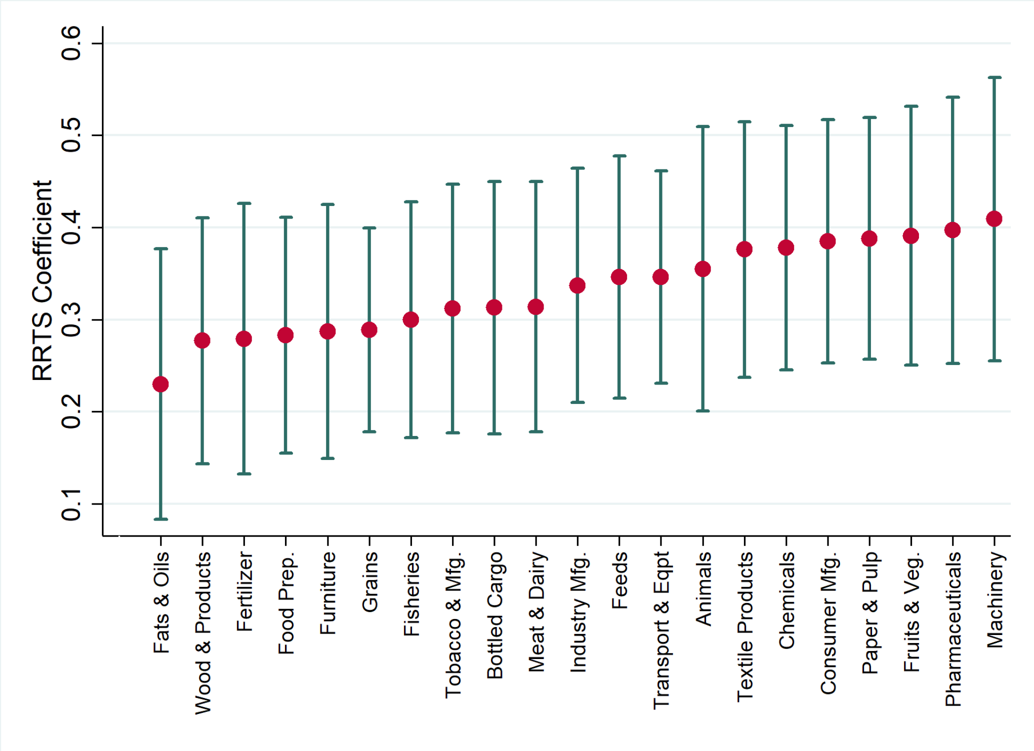
Table 4.4: RRTS effect on product diversity

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 4.3 shows that the product diversity effect of the RRTS is positive across all product groups. Generally, manufactured products appear to have gained the most. To some extent, this is an artifact of the number of products under each category. For example, there are 22 products defined 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 4.4, 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. While the RRTS coefficients that distinguish between distance thresholds are individually insignificant, estimates for the long distance connections are larger for most product groups except for live animals, and fats and oils. 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.

Figure 4.3: Product diversity effect by product group



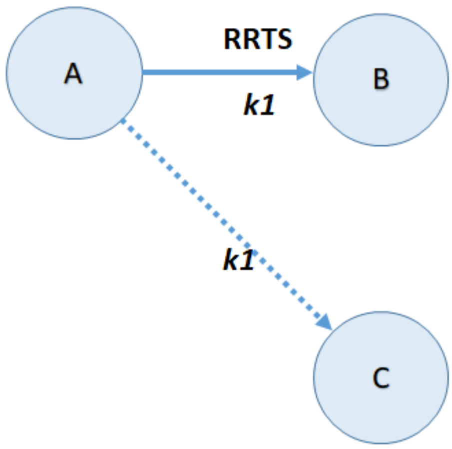
Source: Author
Note: Whiskers represent confidence intervals of 95%. All regressions include port-pair and year FEs with robust standard errors clustered at city pairs.

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 if there is "learning by exporting."

However, it is challenging to identify the RRTS effects on export destination expansion while addressing issues of selection through port-pair fixed effects. It is more feasible to examine whether the RRTS connection of a port-pair 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 4.1 and 4.2, we introduce $ProbX_{ij,t}^{k}$ as a dependent variable, which is 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 possible endogeneity since RRTS-enabled ports are more likely to receive RRTS investments to maximize

Figure 4.4: RRTS and new markets



Source: Author

network effects. Figure 4.4 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?

The estimates from a linear probability model in Table 4.5 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%.

The effect of the RRTS on the probability of exporting to new destinations is illustrated by product groups in Figure 4.5. With the exception of fisheries, all of the products that have greater likelihood of entering new export markets outside the RRTS networks are manufactured products. Probabilities of 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

Table 4.5: Probability of exporting to a new non-RRTS destination

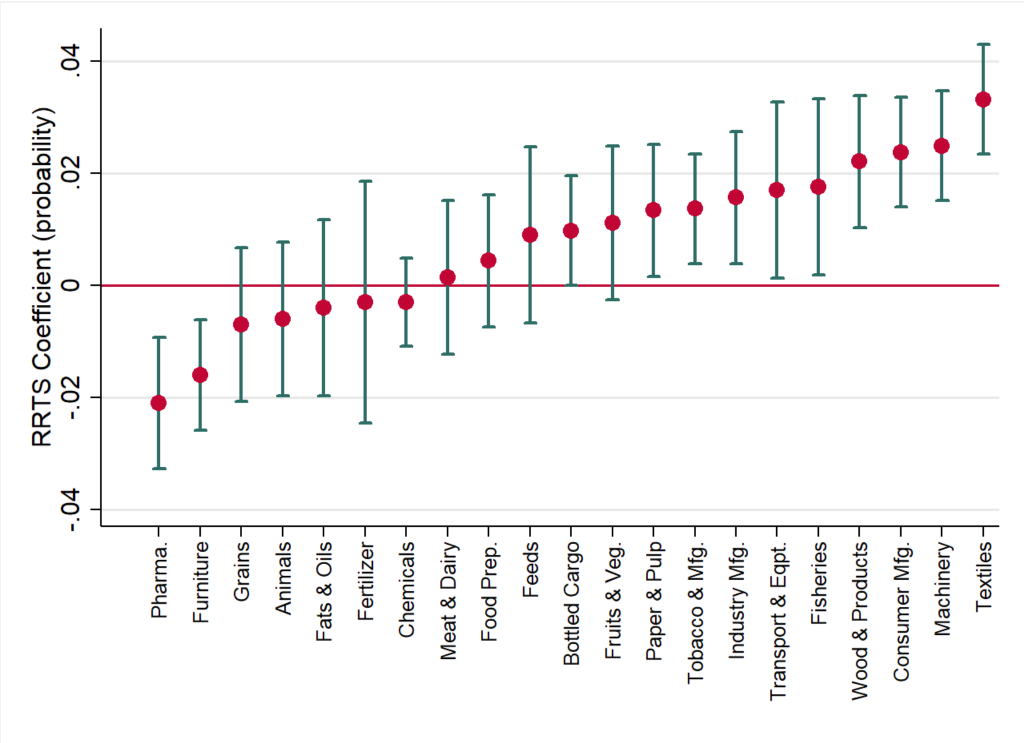
Dependent variable: Probability of new export destination				
	(1)	(2)	(3)	(4)
RRTS	-0.00004	-0.000361	0.00954**	0.00781
	-0.00091	(0.00142)	(0.00458)	(0.00496)
RRTS x Short		2.90e-05		0.00209
		(0.00159)		(0.00623)
Short		0.00278***		
		(0.000969)		
Log distance	0.00028	0.00148***		
	-0.00024	(0.000324)		
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.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

agricultural product groups among the beneficiaries is also notable. A potential explanation is that the time-sensitive nature of agricultural products limits the potential for market expansion outside of the RRTS network. Details of the results are in Table A-13.

The results from this subsection suggest significant extensive margin gains associated with RRTS for both product variety and market expansion. This highlights the importance of fixed costs as a channel through which RRTS reduces trade costs.

Figure 4.5: RRTS effect on the probability of new markets, 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.

Lumpiness of trade - frequency of trade transactions

We use a decomposition exercise to examine how the RRTS affects the various components of trade values. This allows us to examine how the different margins of trade adjust to changes in trade costs. The exercise entails a shift to a linear framework from the exponential form of Poisson so that each component adds up to its aggregated element. 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 4.3 and 4.4 are each regressed as functions of the gravity covariates in OLS. By definition, this excludes zero flows.

The top panel of Table 4.6 presents the results with gravity covariates, whereas the lower panel shows the estimates with port-pair fixed effects. The direction of the effects is broadly similar for both sets of estimates.[5] The preferred specification in the lower panel shows that pairs connected by RRTS increased their average transaction frequency by 7.7% (column 2). Using the pre-RRTS period as base, this implies that the RRTS connection increased the number of transactions from 4.4 months to 4.7 months in a year. The increase is largely attributable to the short distance connections as shown in column (7), which trade 9.3% more frequently than they otherwise would without the RRTS.

On average, the higher transaction frequencies are not accompanied by significant reductions in average shipment value or volume as a clear story of trade-off between transport and inventory costs predicts. Nonetheless, a zero-sum relationship is not necessary for inventory savings to materialize especially when accompanied by trade expansion. It is also useful to note that the results in frequency represent a lower bound since zero flows are not included in this decomposition exercise. The story of how RRTS affects inventory management is again discussed in the next section when examining lane meter charging and time-sensitive products.

[5] The elements of the decomposition estimates add up closely although there are small discrepancies from rounding off. The ubiquity of single-frequency product-pair-year transactions, which comprise 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 for the estimation.

Table 4.6: 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

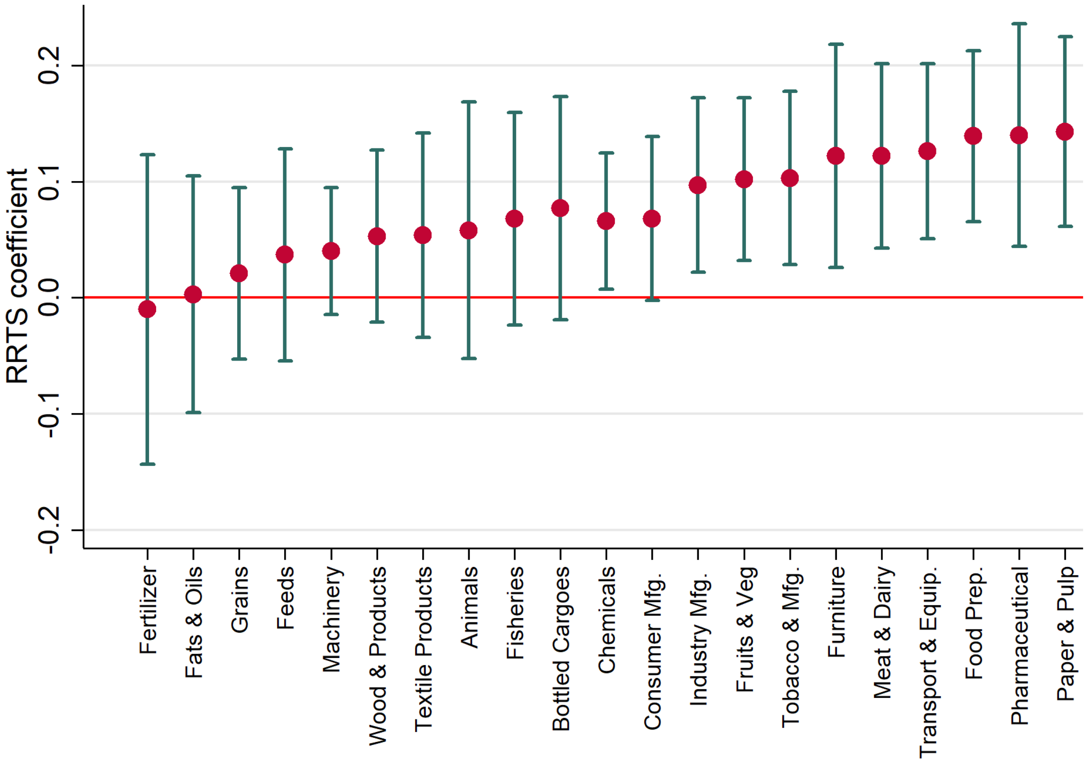
Robust standard errors clustered at city pairs.

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

Figure 4.6 shows the RRTS effect on the frequency of trade by product. About half of the 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. Details of the results are summarized in Table A-14.

Table 4.7 summarizes the estimated RRTS effects for the product groups across the aspects examined in this 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 a reduction in trade.

Figure 4.6: RRTS and lumpiness: Shipment frequency



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.

Table 4.7: 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.

4.4.2 Mechanisms

Lane Meter Charging

Lane meter charging in RRTS implies an advantage for higher value products. Conditional on vehicle size, storage requirements, and route, the same freight cost applies regardless of the cargo carried. This means freight costs can be minimized by packing more value into a shipment.

We examine the effect of lane meter charging by allowing RRTS impacts to vary by the distribution of product unit values. In equation 4.5, $Quval_q^k$ is a dummy variable, where q indicates the quartile distribution of the average unit value of product k in the data 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.

$$X_{ij,t}^{k} = exp[\alpha_{ij} + \delta_1\, RRTS_{ij,t} + \delta_q\, RRTS \times Quval_q^k + \gamma\, Quval_q^k + \kappa_{K,t} + \epsilon_{ij,t}^{k}] \quad (4.5)$$

Table 4.8 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 when considering the overall sample and effects 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. These patterns make intuitive sense since the fixed costs of trade in RRTS goes down with product value. 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 value 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. The probability of expanding to new non-RRTS destinations is discernible for products in the third and fourth quartile of the value distribution. The results in column (7) show that 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.

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. Results for the regressions with gravity covariates are summarized in Table A-15.

Table 4.8: 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

Time-sensitive products

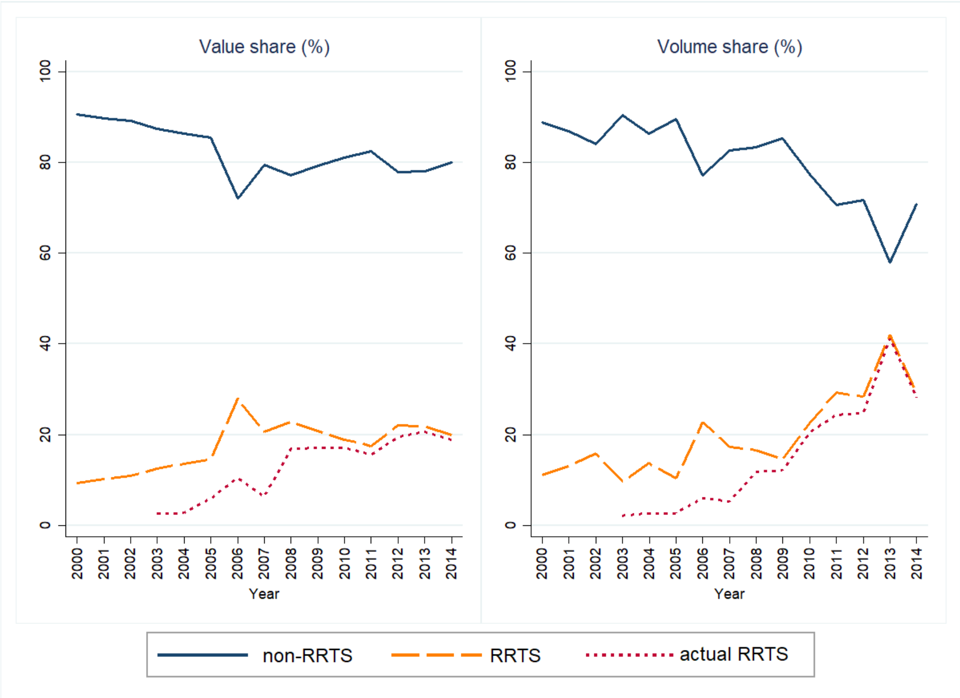
The absence of cargo handling procedures combined with the possibility of more frequent transactions are foreseen to be valuable for products with sensitive shelf lives. Products that previously would have met damage in transit have greater chances of reaching their destination markets with less spoilage. Hence, routes that are part of the RRTS are expected to experience growth in trade of time-sensitive products. These are fresh fruits and vegetables, fish and fish preparations, live animals, and meat and dairy.[6]

Figure 4.7 presents the value and volume shares of trade in time-sensitive goods in RRTS pairs. The share of RRTS trade in time-sensitive goods, as shown by the solid line, suggests increasing trends over time in both value and volume. However, the increase is more modest once all RRTS pairs are considered regardless of the time of connection as demonstrated by the dashed line. An analysis of the PSA data set suggests that the drop in 2014 can be attributed to a large increase in trade across all products in liner routes.

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 4.9 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 effect are large, although not very precisely estimated.

[6] In the international trade literature, products in the value chain trade, such as 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 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.

Figure 4.7: Value and volume shares of time-sensitive products by RRTS



Source: Author

Table 4.9: 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 observed in the extensive margins. In column (5), results show that there are 18% more varieties of time-sensitive products traded 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 5.1. 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 results distinguishing by RRTS distance thresholds do not yield significant insights. Coefficients from the regressions with gravity covariates are collected in Table A-16.

4.4.3 Spillover effects

The RRTS alters the relative cost distribution between trading partners and can therefore have impacts beyond the 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 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 results are summarized in Table 4.10. Note that the liner indicator is dropped from the estimation because it is treated as a time-invariant pair characteristic. The results in column (1) suggest that RRTS strongly complements liner trade. Trade on liner routes that are serviced by RRTS in both origin and destination is 52% larger 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, $RLineD_{ij,t}$,. Albeit positive, the coefficients are not significant reinforcing the observation that RRTS is crucial for transshipment activities.

The volume of trade is used in place of trade value as a dependent variable in columns (3) and (4) to examine the possibility that volume may matter more in terms of the hub and spoke network structure of shipping routes. The results are largely similar to the results with trade value as regressand. Finally, in the lower panel of Table 4.10, we allow for the possibility that the complementary relationship between RRTS and liner routes is not product-specific. Under this data structure, the trade-enhancing effects of the RRTS are magnified. Moreover, liners that have RRTS service in origin ports also trade 32% more compared to liners without this access from the city where they depart.

We also explore the potential of RRTS in alleviating trade imbalance in liner routes. The premise is that by promoting trade among smaller ports, the RRTS facilitates the consolidation of cargoes which are then carried by liners. Trade imbalance between trading partners is defined as the ratio of the absolute value of the difference between the trade value or volume exported by i to j, and that imported

Table 4.10: Interaction between liner and RRTS routes

Dependent variables: Value and volume of trade

	With products			
	Value	Value	Volume	Volume
	(1)	(2)	(3)	(4)
Liner O-D RRTS	0.417***	0.501***	0.359***	0.380*
	(0.099)	(0.177)	(0.106)	(0.222)
Liner O-RRTS		0.247		0.160
		(0.156)		(0.173)
Liner D-RRTS		0.00237		-0.041
		(0.140)		(0.223)
Observations	539,175	539,175	539,175	539,175
Product-Year FE	Yes	Yes	Yes	Yes
	Without product dimension			
	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
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

from j to i; to the sum of both flows: $\frac{|X_{ij,t}-X_{ji,t}|}{X_{ij,t}+X_{ji,t}}$. This takes the place of $X^k_{ij,t}$ in equation 4.2. A value closer to zero implies a more balanced trade. Naturally, zero flows are excluded from this set of analyses as a bi-directional zero flow will appear as balanced trade. The results in Table 4.11 suggest that the RRTS did not have significant impacts on trade imbalance on liner routes. Instead, there is a suggestion of imbalance attenuation in terms of volume when liner destinations are served by RRTS, albeit only marginally significant. This makes intuitive sense. Consider for example, the liner route between Manila and Iloilo City, where the volume of regular exports from the former is massively unmatched by the latter city. RRTS services in Iloilo City can attenuate the trade imbalance if it enables Iloilo to act as a consolidation point for other nearby smaller municipalities.

Table 4.11: Liner trade imbalance and RRTS routes

Dependent variables: Value and volume of trade				
	Value (1)	Value (2)	Volume (3)	Volume (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

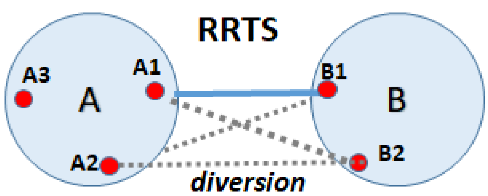
Estimator: Poisson quasi maximum likelihood.
All regressions include port-pair and year fixed effects.
Robust standard errors in parentheses clustered at city level.
*** p<0.01, ** p<0.05, * p<0.1

Trade displacement

We describe trade displacement as 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. We examine trade displacement by identifying non-RRTS port-pairs within the same municipal pairs as the RRTS ports. This is illustrated in Figure 4.8. 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 we categorize them using a dummy variable $TD_{ij,t} = 1$. We ensured that ports such as A3 that are unlikely to be trading with ports in city B because of geographical location are excluded from the TD definition.

Columns (1) and (2) of Table 4.12 present the results for the trade displacement

Figure 4.8: Defining trade displacement



Source: Author

analysis. The contemporaneous and lagged $TD_{ij,t}$ indicators are individually and jointly insignificant across the regressions. This confirms that the positive RRTS effects uncovered in previous analyses do not stem from mere substitution effects away from non-RRTS ports.

The absence of significant trade displacement effects is consistent with our 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.

Table 4.12: RRTS, trade displacement, and market access spillovers

Dependent variable: Value of trade

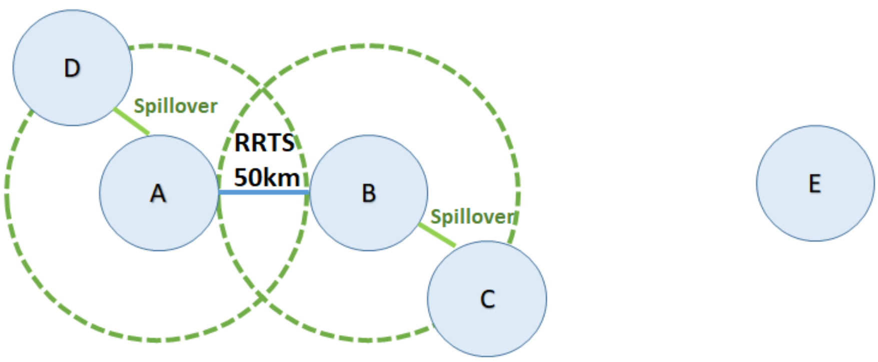
	Trade displacement			
	(1)	(2)	(3)	(4)
RRTS	0.491**	0.491**	0.290***	0.292***
	(0.191)	(0.191)	(0.108)	(0.109)
Trade diversion	-0.136	0.0485	-0.192	-0.0533
	(0.396)	(0.285)	(0.292)	(0.144)
Trade diversion (t+1)		-0.200		-0.171
		(0.320)		(0.234)
Log distance	-0.0943*	-0.0943*		
	(0.0563)	(0.0563)		
Language	-0.295	-0.294		
	(0.197)	(0.197)		
Liner	1.234***	1.233***		
	(0.246)	(0.246)		
	Market access			
	(1)	(2)	(3)	(4)
RRTS	0.448*	0.458*	0.614***	0.386**
	(0.258)	(0.255)	(0.134)	(0.150)
Market access	-0.0990	0.0867	0.1593	0.103
	(0.206)	(0.150)	(0.100)	(0.0989)
Market access (t+1)		-0.205*		-0.0350
		(0.110)		(0.0705)
Log distance	-0.103*	-0.102*		
	(0.0569)	(0.0567)		
Language	-0.316	-0.318		
	(0.203)	(0.203)		
Liner	1.249***	1.249***		
	(0.258)	(0.257)		
Observations	2,052,195	2,052,195	2,052,195	2,052,195
Origin-year FE	Yes	Yes	No	No
Destination-year FE	Yes	Yes	No	No
Product group-yr FE	Yes	Yes	Yes	Yes
Port-pair FE	No	No	Yes	Yes

Estimator: Poisson quasi maximum likelihood.
Robust standard errors clustered at city pairs.
*** p0.01, ** p0.05, * p0.1

Market access potential

Ports linked by RRTS can also induce trading activities in nearby locations. This happens when trade between an RRTS pair generates activities in the nearby areas because of increased demand within the linked pairs. Examining this externality involves defining a market access potential spillover indicator, $MA_{ij,t} = 1$ 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 4.9, 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 identifying trade displacement.

Figure 4.9: Defining market access spillovers



Source: Author

The results are summarized in the bottom panel of Table 4.12. Contemporaneous market access spillovers are insignificant across regressions. The introduction of a one period lead term in column (2) reveals a marginally significant negative market access effect. However, the negative effect disappears in the preferred specification with pair fixed effects in column (4).

4.5 Conclusion

We analyze the cost reducing features of the RRTS, and relate these to observed patterns of trade. The RRTS is associated with increasing trade flows, with connected port-pairs trading 35% more than they would have without the infrastructure. These gains do not come from displacing trade from nearby ports.

The extensive margins measured in terms of both product diversity and higher probability of exporting to new non-RRTS destinations are strong sources RRTS of gains. Gains along the intensive margin are more limited and tend to be driven by short-distance RRTS connections. These are suggestive of the relative importance of the fixed cost reducing feature of the RRTS. The higher frequency of trade associated with RRTS port-pairs further confirms this, and points to inventory management as a way of reducing trade costs.

The lane meter charging modality of the RRTS leads to the expectation 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 the lowest value products in the bottom quartile of the product value distribution.

The gains for time-sensitive products mainly come from the extensive margins and increased trade frequency. Along RRTS routes, time-sensitive goods have 18% more product variety, have a 1.2 percentage points greater chance 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. However, this is observed alongside a possible reduction in the intensive margins compared to other products traded in RRTS routes.

Outside of directly connected ports, the RRTS plays an important 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 52% to 55% larger compared to routes without access in both ends of the journey.

Our findings provide insights into the types of product that benefited the most from the RRTS and the mechanisms through which the gains have been mediated. We establish an empirical link between RRTS and trade patterns, which is a first step in understanding the welfare distribution implications of the RRTS.

In doing so, this work contributes to the literature that highlights the importance of intranational trade costs in regional development. Notwithstanding its domestic setting, the insights from this work can be informative for settings in other archipelagic countries, or small island economies that face similar connectivity challenges to those in the Philippines.

Chapter 5

Transport Costs and Pricing of Agricultural Products in the Philippines

The Philippine Government launched the Roll-on Roll-off (RORO) Terminal System (RRTS) in 2003 with the aim of bringing down maritime transport costs within the Philippines. The RRTS integrates land-based highways with maritime routes of RORO ships to create a seamless interface between land and sea transport. The RRTS reduces trade costs by sidestepping cargo handling, which is one of the most labor intensive and time consuming procedures in maritime trade (Brancaccio et al., 2019). At the same time, the smaller RORO ships that have median capacities of 160 twenty foot equivalent units (TEUs) compared to 375 TEUs of small container ships are more cost-effective and better-suited to short haul journeys and areas outside of main economic centers such as Metro Manila and Cebu.

In this chapter, we exploit the variation in timing at which province pairs become linked by the RRTS to analyze its causal impact on price gaps of agricultural products between origin and destination provinces. We also exploit weather shocks as exogenous sources of price increases to uncover welfare impacts of the RRTS through changes in markups. To the best of our knowledge, this is the first empirical investigation on the impact of the RRTS on pricing patterns, which is made possible by a data set that reflects actual supplier-market relationship between provinces, and a historical database that tracks the starting dates of RRTS services by route.

We focus on 13 agricultural products with price information that can be mapped to actual marketing relationships between provinces. The agricultural focus coincides with the goals of the RRTS in supporting farming profitability and food security. In Chapter 3, the RRTS is found to reduce province border effects of agricultural products – indicating the attenuation of trade costs. Moreover, this trade cost reduction translates into changes in trading patterns that confer advantage to time-sensitive products that are traded more frequently along RRTS routes.

The RRTS is expected to reduce price differences between origin and destination markets. In the first instance, it brings down the fixed and variable costs of transport. Fixed costs come down from simplified documentary requirements, while the sidestepping of cargo handling procedures impinges on both fixed and variable costs. Lower transport cost can in turn foster greater competition in two fronts. First, the RRTS introduces competition in routes that were previously serviced infrequently by few shipping companies (Austria, 2002). The smaller size of RORO vessels and the government support for purchasing ships also mean that the cost of market entry is lower. The RRTS also features freight charging based on lane meter, which is a more transparent means of detecting excess profits in a route. This provides an additional mechanism of encouraging competition.

Second, lower transport costs reduce the fixed costs of entry for intermediaries who source agricultural produce from one province and market these in other provinces. In the Philippines, intermediaries act as consolidators for small farmers, and are the primary means by which farmers market their products (Intal and Ranit, 2001).

The competitive effects in shipping and intermediation make consumer and producer markets more contestable, which should manifest in a reduction of markups. This competitive effect is crucial. Trade costs savings from the RRTS would benefit neither producers nor consumers if market structure in services that mediate between them do not become more competitive.

We examine the competitive effects of the RRTS using weather shocks as sources of exogenous price increases. Weather shocks create a setting that provide us with three kinds of supplying provinces for a product, k: (i) provinces with supplies that are directly damaged by the weather event; (ii) provinces where supplies are unaffected, and are connected by RRTS; and finally, (iii) provinces where supplies are unaffected but are not connected by RRTS. The latter two sets of provinces are poised to benefit from higher prices when supplies in a competing province are damaged by a climatic shock. Lower trade costs in RRTS province pairs should mean that farmers in RRTS supplying provinces are able to take advantage of the price increase more than a similar supplying province that is unaffected by the weather shock but does not have RRTS access. At the same time, consumer prices in RRTS markets should not increase more than their non-RRTS counterparts. However, these predictions on farmgate and retail prices will only happen if intermediation and shipping services are more competitive in RRTS routes. Without this, the greater part of the surplus will accrue to intermediaries and shipping companies.

Figures 5.1 and 5.2 present the origin-destination median price gaps between province pairs without RRTS (solid line), pairs that eventually became part of the RRTS regardless of the time of connection (long dashed line), and pairs according to their actual connection status (short dashed line). The figures suggest that even prior to the program in 2003, province pairs that eventually had RRTS already exhibited lower price gaps compared to non-RRTS province pairs. A large portion of this can be explained by the short haul nature of the RRTS, and that distance itself is also a key determinant of price differences between a province pair. Nonetheless, the introduction of the RRTS generally coincides with lower price gaps as can be seen by the wedge between the long and short dashed lines in the early stages of the RRTS program. This is reflected in both levels and in price gap ratios, although it is not immediately apparent that the RRTS effect is substantial.

Figure 5.1: Median spatial price gap level by RRTS status

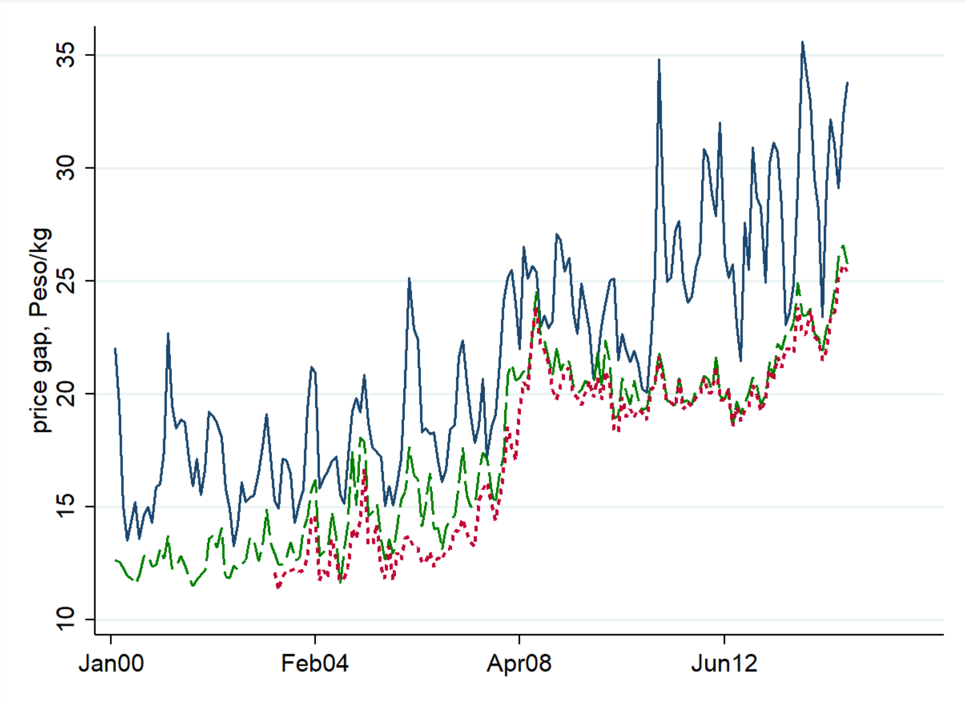
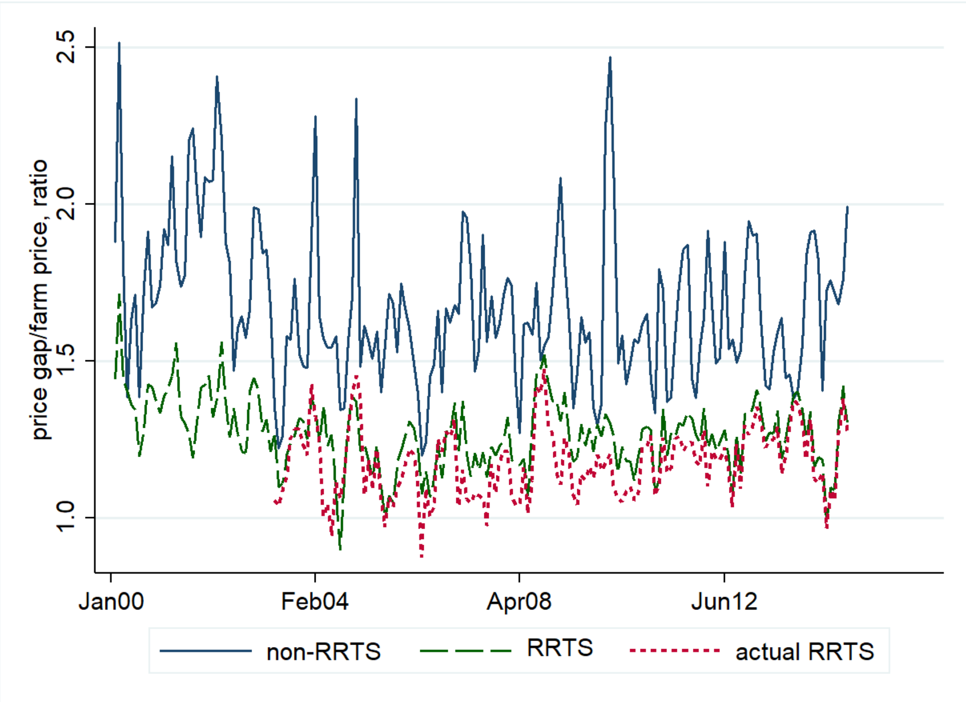


Figure 5.2: Median spatial price gap ratio by RRTS status



Source: Author based on PSA (2018)

Table 5.1: Median price wedge ratio by product

	RRTS			Non RRTS		
	Median wedge ratio	Standard deviation	Obs. (pair-month)	Median wedge ratio	Standard deviation	Obs. (pair-month)
Banana	1.72	0.64	948	2.14	1.15	7,410
Cabbage	2.30	1.88	730	3.16	2.40	3,200
Calamansi	1.38	1.33	513	1.85	2.82	5,546
Carrots	2.40	3.51	395	2.90	3.07	4,677
Coconut	1.74	1.11	294	2.62	1.56	1,619
Corn	0.33	0.29	129	0.45	0.29	656
Eggs	0.25	0.12	2,037	0.31	0.13	2,499
Mango	1.19	1.30	942	1.24	0.93	3,366
Onions	1.54	1.38	339	1.55	1.33	8,251
Pineapple	3.11	1.45	231	4.31	3.63	1,750
Potato	1.25	0.96	357	1.52	0.92	4,968
Rice	1.18	0.32	3,245	1.25	0.33	10,465
Tomato	2.13	1.66	795	2.11	2.02	3,709
Overall	1.17	1.42	10,955	1.60	2.04	58,116

Price differences also tend to be less dispersed in RRTS connected pairs, with spikes that are generally less pronounced than their non-RRTS counterparts. Table 5.1 shows that across products, median price ratios in RRTS connected provinces are lower except for a very small margin for tomatoes. However, for four products – carrots, mangoes, onions, and potatoes, the standard deviation of gap ratios are larger in RRTS connections. The price gap ratio for each product are illustrated in Figures A-1 to A-14 in the Appendix.

Our results confirm that conditional on distance, province pairs that are connected by RRTS on average exhibit a 28% narrower price gap as a proportion of farmgate prices compared to similar province pairs. This is because RRTS supplier provinces enjoy higher farmgate prices without passing this on to their markets. Exploiting weather shocks as exogenous sources of price changes, we find that RRTS connection leads to a distribution of surplus that is overall welfare enhancing. Provinces whose supplies are unaffected by weather shocks and are RRTS linked experience larger passthrough of price increases to their farmgate prices compared to other unaffected supplying provinces that are not connected. This implies revenue gains for RRTS farmers. At the same time, the higher farm profits in RRTS connected provinces do not come at the expense of consumers. Retail prices in RRTS connected markets are not significantly higher than unconnected provinces. The combined effect leads to a reduction in wedges during price shocks, and suggests a squeezing of shipping and intermediary markups consistent with a competition inducing effect of the RRTS. Finally, there is no evidence that the RRTS significantly affected the volatility of farm income or consumer prices.

5.1 Related literature

Changes in trade costs translate to changes in pricing patterns. Foremost, declining trade costs increase passthrough rates of price changes both across markets and along the supply chain. For example, Donaldson (2018) demonstrates that the expansion of the railway network in colonial India reduced transport costs, which in turn narrowed interregional price gaps between supply and destination markets. The transmission of prices across supply chains informs on welfare distribution implications of shocks or policy changes such as trade liberalization that alter relative prices (Antras and Costinot, 2011; De Loecker et al., 2016; Fafchamps and Hill, 2008).

Findings of asymmetric price passthrough along the supply chain are common (Meyer and Cramon-Taubadel, 2004). In particular, the nature of a price change — whether positive or negative; whether it originates from producer or consumer markets — influences the size and speed of passthrough. A possible implication is that consumers do not fully benefit from price reductions at the factory or farm level. Likewise, price increases that originate from retail markets do not fully translate to higher prices for producers. The reverse of both scenarios is also possible, although from a policy point of view, the shortchanged consumer or the small producer is more relevant.

There are many sources of imperfect passthroughs. Adjustment costs can be prohibitive, and there may be uncertainties about whether a price change is transient or permanent in nature. The size of the price shock also matters and motivates the threshold error correction models, where agents make adjustments only when prices change beyond certain thresholds (Vavra and Goodwin, 2005). The thresholds are in turn influenced by adjustment or transaction costs as determined by search costs

(Allen, 2014; Aker, 2010; Fafchamps and Minten, 2012; Jensen, 2007); inventory costs and practices (Ahn et al., 2011; Alessandria et al., 2010; Vavra and Goodwin, 2005); retailer optimization behavior in intertemporal pricing (Azzam, 1999); and interaction effects of scale with market structure (Amiti et al., 2014, 2019). Finally, Ahn and Lee (2015) also find that product characteristics, specifically perishability, is a strong determinant of passthrough as they impinge on marketing practices like product turnover and marketing horizon.

The price gap between origin and destination includes markups, which are affected by the interaction between trade costs and market structure. Atkeson and Burstein (2008) demonstrate that trade costs play a key role in enabling firms to price-to-market. In a low trade costs world, competition will arbitrage excess margins away, making discriminatory pricing unviable.

In the international shipping industry, the number of carriers servicing a route is a strong predictor of freight charges and maritime trade costs (Bertho et al., 2016). Moreover, the exercise of market power manifests in the way that shipping companies vary freight charges according to product characteristics. Hummels et al. (2009) observe that in the presence of oligopoly, shipping companies optimize profits by charging higher fees for higher value products since shipping costs form a smaller share of the delivered price. Shipping markups also tend to be higher for products with inelastic import demand.

Remoter areas also tend to face higher markups. French firms are shown to charge higher free-on-board (fob) prices for exports to more distant countries, with a doubling of distance leading to 3.5% increase in fob unit values (Martin, 2012). Using origin-destination mapped micro level data, Atkin and Donaldson (2019) show that markups vary with distance and that the effect of distance on trade costs is four to five times higher in poorly connected Ethiopia and Nigeria compared to the US. During times of import shocks, the share of intermediary surplus tends to be larger for remoter markets in the two Sub Saharan African countries. In a similar vein, Minten and Kyle (1999) find that bad roads in the Democratic Republic of

Congo are associated with higher trader profits.

In Belgium, the extent to which firms transmit exchange rate shocks to buyers is strongly determined by their market shares (Amiti et al., 2014, 2019). Small firms exhibit almost complete passthroughs. In contrast, firms with large market shares set high markups which they are then able to adjust during periods of external price changes. This explains why large fluctuations in exchange rates have small passthroughs in final prices. Berman et al. (2012) find the same with French exporting firms that adjust less on quantity and instead change their markups during episodes of depreciation.

In many developing countries, arbitrage is performed by intermediaries, especially for small producers who do not have sufficient scale to invest in transporting their own products (Ahn et al., 2011). A more competitive intermediation sector can move products from surplus to deficit areas faster, more cheaply, and with lower markups. As part of the process, producers ought to benefit from higher factory or farmgate prices, and consumers from lower purchase prices.

The market structure in intermediation has important welfare implications. Bergquist (2018) finds that agricultural intermediaries in Kenya exert significant market power to the detriment of consumers. Osborne (2005) likewise confirms monopsonistic behavior in intermediation using transaction level data from grain markets in Ethiopia, which is especially more pronounced for remote producers. In Uganda, Fafchamps and Hill (2008) find that intermediaries in the coffee market do not reflect world price increases in their purchasing prices from farmers as much as they reflect them on their selling prices, implying that they capture most of the rents from world price increases. Moreover, while the number of intermediaries sourcing coffee in an area increases when world prices are high, negative search externalities mean that this may not translate to higher farm purchase prices when collusion is possible (Bergquist, 2018; Fafchamps and Hill, 2008).

In our setting, we expect the reduction of effective distance between markets through the RRTS to lead to smaller markups.

Interestingly, Fuje (2019) shows that intermediary market power interacts strongly with transport costs. The withdrawal of fuel subsidies in Ethiopia in 2008, raised diesel prices and increased the transportation cost of grains. In the context of an oligopolistic trucking service market, the result has been a reduction of purchase prices and incomes of grain farmers.

Finally, trade cost reductions have implications for price volatility. The empirical and theoretical literature on trade exposure and volatility offer ambiguous predictions and results (Burgess and Donaldson, 2010; di Giovanni and Levchenko, 2009; Newberry and Stiglitz, 1981). On the one hand, price differences are more easily arbitraged away in better integrated markets and can be a powerful means of reducing volatility (Jacks et al., 2011). For example, US firms use faster air transport to smoothen effects from international demand volatility (Hummels and Schaur, 2010). On the other hand, Fuje (2019) finds that increasing transport costs lead to a wider spatial dispersion of grain prices in Ethiopia. Moreover, this price dispersing effect increases with distance to markets.

However, lower trade costs also mean greater transmission of external shocks to the local economy. Using a panel of 61 countries, di Giovanni and Levchenko (2009) demonstrate three mechanisms through which the openness-volatility relationship operates. First, sectors that are more open to trade are more vulnerable to supply and demand shocks elsewhere. Second, a more open sector tends to co-move less with other sectors. Finally, openness encourages specialization. The first and third channels increase aggregate volatility, while the second attenuates it.

In the context of declining trade costs from the expanding national highway network in India, Allen and Atkin (2019) find that market access increased the volatility of nominal incomes of exposed farmers but stabilized the consumer price index (CPI), with net effects suggesting greater volatility in real incomes. This implies that consumers face less consumption risks at the expense of producers incurring greater revenue risks. However, farmers respond to risk exposure by changing their crop choices which effectively reduces income volatility and amplifies the gains from trade. Nonetheless, adjusting crop choices may not be feasible in circumstances of severe credit constraints or high transition costs.

In a historical setting, the rail network expansion in colonial India raised the nominal income volatility of farmers but strongly stabilized consumer prices such that real incomes were less volatile following access to the rail network (Burgess and Donaldson, 2010). An important corollary finding is that the lower trade costs from rail access improved food security. The railways significantly reduced famine intensity and weakened the link between droughts and incidences of famine. These findings underscore the importance of infrastructure investments that reduce trade costs, and in doing so mitigate the effects of climatic shocks to incomes and access to food.

5.2 Methodology

We focus on 13 agricultural products that are largely produced and consumed within the Philippines with little or modest transformation. This minimizes effects of price movements that originate in upstream and international markets. Agricultural products are ideal for spatial price analysis because supplies tend to be inelastic in the short run, and as such have strong price linkages in horizontal and downstream markets (Ahn and Lee, 2015).

The expected value of the difference in price between retail price, $P^k_{d,t}$, and farmgate price, $P^k_{o,t}$, of product k in month-year t is a function of a host of cost shifters such as those traditionally used to estimate gravity models like distance, colonial ties, language, etc, represented by $\tau^k_{od,t}$ in equation 5.1. We consider a model of imperfect competition where markups $\mu^k_{od,t}$ also vary by $\tau^k_{od,t}$ through its effects on the marginal cost of marketing $c^k_{od,t}$, and the market structure dynamics in origin and destination markets (η^k_o, γ^k_d) (Atkin and Donaldson, 2019; Martin, 2012).

$$E[P^k_{d,t} - P^k_{o,t}] = \tau^k_{od,t} + \mu(c(\tau^k_{od,t}), \eta^k_o, \gamma^k_d) \tag{5.1}$$

Where $\tau^k_{od,t}$ is specified as follows:

$$E[\tau^k_{od,t}] = \alpha_0 + \beta_1 lnDist_{od} + \beta_2 Lang_{od} + \delta RRTS_{od,t} \tag{5.2}$$

$lnDist_{od}$ is the logarithm of distance between the origin and destination province, $Lang_{od}$ is a dummy variable equal to one when the majority of the population in a province pair shares a common language.[1] We relate the introduction of RRTS to changes in $\tau^k_{od,t}$ using $RRTS_{od,t}$ which is a dummy variable that is equal to one once a province pair becomes connected by the RRTS.

5.2.1 RRTS and price wedges

The analyses of price relationships between origin and destination is made possible by mapping supplier provinces to their actual markets. This is a step forward from most spatial price analysis that focus on co-movement of prices. The mapping process is described in detail in Section 5.3.

A gravity-like equation is used to estimate the effect of RRTS connection to price wedges. In equation 5.3, the dependent variable is the price gap between the retail price in market province, d, and the the farmgate price in supplying province, o for product k and for month-year t, $PWedge_{od,t}$. Alternatively, the price gap is also expressed as a ratio to the farmgate price $PRatio^k_{od,t} = \frac{P^k_{d,t} - P^k_{o,t}}{P^k_{o,t}}$ to normalize against unit prices. This metric is suitable when retail prices correlate highly with farmgate prices, i.e. when transport, marketing costs, and markups do not obfuscate the intrinsic valuation of a product.[2] The average farmgate and retail prices by product are shown in Table 5.2. Nonetheless, lane meter charging in the RRTS means that freight costs remain the same regardless of consignment value, holding vehicle size and distance traveled constant. These are more appropriately captured

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[1] We did not include religion as a control variable because a variance inflation factor analysis reveals high collinearity with distance. Eighty percent of the population in the Philippines identify as Roman Catholic, and other religions such as Islam exhibit strong patterns of geographical clustering.

[2] Figure A-14 in the Appendix, which plots average farm and retail prices by product suggest this is to be the case for the sample. Farmgate and retail prices also correlate significantly by 80%.

Table 5.2: Average farmgate and retail prices

	Farmgate		**Retail**		**Obs.**
	PhP/kilo	S.D.	PhP/kilo	S.D.	
Banana	6.7	3.9	18.9	7.7	8,358
Cabbage	11.6	6.9	41.4	14.8	3,930
Calamansi	14.4	7.8	39.4	16.0	6,059
Carrots	16.5	9.2	59.2	21.2	5,072
Coconut	4.1	2.0	14.2	5.4	1,913
Corn	10.8	2.9	15.4	4.3	785
Eggs	73.5	17.2	93.0	19.1	4,536
Mango	26.6	8.9	60.3	18.2	4,308
Onions	23.7	12.1	59.7	24.1	8,590
Pineapple	7.8	4.5	37.5	12.9	1,981
Potato	20.8	9.3	50.3	16.8	5,325
Rice	12.2	3.6	27.3	7.8	13,710
Tomato	11.3	6.4	32.4	12.3	4,504
Overall	18.6	17.9	42.8	25.4	69,071

in terms of changes in price wedge levels. Finally, the estimating equation also includes province-year fixed effects by origin, η_{oy}, destination, γ_{dy}, and ω_{km} is a set of product-month fixed effects to control for product seasonality.

$$PWedge^k_{od,t} = \alpha_0 + \delta\, RRTS_{od,t} + \beta_1\, lnDist_{od} + \beta_2\, Lang_{od} + \eta_{oy} + \gamma_{dy} + \omega_{km} + \epsilon^k_{od,t} \tag{5.3}$$

However, equation 5.3 potentially suffers from endogeneity since province-pairs are likely to select into RRTS investments in anticipation of trade benefits. We address this by using pair fixed effects to control for time-invariant characteristics that influence the likelihood of RRTS connection. They also control for long-standing market structure relationships between province pairs. This identification strategy follows the literature that estimate the effects of regional trade agreement on trade flows between country pairs (Head and Mayer, 2014).

The set of province-pair fixed effects is introduced as α_{od} in equation 5.4. Product seasonality is accounted for by ω_{km}, and changes in market conditions within the country are captured by a set of year dummies ϕ_y. $\delta\, RRTS_{od,t}$ is left to capture the variation coming from the switching on of RRTS connection for a pair of provinces.

$$PWedge^k_{od,t} = \alpha_0 + \alpha_{od} + \delta\, RRTS_{od,t} + \omega_{km} + \phi_y + \epsilon^k_{od,t} \tag{5.4}$$

Being able to treat RRTS as an exogenous variable presents an opportunity to test the variation of price wedge responses to RRTS along product characteristics. One prediction from Hummels et al. (2009) is that the marginal costs of marketing $c^k_{od,t}$ and therefore markup $\mu^k_{od,t}$ are increasing in product value and decreasing with import demand elasticity.

In our context, this means that the RRTS should reduce average price wedges for higher value products. The lane meter charging also means that cost savings in RRTS increases with product value because given the same route and vehicle size, freight charges remain the same regardless of the cargo carried. Indeed, in Chapter 4, we find that higher value products are traded more extensively and more frequently on RRTS routes. We test this prediction by taking the average farmgate value of each product in the sample $Uval^k$ as a time-invariant characteristic that captures a product's intrinsic value, and interact this with RRTS linkage status, $Uval^k \times RRTS_{od,t}$. Unfortunately, the products in our sample lack sufficient variation in terms of demand import elasticity to test the prediction of Hummels et al. (2009) along this dimension.

5.2.2 RRTS and surplus distribution

Equation 5.1 demonstrates the challenges of identifying and distinguishing the effects of the RRTS on markups. RRTS directly affects $\tau^k_{od,t}$ because it brings down both the fixed and variable components of trade costs. In doing so, RRTS also affects $c^k_{od,t}$ and by extension $\mu^k_{od,t}$. At the same time, $c^k_{od,t}$ also varies with product characteristics. For example, higher value products tend to have higher marginal costs of marketing because they require more specialized handling and have higher insurance costs. In the absence of detailed price cost margin information, it is difficult to disentangle movements that come from changes in marginal costs and those that come purely from changes in markups.

We set up an identification strategy that estimates the effect of RRTS on markups through shocks from extreme weather events. These provide exogenous sources of price increase and allow us to capture the differential effects of price change passthroughs by RRTS status. Passthroughs are shown to sufficiently capture how markups respond to changes to shocks or any trade cost shifter in oligopolistic settings (Atkin and Donaldson, 2019; Weyl and Fabinger, 2013).

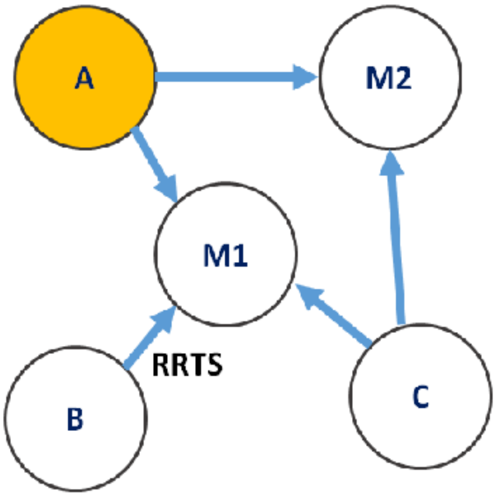
One limitation is that we are not able to distinguish between the markup of intermediaries and shipping companies. Instead, based on the assumption of imperfect competition in shipping and intermediation services, we conjecture from existing literature that trade cost reduction squeezes the markups of both sets of agents (Bergquist, 2018; Fuje, 2019; Hummels et al., 2009).

In general, weather shocks drive up prices in both producer and consumer markets because the supply of agricultural products is inelastic in the short run. At the same time, the intensity of a weather shock varies across supplying provinces. This provides a setting in which some suppliers are severely affected while others not at all. Among provinces whose supplies are unaffected, the variation in terms of RRTS connection allows us to examine whether prices respond differently along connection status. In addition, the price changes from weather shocks offer a scenario whereby markup opportunities change, while product-specific marginal costs remain the same given RRTS connection status.

The trade costs reducing effect of the RRTS implies that farmers in RRTS connected provinces that are not directly affected by the weather shock should benefit more from the sudden price increase compared to their unconnected counterparts. At the same time, retail prices in RRTS connected provinces should not increase more than non-RRTS provinces. This combined effect should reduce price wedges during periods of positive price shocks.

Figure 5.3 illustrates our identification setting. Three provinces, A, B, and C, are major suppliers of the same product to a common market, M1. Suppose that a big storm affects A in time t without affecting supplies in B and C. Because A is a

Figure 5.3: Transmission of price shocks and RRTS



Source: Author

major supplier, the weather shock induces a sudden supply scarcity which translates into an overall price increase. Farmers in unaffected supplying provinces B and C stand to benefit from this unexpected price increase. The RRTS connection between B and M1 leads to the expectation that farmers in B will benefit more than farmers in province C from the price rise. At the same time, the market M1, which has at least one RRTS connection should experience less increase in retail prices compared to the completely unconnected M2.

The change in price due to a weather shock in the affected province is captured by the deviation of farmgate prices (deflated by the provincial monthly CPI) from its average price for the month from 2000 to 2014, $\Delta P^k_{\tilde{o},t}$. In equation 5.5, $\Delta P^k_{\tilde{o},t} \times RRTS_{od,t}$ captures the differential price wedge changes induced by weather shocks based on RRTS linkage status of unaffected supply provinces. We use $\tilde{o}$ to denote supplying provinces that are affected by the weather shock, which we need to distinguish from those that are not, o, in time t.

$$PWedge^k_{od,t} = \alpha_0 + \alpha_{od} + \delta_1\, RRTS_{od,t} + \delta_2\, \Delta P^k_{\tilde{o},t} + \delta_3\, \Delta P^k_{\tilde{o},t} \times RRTS_{od,t} + \omega_{km} + \phi_y + \epsilon^k_{od,t} \quad (5.5)$$

We address the endogeneity between $PWedge^k_{od,t}$ and $\Delta P^k_{\tilde{o},t}$ by instrumenting the latter with the deviation of rainfall levels from the average rainfall a province receives for a given month from 1970 to 2018, $\Delta Rain_{\tilde{o},t}$. A province is deemed to have experienced a weather shock when the deviation of accumulated rainfall or the recorded wind velocity for the month exceeds its long term average by more than the interquartile range of its distribution from 1970 to 2018.

The reduced form equation is described in equation 5.6, where we expect a positive relationship between $Rain_{\tilde{o},t}$ and $\Delta P^k_{\tilde{o},t}$. Furthermore, we expect access to RRTS to reduce weather-induced price deviations as it facilitates arbitrage.

$$\Delta P^k_{\tilde{o},t} = \alpha_0 + \alpha_{od} + \delta_1\, RRTS_{od,t} + \delta_2\, \Delta Rain_{\tilde{o},t} + \delta_3\, \Delta Rain_{\tilde{o},t} \times\ RRTS_{od,t} + \omega_{km} + \phi_y + \epsilon^k_{od,t} \quad (5.6)$$

Here, RRTS is treated as exogenous given the pair fixed effects that control for selection and endogeneity. This enables us to use $\Delta Rain_{\tilde{o},t} \times RRTS_{od,t}$ as instrument for $\Delta P^k_{\tilde{o},t} \times RRTS_{od,t}$ to identify differential effects of the price shocks by RRTS status.

In affected provinces, prices may increase due to input sourcing difficulties and damages. For this reason, we estimate equation 5.5 and 5.6 without the directly affected supply provinces.

The exclusion restriction requires that the effect of $\Delta Rain_{\tilde{o},t}$ on pricing patterns in unaffected provinces is only mediated through changes in prices in the affected provinces. This is a valid assumption provided that the weather shock is geographically limited enough to leave the supplies of some provinces unaffected, and this is borne out by the weather data.

However, weather shocks can change the direction of trade and hence prices even in unaffected provinces. For example, supplies can be diverted from original markets to affected supplier provinces. This is most likely for grains where the government may redirect necessity goods in times of calamities. Agricultural products can also be redirected to areas with large market size and purchasing power such as Metro Manila and Cebu. In light of these possibilities, we progressively reduce the samples to exclude observations on grains, and Metro Manila and Cebu as markets.

Price increases directly induced by weather shocks in destination provinces are not dealt with since these do not persist in the same way that shocks to supplying provinces do. This is a limitation imposed by the monthly nature of the price data set and the different periods of data collection for farmgate and retail prices within a given month. Inquiries with the PSA reveal that farmgate prices are collected once within the last ten days of the month, whereas retail prices are collected three times per week on weekdays.

Finally, the differential effect of RRTS connection on volatility is examined using the coefficient of variation of the prices in origin and destination provinces as dependent variable.

5.3 Data

Products and province pairs. We choose province pairs and products for which: (i) the mapping of production and consumption provinces is possible; (ii) farmgate and retail prices are available. This effectively limits the coverage to agricultural products; (iii) products that are either homogeneous or are distinguished by major varieties; (iv) primarily produced and consumed within the Philippines; and (v) sufficient variation along RRTS linkage status.

Mapping of origin-destination provinces. The marketing cost structure studies (MCSS) of the Bureau of Agricultural Statistics inform on the main supply and demand centers for particular products. In some cases, the studies include information on harvest and marketing seasons, which are also taken on board.

However, the MCSS only covers a select set of commodities and major supply and demand provinces. The product set is augmented using the maritime domestic trade data from the Philippine Statistical Authority (PSA). The PSA records monthly trade data by port, which is aggregated to the province level. However, transshipment is an issue because the PSA relies on outward coasting manifests which record vessel cargoes from the exiting port. Moreover, some ports serve as exit points for landlocked provinces.

We mitigate concerns about transshipment in several ways. First, only provinces that exhibit production surplus for a product from 2000 to 2014 are included as exporting provinces. Surplus is determined by comparing production data and our consumption estimates based on consumption surveys and the population projection data of the PSA. Second, only provinces that export at least an average of 10% of annual production to the destinations in the sample are considered as supplier provinces. Third, exports from exit ports of landlocked provinces are attributed to the producer province. For example, highland vegetables being shipped from Batangas or Manila are attributed to Benguet and the Mountain Province weighted according to the producer survey sampling distribution in the MCSS. Finally, the inferred exporter-importer province relationships by product are verified in interviews with the Department of Agriculture.

In reality, a province is not geographically seamless. Some areas experience deficit in particular products while some municipalities are in surplus. A province can be both an importer and exporter of a product because municipalities within a province have different endowments and locational advantages. Unfortunately, we cannot address this limitation since provinces are the smallest unit of observation for prices. Moreover, from a production-centric analysis, only the major supplying provinces are expected to be most affected by price changes. For this reason, intraprovincial flows are excluded from the sample.

For rice, we exclude provinces where the National Food Authority (NFA) paddy and rice warehouses are located to weed out price influences from the buffer stocking operations of the government agency.

We also exclude maritime flows between adjacent provinces that are contiguous by land to minimize price effects outside of maritime trade relationships.

Farmgate and retail prices. Monthly farmgate prices are employed for producer provinces, while retail prices are used for destination provinces. These are sourced from the PSA's CountryStat database.

Only observations that have contemporaneous information on farmgate and retail price data are included in the sample. More often, it is the farmgate price that is missing. Based on the PSA's price data collection method, price availability serves as an indicator of seasonality. Prices for months when production are minimal are normally not collected (CountryStat 2018). When available, farmgate prices of close substitutes (for example, different varieties of onions) are also included.

The process of origin-destination mapping and price matching yields thirteen agricultural products, which make up 69,071 observations with 464 origin-destination-product-variety combinations. The mapping across the three data sets is summarized in Table A-17 in the Appendix.

Weather shocks. Daily readings of rainfall and wind velocity come from the Philippine Atmospheric Geophysical Astronomical Services Administration (PAGASA). The records come from 59 synoptic stations distributed in different parts of the country from 1970 to 2018. This data set is combined with PAGASA's data on typhoon incidence which identifies affected areas. This allows us to establish long term weather patterns in each province by month and distinguish events of substantial deviations from them as weather shocks.

Starting dates of RORO services by route. We constructed this data set using various sources from the Maritime Industry Authority, Philippine Ports Authority, PSA, aid agencies, newspaper articles, and a survey of RORO service providers. The process of building data set is described in Section 2.1. RRTS connected province pairs comprise 16% of our observations.

5.4 Results

5.4.1 RRTS and price wedges

Table 5.3 summarizes the results from estimating equations 5.3 and 5.4. The top panel pertains to results that measure price gaps in levels as the dependent variable, $PWedge^k_{od,t} = P^k_{d,t} - P^k_{o,t}$. In the lower panel, the regressand is expressed as the price wedge ratio $PRatio^k_{od,t} = \frac{P^k_{d,t} - P^k_{o,t}}{P^k_{o,t}}$.

The first column presents the results from estimating equation 5.3. A 10% increase in distance is shown to widen price gaps between origin and destination by an average of PhP 0.16 per kg. In column (2) the RRTS effect is allowed to vary by distance thresholds. A dummy variable $Short_{od} = 1$ if the distance between a province pair is less than the median distance of the RRTS connection for each product. In both columns (1) and (2), RRTS is associated with wider price differences, although the effect for short distance RRTS connections in terms of price wedge ratio is negative.

In columns (3) and (4), the relationship between RRTS and price gaps are estimated using the preferred specification with pair fixed effects as described in equation 5.4. The gap widening effect of the RRTS disappears in this set of results. Moreover, RRTS is now associated with a narrower price gap of about PhP 1.3 per kilo on average. The effect is magnified when the distance between pairs are relatively short, showing wedges to be narrower by PhP 1.7 per kg (1.086 +0.649, significant at 10%). The change in results with different specifications suggest the importance of unobserved province pair characteristics in determining RRTS linkage and explaining pairwise marketing relationships.[3] RRTS is also shown to reduce price gap ratios in the bottom panel. Conditional on distance, price wedge ratios in

[3]Regressions with dependent variables that assume a period lag between farm and retail price relationships have similar results albeit less precisely estimated.

Table 5.3: RRTS and price wedges

Dependent variable: Price wedge level	(1)	(2)	(3)	(4)
RRTS	2.151***	2.558***	-1.347**	-1.086
	(0.790)	(0.979)	(0.605)	(0.883)
RRTS x Short		-1.567		-0.649
		(1.288)		(1.161)
Short		-3.431***		
		(1.250)		
Log distance	1.594**	-0.365		
	(0.754)	(1.089)		
Language	-1.256	-1.274		
	(0.827)	(0.805)		
Constant	27.01***	39.56***	29.88***	29.82***
	(4.792)	(6.627)	(3.808)	(3.791)
R-squared	0.682	0.685	0.686	0.686

Dependent variable: Price wedge ratio	(1)	(2)	(3)	(4)
RRTS	0.136*	0.262***	-0.0115	0.101
	(0.0805)	(0.0875)	(0.0645)	(0.0826)
RRTS x Short		-0.315**		-0.280**
		(0.126)		(0.127)
Short		-0.266**		
		(0.130)		
Log distance	0.146	-0.0273		
	(0.105)	(0.127)		
Language	0.0263	0.0239		
	(0.109)	(0.112)		
Constant	-0.339	0.786	1.054***	1.029***
	(0.698)	(0.869)	(0.304)	(0.300)
R-squared	0.492	0.493	0.463	0.464
Product-month FE	Yes	Yes	Yes	Yes
Origin-year FE	Yes	Yes	No	No
Dest-year FE	Yes	Yes	No	No
Pair FE	No	No	Yes	Yes
Year FE	No	No	Yes	Yes
Observations	69,071	69,071	69,071	69,071

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

RRTS province pairs are on average narrower by 28%.

The price gap reduction associated with the RRTS can be welfare enhancing when increases in farmgate prices are larger than those in retail prices, or when farmgate price reductions translate to price reductions that are at least as large in the retail markets. This is examined in Table 5.4 where the RRTS effect on farmgate and retail price components of the price wedge are estimated. Focusing on the preferred specifications in columns (3) and (4), the results suggest that RRTS producer provinces enjoy higher farmgate prices, without increasing retail prices in their markets by the same magnitude. On average, a farmer in an RRTS connected supplier province receives PhP 2.9 per kg more for their product. This is a substantial effect and represents a 16% increase in farmgate prices based on the average prices presented Table 5.2. On the other hand, retail prices in RRTS market provinces are not statistically different than those in unconnected markets. Hence, the reduced price gaps in RRTS pairs observed in Table 5.3.

It must be noted that the sample size in the component price regressions are the same as in the price wedge regressions. This means that farmgate prices of supplier provinces that produce product k appear as many times as the number of the destinations at time t. Likewise, destination provinces that receive k from several origin provinces also appear as frequently in time t as the number of their suppliers. Ideally, a province-product combination should only appear once for each t. However, our identification for RRTS connection relies on pair fixed effects which can only be applied in a pairwise data structure.

Lane meter charging in the RRTS implies that higher value products gain more in terms of transport cost reduction compared to other products. At the same time, expensive goods typically have higher marginal costs of marketing. In the presence of market power, Hummels et al. (2009) demonstrate that shipping companies optimize shipping revenues by charging higher freight on higher value products. All these factors lead to the prediction that RRTS should reduce price wedge levels more for

Table 5.4: Price wedge components

Dependent variable: Farmgate price	(1)	(2)	(3)	(4)
RRTS	0.0543	-0.571	2.916***	3.016***
	(0.488)	(0.621)	(0.905)	(1.084)
RRTS x Short		1.262		-0.289
		(0.897)		(1.571)
Short		0.0506		
		(0.468)		
Log distance	-0.675**	-0.490		
	(0.310)	(0.317)		
Language	-0.548*	-0.483*		
	(0.292)	(0.281)		
Constant	30.95***	34.67***	20.98***	25.35***
	(1.986)	(2.306)	(1.762)	(2.083)
R-squared	0.898	0.900	0.871	0.873
Dependent variable: Retail price	(1)	(2)	(3)	(4)
RRTS	1.507*	0.332	0.687	0.736
	(0.776)	(1.031)	(0.973)	(1.304)
RRTS x Short		3.439**		-0.186
		(1.602)		(1.724)
Short		-0.530		
		(0.996)		
Log distance	0.982	-1.660**		
	(0.736)	(0.762)		
Language	-1.441*	-4.034***		
	(0.736)	(1.324)		
Constant	55.50***	73.73***	50.71***	55.83***
	(4.231)	(6.020)	(3.034)	(2.657)
R-squared	0.848	0.854	0.847	0.853
Product-month FE	Yes	Yes	Yes	Yes
Origin-year FE	Yes	Yes	No	No
Dest-year FE	Yes	Yes	No	No
Pair FE	No	No	Yes	Yes
Year FE	No	No	Yes	Yes
Observations	69,071	69,071	69,071	69,071

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

Table 5.5: RRTS and unit values

Dependent variable: Price wedge level				
	All		Without Eggs	
	(1)	(2)	(3)	(4)
RRTS	1.103	1.072	-2.752	-2.415
	(0.962)	(0.959)	(3.120)	(2.964)
$RRTS \times Uval$	-0.103***	-0.0829**	0.152	0.231
	(0.032)	(0.035)	(0.234)	(0.248)
$RRTS \times Uval \times Short$		-0.0512		-0.246**
		(0.0395)		(0.121)
Uval	1.200***	1.203***	1.077***	1.084***
	(0.387)	(0.387)	(0.353)	(0.351)
Constant	-80.67***	-80.71***	-15.48***	-15.62***
	(29.08)	(29.10)	(4.978)	(4.924)
Observations	69,071	69,071	64,535	64,535
R-squared	0.682	0.682	0.697	0.698

All regressions include product-month, province pair, and year fixed effects.
Robust standard errors in parentheses clustered at province pairs.
*** p<0.01, ** p<0.05, * p<0.1

higher value goods. This effect is captured in Table 5.5 with $RRTS_{od,t} \times Uval^k$.[4]

Across specifications and samples in Table 5.5, higher unit values are associated with larger price gaps. The full sample in columns (1) and (2) show that for each one peso increase in farmgate price, an RRTS connection reduces the price gap by an average of PhP 0.10 per kg. The effect for short distance RRTS connections is larger at 13%, and is highly significant. However, this strong effect appears to be largely driven by eggs. In columns (3) and (4), we exclude eggs from the sample, the average price of which is 200% larger than mangoes (see Figure A-14), the next highest value product in the sample. The $RRTS_{od,t} \times Uval^k$ coefficient is only significant once conditioned on distance, suggesting a gap reduction of around 25%. The results with the gravity covariates summarized in Table A-18 largely mimic the results in Table 5.5.

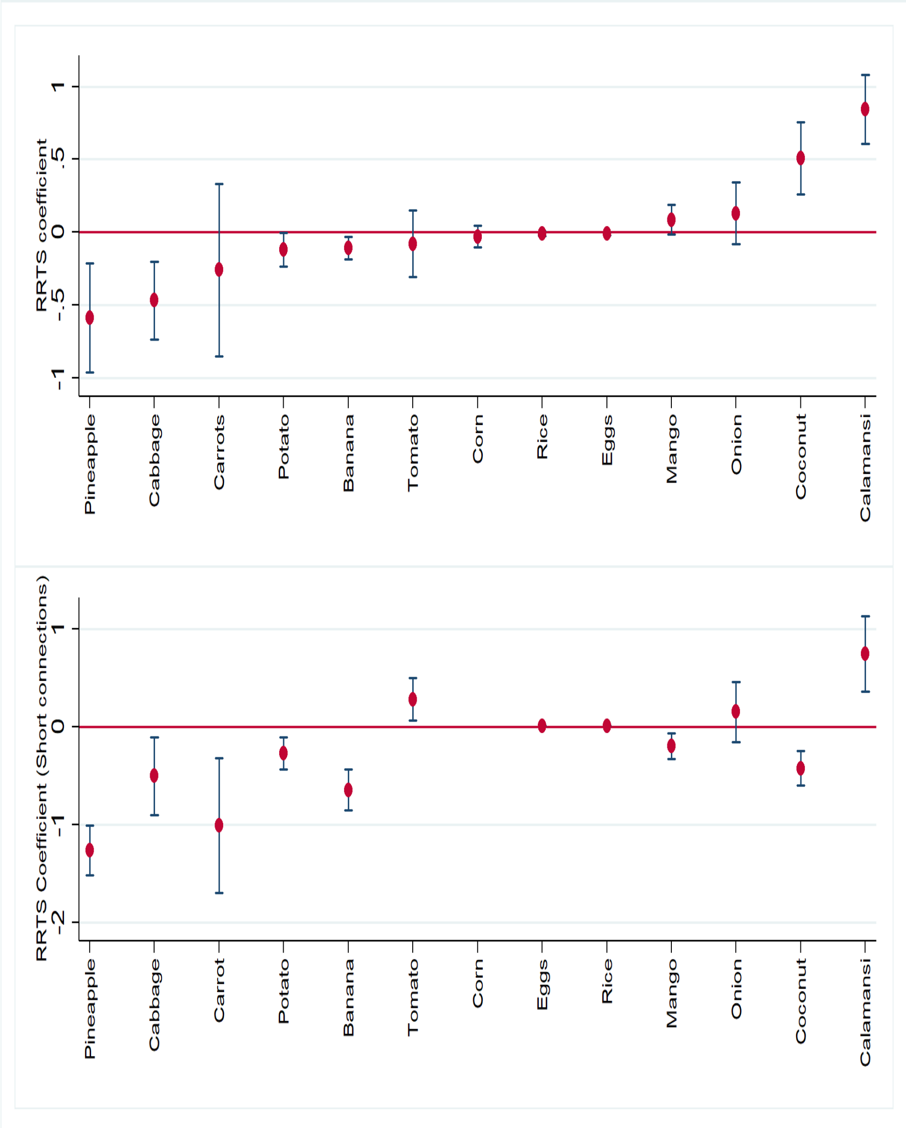
Using the preferred specification, Figure 5.4 shows a heterogeneous effect of RRTS on price gaps by product. The overall wedge ratio effect of the RRTS is negative for majority of the products, but are only significant for pineapple, cabbage, potatoes, bananas, and eggs. For carrots, coconuts, and mangoes, the wedge

[4]For this investigation, $PWedge^k_{od,t}$ rather than $PRatio^k_{od,t}$ as dependent variable is better-suited for the effect we wish to investigate.

reduction is only significant for short distance RRTS connections. These effects are confirmed to be beneficial in that retail price increases are less than farmgate price increases, and retail price reductions are larger than farmgate price reductions (See Table A-20).

The most unexpected results are with calamansi and tomato. Potentially, this can be explained by the highly perishable nature of these products, which suffer from post harvest losses as high as 32% and 38% respectively in the absence of investments in specialized handling (Mopera, 2016). While bananas and mangoes can have similar rates of post harvest damages, the processing industries that are largely geared towards export markets have substantial investments in post harvest infrastructure. These facilities and infrastructures are comparably immature and small for calamansi and tomatoes. Interestingly, these same two products did not register any significant reduction in border effects in Chapter 3.

Figure 5.4: RRTS and price wedge ratio by product



Notes: Whiskers represent 95% C.I. All regressions include province-pair and year fixed-effects. Detailed of results on price gap ratios are in Table A-20.

5.4.2 RRTS and surplus distribution

We now investigate how pricing patterns along the marketing chain respond to exogenous price increases that come from weather shocks.

We start by first establishing the presence of a price relationship among provinces supplying the same products. In equation 5.7, $P^k_{o,t}$ is the farmgate price of product k for month-year t in supplying province o; and $P^k_{\ddot{o},t}$ is the farmgate price of the same k at time t in other supplying provinces, $\ddot{o}$, for all $o \neq \ddot{o}$.[5] ω_{km} and ϕ_y account for product seasonality and year trends respectively. An Augmented Dickey-Fuller Fisher panel unit root test suggests that a substantial portion of the price series in the panel are stationary (Pesaran, 2012), consistent with price theory predictions for agricultural commodity prices given its natural cycle of production and storage requirements (Wang and Tomek, 2007).

$$P^k_{o,t} = \alpha_o + \rho_1 P^k_{\ddot{o},t} + \omega_{km} + \phi_y + \epsilon^k_{i,t} \tag{5.7}$$

The results from estimating equation 5.7 show that the price association between supplying provinces is highly significant with about 10% of a peso increase in other provinces translating to price changes in a supplying province. The results remain qualitatively similar when prices are expressed in terms of monthly changes. Moreover, as expected, the degree of price relationships strengthens when a pair of supplying provinces are connected by RRTS. In levels, RRTS increases the price relationship by an additional 15 percentage points, whereas in changes, there is an average increment of 9 percentage points. The detailed results are summarized in Table A-21.

Weather disturbances are sources of positive price shocks and provide an opportunity to evaluate how RRTS affects welfare distribution from a shock-induced price surplus. We can examine the differential response to the positive price shock by RRTS linkage status because we suppose that $\tau^k_{od,t}$ and $c^k_{od,t}$ do not change with the weather shock in provinces where supplies are unaffected by the climatic event.

[5] For this exercise in equation 5.7, we temporarily suspend the distinction between o and $\tilde{o}$.

For this set of exercise, carrots and onions are excluded since they are produced in concentrated regions in the country - the Cordillera Administrative Region for the former, and the Ilocos Region for the latter. This implies that producing provinces tend to be affected by the same weather shocks contemporaneously.

Results from the reduced form equation is summarized in Table 5.6. Each column represents a different sample set to weed out influences on prices that may come from redirection of trade. $\Delta Rain_{\tilde{o},t}$ and $\Delta Rain_{\tilde{o},t} \times RRTS_{od,t}$ are confirmed to be relevant regressands with $\Delta P^k_{\tilde{o},t}$ as dependent variable. The signs of the coefficients also make intuitive sense. Deviations in rainfall, $\Delta Rain_{\tilde{o},t}$, increase deviations from long term price trends. On average, RRTS connection weakens the link between rainfall shocks and price changes. Moreover, the deviation-reducing effect of RRTS is large enough to overwhelm the tendency of excess rainfall to translate into price deviations.

$\Delta Rain_{\tilde{o},t}$ is not significant across all samples when $\Delta P^k_{\tilde{o},t} \times RRTS_{od,t}$ is the dependent variable as shown in the lower panel. However, this is not necessary for identification if the model without interaction is identified (Wooldridge, 2010). The combined results confirm that the rank condition of instruments is satisfied. Table A-22 in the Appendix summarizes the results with $\Delta P_{\tilde{o},t} \times RRTS_{od,t} \times Short_{od}$ as dependent variable.

The results from the structural equation in equation 5.5 is summarized in Table 5.7. The top panel with price wedge in levels as dependent variable shows that on average, extreme weather events tend to reduce price gaps between province pairs. Having an RRTS connection has the effect of further reducing these price wedges. In the case of the sample that most satisfies the exclusion restriction in column (7), the reduction in wedges in unaffected provinces with RRTS connection is twice as large as in the non-RRTS pairs. The specification that distinguishes by RRTS distance thresholds in column (8) suggests that the gap-narrowing effect in levels is larger by PhP 1.8 per kg for more proximate RRTS trading partners.

The bottom panel with price wedge ratio as dependent variable confirms the wedge reducing effect of the RRTS. Albeit less precisely estimated, the results from

Table 5.6: Reduced form regressions

Dependent variable: $\Delta P^k_{\tilde{o},t}$	All unaffected (1)	No grains (2)	No hubs (3)	No grains & hubs (4)
RRTS	-0.327**	-0.476**	-0.335*	-0.522*
	(0.153)	(0.219)	(0.193)	(0.291)
Rain	0.000843***	0.00173***	0.000839***	0.00169***
	(0.000132)	(0.000102)	(0.000152)	(0.000121)
RRTS x Rain	-0.200***	-0.264***	-0.439***	-0.675***
	(0.0767)	(0.0801)	(0.158)	(0.212)
Constant	0.260	0.332*	0.225	0.369*
	(0.192)	(0.186)	(0.166)	(0.198)
R-Squared	0.128	0.127	0.075	0.077

Dependent variable: $\Delta P^k_{\tilde{o},t} \times RRTS_{od,t}$	All unaffected (1)	No grains (2)	No hubs (3)	No grains & hubs (4)
RRTS	0.00451	-0.0567	0.0622	0.0603
	(0.0669)	(0.100)	(0.0739)	(0.113)
Rain	3.34e-05	0.000164***	3.46e-05	0.000142**
	(4.03e-05)	(5.63e-05)	(4.62e-05)	(6.59e-05)
RRTS x Rain	0.821***	0.799***	0.684***	0.658***
	(0.0601)	(0.0598)	(0.112)	(0.154)
Constant	-0.127*	-0.0848	-0.0820	-0.0927
	(0.0707)	(0.0871)	(0.0542)	(0.0890)
R-Squared	0.114	0.114	0.046	0.042
Observations	52,682	38,787	33,290	22,942

All regressions include province-pair, product-month, and year FE.
Robust standard errors in parentheses clustered at province pairs.
*** p<0.01, ** p<0.05, * p<0.1

column (7) suggest that unaffected provinces that have RRTS connection reduced their price wedge by close to 25 percentage points more compared to unaffected non-RRTS province pairs. The effect of long versus short distance RRTS connections are statistically indistinguishable.

Table 5.8 shows the results on the movements in the components of the price wedge. The top panel summarizes the effects on farmgate prices. As in the results in Table 5.4, the RRTS effect on average farmgate prices are positive and significant. Moreover, across the different samples and specification, RRTS is shown to increase the passthrough of positive price shocks to farmgate prices. Farmers in non-RRTS supplier provinces also experience increase in revenues, but RRTS enhances this gain. The effect is largest in column (7) suggesting that the marginal revenue per kilo is three times as large in RRTS connected supplier provinces compared to similar non-RRTS provinces. Taking off from Table 5.2, this means that whereas non-RRTS supplying provinces have a passthrough of 9% in terms of average farmgate prices, the passthrough is close to 28% for RRTS supplying provinces. The results in column (8) shows that the effect rises to more than PhP 7 per kg or 4.6 times more than a non-RRTS supplying province in short distance connections.

Table 5.7: RRTS and passthrough to price wedges

Dependent variable: Price wedge level	All unaffected		No grains		No hubs		No grains & hubs	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RRTS	-1.362*	-0.515	-1.572	-0.399	-2.337**	-0.480	-2.569**	-0.651
	(0.695)	(1.259)	(0.956)	(1.311)	(0.941)	(1.933)	(1.302)	(1.927)
$\Delta P_{\tilde{o},t}$	-1.144	-1.139	-0.951*	-0.932*	-2.623***	-2.602***	-1.606***	-1.544***
	(0.765)	(0.758)	(0.515)	(0.511)	(0.743)	(0.741)	(0.453)	(0.440)
RRTS x $\Delta P_{\tilde{o},t}$	-0.837**	-0.649	-0.926**	-0.640	-3.032**	-2.180	-3.564**	-2.661
	(0.376)	(0.578)	(0.382)	(0.477)	(1.280)	(2.057)	(1.519)	(1.915)
RRTS x $\Delta P_{\tilde{o},t}$ x Short		-0.286		-0.475		-1.352		-1.771
		(0.555)		(0.508)		(2.237)		(2.773)
RRTS x Short		-0.912		-1.305		-2.039		-2.169
		(1.203)		(1.158)		(2.019)		(1.955)
Dependent variable: Price wedge ratio	**All unaffected**		**No grains**		**No hubs**		**No grains & hubs**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RRTS	-0.0517	0.352	-0.117	0.306	-0.148*	0.393	-0.199*	0.340
	(0.0728)	(0.224)	(0.101)	(0.227)	(0.0794)	(0.348)	(0.110)	(0.339)
$\Delta P_{\tilde{o},t}$	-0.217***	-0.211**	-0.238***	-0.231***	-0.364***	-0.358***	-0.314***	-0.300***
	(0.0839)	(0.0841)	(0.0642)	(0.0646)	(0.0732)	(0.0742)	(0.0578)	(0.0579)
RRTS x $\Delta P_{\tilde{o},t}$	-0.0735	-0.165*	-0.173**	-0.224**	-0.191*	-0.116	-0.246*	-0.116
	(0.0713)	(0.0899)	(0.0709)	(0.103)	(0.110)	(0.145)	(0.139)	(0.130)
RRTS x $\Delta P_{\tilde{o},t}$ x Short		0.128		0.0728		-0.122		-0.253
		(0.106)		(0.140)		(0.166)		(0.220)
RRTS x Short		-0.436*		-0.469**		-0.587		-0.606*
		(0.231)		(0.238)		(0.361)		(0.360)
1st stage F-Stat	19.795	13.91	131.663	88.357	11.695	7.915	29.176	12.71
Observations	52,682	52,682	38,787	38,787	33,290	33,290	22,942	22,942

All regressions include product-month, province pair, and year fixed effects.
Robust standard errors in parentheses clustered at province pairs.
*** p<0.01, ** p<0.05, * p<0.1

In the bottom panel, RRTS is also shown to have significant price-raising effects on retail prices in contrast to Table 5.4. Nonetheless, increases in farmgate prices are consistently larger than retail price changes across all samples. Moreover, weather shocks do not induce significant changes in retail prices in RRTS markets any differently than in retail markets without RRTS connections. In the bottom panel of Table 5.8, the passthrough coefficient from the weather-induced price rise is positive and significant but disappears once the large demand from Metro Manila and Cebu are excluded. Throughout the different samples, the magnitude of price increase passthroughs in retail prices are generally smaller than the passthrough to farmgate prices.

Supplying provinces connected by RRTS that are not directly affected by the weather shock benefit from higher revenues, without passing this on to their retail markets. For example, in column (7) of Table 5.8, the farmer in an unaffected RRTS source province receives PhP 5.13 (USD 0.10) more on average per kilo than non-RRTS provinces. On the other hand, the markets of RRTS provinces only increase their prices by PhP 1.56 (USD 0.03). This results in the reduction of the price gap levels by PhP 3.56 (PhP 1.56-PhP 5.13) which is reflected in the top panel of column (7) of Table 5.8. These are suggestive of a reduction in markups that accrue to agents that mediate between producer and consumer provinces.

Table 5.8: RRTS and passthrough of price shocks to farmgate and retail prices

Dependent variable: Farmgate prices

	All unaffected		**No grains**		**No hubs**		**No grains & hubs**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RRTS	3.509***	4.527***	6.151***	6.734***	4.437***	5.437***	7.989***	8.713***
	(0.759)	(0.856)	(1.210)	(1.314)	(0.829)	(1.202)	(1.371)	(1.898)
$\Delta P_{\tilde{o},t}$	0.192	0.192	1.020***	1.029***	0.621	0.633	1.663***	1.612***
	(0.409)	(0.409)	(0.275)	(0.270)	(0.450)	(0.450)	(0.314)	(0.336)
RRTS x $\Delta P_{\tilde{o},t}$	1.970***	2.501***	2.864***	3.319***	3.052***	3.022*	5.126***	2.840
	(0.522)	(0.824)	(0.764)	(1.091)	(0.989)	(1.562)	(1.840)	(1.793)
RRTS x $\Delta P_{\tilde{o},t}$ x Short		-0.787		-0.731		0.0375		4.518
		(0.987)		(1.387)		(2.004)		(3.267)
RRTS x Short		-1.094*		-0.652		-1.079		-0.736
		(0.628)		(0.854)		(1.064)		(1.635)

Dependent variable: Retail prices

	All unaffected		**No grains**		**No hubs**		**No grains and hubs**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RRTS	2.147**	4.012***	4.579***	6.335***	2.099*	4.957***	5.419***	8.061***
	(0.983)	(1.236)	(1.471)	(1.450)	(1.108)	(1.695)	(1.519)	(1.879)
$\Delta P_{\tilde{o},t}$	-0.952	-0.947	0.0689	0.0962	-2.002**	-1.969**	0.0565	0.0685
	(0.782)	(0.776)	(0.557)	(0.551)	(0.848)	(0.846)	(0.476)	(0.460)
RRTS x $\Delta P_{\tilde{o},t}$	1.133**	1.852**	1.938***	2.679***	0.0193	0.842	1.562	0.179
	(0.528)	(0.736)	(0.726)	(0.958)	(1.075)	(0.950)	(1.138)	(0.766)
RRTS x $\Delta P_{\tilde{o},t}$ x Short		-1.073		-1.206		-1.315		2.747
		(0.734)		(1.124)		(1.302)		(1.916)
RRTS x Short		-2.005*		-1.958**		-3.118*		-2.905*
		(1.023)		(0.947)		(1.671)		(1.609)
Observations	52,682	52,682	38,787	38,787	33,290	33,290	22,942	22,942

All regressions include product-month, province pair, and year fixed effects.
Robust standard errors in parentheses clustered at province pairs.
*** p<0.01, ** p<0.05, * p<0.1

This is one of the few studies that establishes an empirical relationship between transport costs and markup patterns in the Philippines. Market power in agricultural intermediation and transport in the Philippines is often alluded to in policy discussions but evidence are either missing or inconclusive (Intal and Ranit, 2001).

The vast majority of the literature on variable markups typically take producer prices as given and trace markups from movements in retail or export prices. Fafchamps and Hill (2008), Fuje (2019), Martin (2012), and Osborne (2005) are among the few that relate transport and trade costs to changes in markup behavior through changes in producer prices. Our findings add to the literature that demonstrate how market structure affects both purchasing and marketing prices.

While we are unable to distinguish between markup changes of shipping companies and intermediaries, our findings that most of the significant positive price changes stem from farmgate prices in a context where direct marketing of products by farmers are rare, lead us to conjecture that the competitive effect on the intermediation sector is an important channel through which narrower price gaps are realized.

5.4.3 RRTS and price volatility

The effect of RRTS on price volatility is measured as the coefficient of variation of the price wedge ratios and their components averaged across RRTS connection status of province pairs by product. This is used as the dependent variable in place of $PWedge^k_{od,t}$ in equations 5.3 and 5.4.

The results in Table 5.9 suggest that RRTS does not have a significant impact on price volatility. The volatility reducing effects in long distance RRTS connections, and volatility heightening effect in short distance connection in estimates with gravity covariates (top panel), do not withstand the more demanding pair fixed effects estimation (bottom panel). These results remain qualitatively similar even after excluding the sample during periods of weather shocks.

These results suggest that the improved farming profitability in the previous set

Table 5.9: RRTS and price volatility

Dependent variable: Coefficient of variation of price wedge ratio, farmgate, and retail prices						
	Price wedge ratio		**Farmgate price**		**Retail price**	
	(1)	(2)	(3)	(4)	(5)	(6)
RRTS	0.00913	-0.00225	-0.0227	-0.0392**	-0.0171	-0.0423**
	(0.0183)	(0.0225)	(0.0146)	(0.0158)	(0.0149)	(0.0173)
RRTS x Short		0.0294		0.0405**		0.0618***
		(0.0268)		(0.0191)		(0.0183)
Short		0.0279		-0.000248		2.30e-05
		(0.0185)		(0.00836)		(0.0130)
Log distance	0.0339**	0.0505**	0.0264*	0.0314**	0.0405***	0.0484***
	(0.0166)	(0.0214)	(0.0138)	(0.0152)	(0.0139)	(0.0150)
Language	0.0177	0.0172	-0.00435	-0.00459	-0.00492	-0.00530
	(0.0160)	(0.0160)	(0.0122)	(0.0125)	(0.0133)	(0.0135)
Constant	0.266***	0.157	0.150*	0.113	0.0262	-0.0305
	(0.0925)	(0.116)	(0.0777)	(0.0898)	(0.0740)	(0.0835)
Origin-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Dest-year FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.802	0.804	0.868	0.870	0.739	0.752
	Price wedge ratio		**Farmgate price**		**Retail price**	
	(1)	(2)	(3)	(4)	(5)	(6)
RRTS	0.0168	0.00618	-0.00570	-0.0248	0.00335	-0.0181
	(0.0267)	(0.0363)	(0.0217)	(0.0255)	(0.0216)	(0.0285)
RRTS x Short		0.0252		0.0450		0.0506
		(0.0444)		(0.0319)		(0.0318)
Constant	0.417***	0.417***	0.515***	0.515***	0.485***	0.485***
	(0.103)	(0.102)	(0.0722)	(0.0700)	(0.0399)	(0.0403)
Prov Pair FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.874	0.875	0.905	0.907	0.842	0.848
Observations	514	514	514	514	514	514

All regressions include product fixed effects.
Robust standard errors in parentheses clustered at province pairs.
*** p<0.01, ** p<0.05, * p<0.1

of results do not come at the expense of increased income volatility. But neither does RRTS cause more stable prices for producers or consumers. This lack of an effect is far from conclusive. As di Giovanni and Levchenko (2009) explain, different mechanisms of openness pull the effect on volatility in different directions. Existing literature suggests nominal incomes to be more variable for more open economies. This appears to be borne out by the results in Table A-21, which show that RRTS connected supplier provinces are more sensitive to price changes in their competing supplier provinces. However, we are unable to examine whether RRTS also reduces volatility by weakening the co-movement of prices with other sectors of the economy, which would require information on sectoral variation in terms of RRTS exposure.

5.5 Conclusion

The RRTS aimed to bring down maritime transport costs within the Philippines and this implies changes in pricing patterns, which have potential effects on welfare through changes in markups of intermediary and shipping services providers.

Using an origin-destination mapped data set, we study how prices in supply and destination markets respond to RRTS access. To the best of our knowledge, this is the first study that investigates changes in transport costs from the RRTS to pricing patterns and its potential implications on markups.

While there is some heterogeneity of effects across products, results show that conditional on distance, the average price gap as a proportion of farmgate prices is 28% smaller in province pairs that have RRTS connections. The gap narrowing effect is driven by higher farm prices without the corresponding differential increase in consumer prices.

Extreme weather events provide exogenous sources of price changes. This presents an opportunity for higher revenues for supplier provinces that are not directly affected by the natural disaster. We exploit these shocks to identify the differential effect of RRTS on the distribution of the surplus from the price increase. Results show that farmers in RRTS provinces whose supplies are unaffected by the weather shock enjoy passthroughs of the price increases that are on average three times as large as non-RRTS suppliers. At the same time, these RRTS connected suppliers do not pass on the increase in farmgate prices to their market provinces. Retail prices in RRTS connected destination provinces are not significantly different to those in non-RRTS provinces. This leads to lower price wedges in RRTS province pairs as measured in both levels and ratios during weather shocks. The greater farming profitability in RRTS provinces does not come at the expense of higher prices for consumers. The findings are consistent with an RRTS-induced competition in intermediation and shipping services.

Finally, we do not uncover evidence that RRTS affected farmgate and retail price volatility, although this is a promising area for further investigation.

Chapter 6

Conclusion

This thesis evaluates the effects of the RRTS on three aspects of domestic trade in the Philippines – trade costs, patterns of trade, and spatial price differences.

The Government of the Philippines introduced the RRTS in 2003 with the aim of reducing maritime trade costs. The program introduced policies to support the use of RORO ships to improve the interface between land and sea transport, thereby streamlining procedures involved in maritime trade such as cargo handling and warehousing.

To the best of our knowledge, this is the first set of empirical investigations on the trade effects of the RRTS. The dearth of empirical work can be explained by the lack of a comprehensive data set that tracks the development of RRTS services by route over time. We fill this data gap through a survey of RORO service providers and using various sources from different government institutions and aid agencies.

Across the three empirical chapters, our results consistently find evidence that the RRTS reduced domestic trade costs in the Philippines.

In Chapter 3, we estimate province border effects as a metric of trade costs. We focus on agricultural products that have production, consumption, and marketing flow studies so that intraprovince trade and interprovince trade by land could be derived. Our results show that domestic trade costs are substantial in the Philippines. On average, provinces trade 28 to 53 times more with themselves than with other provinces. RRTS reduced this home bias tendency by a factor of 0.65. This reduction is confirmed by a trade flow increase of 36% between province pairs that have an RRTS connection compared to similar pairs without access.

However, the reduction of border effects is geographically uneven, with provinces near Metro Manila exhibiting the greatest reductions. There were also provinces in the southwest that heightened their border effects such as Basilan, Sulu, and Tawi-Tawi. A possible explanation is that the relatively large distances between these provinces are not as conducive to the RRTS given RORO's greater efficiency in short-haul journeys. At the same time, these provinces are far from the major domestic ports in the Philippines. Nonetheless, it is useful to keep in mind that our estimates pertain to export oriented border effects.

RRTS had heterogeneous impacts on the border effects of products. Eight out of the 14 agricultural products reduced their border effects. Onions and potatoes, both exhibiting high geographic specificity, reduced their border effects towards zero. Other product characteristics such as storage and handling requirement, and demand elasticity also appear to influence the extent to which border effects respond to the RRTS.

The RRTS tended to reduce border effects over time. The most significant reductions were in 2007 to 2011 which coincided with the fast expansion of RRTS routes in the central islands of the Philippines.

In Chapter 4, we investigate how changes in trade costs from the RRTS manifest in terms of trade patterns. Excepting a few products such as ammunition, cement, and fuels, which are not amenable to RORO transport, we consider the universe of products that are traded domestically. Results show that port-pairs that are connected by RRTS trade 35% more than pairs with similar characteristics but do not have RRTS access. This trade increase can be explained by an 18% rise in the intensive margin, a 37% expansion in the variety of products traded, and a 1 percentage point higher likelihood of exporting to a new non-RRTS destination.

The strongest trade gains, which are observed across all the 21 products groups in the sample, come from the expansion of product variety. Close to half of the product groups showed greater probability of being exported to new destinations following the RRTS. In comparison, only six product groups registered gains along the intensive margins. These differences suggest the importance of fixed costs as an avenue of RRTS trade costs reduction, which is confirmed when we look at the impact of the RRTS on trade frequency. Trade tends to be infrequent when fixed costs are high. Firms economize on trade costs by stocking up on inventories and consolidating larger trade volumes for each shipment. Our results show that on average, RRTS port-pairs trade 7% more frequently than their unconnected counterparts. This effect is strongest for time-sensitive products and high value goods. Perishable products are traded 80% more frequently, while the highest value products are transacted 65% more frequently on RRTS routes. The RRTS-associated gains we uncover do not come from displacing trade from nearby non-RRTS ports.

RORO as a transport mode has a comparative advantage on short distance routes, and is therefore well-suited for servicing feeder traffic. This means that the RRTS can potentially aid the consolidation of trade in long haul liner services. We find that liner routes with RRTS service in both origin and destination ports have 52% greater trade volumes compared to routes without RRTS or when RRTS service is missing in one end of the journey. Nonetheless, we do not uncover strong evidence that RRTS alleviates trade imbalance on liner routes.

In Chapter 5, we investigate how the RRTS influences pricing patterns of agricultural products. We limit our analysis to 13 products for which we can accurately identify production and consumption locations. This allows us to take our analysis a step further beyond co-movement of prices commonly employed in the spatial price gap literature.

We find that province pairs connected by RRTS exhibit price differences that are narrower by PhP 1.35 per kilo (approximately USD 0.026) compared to unconnected province pairs with similar characteristics. The price gap narrowing effect is larger when conditioned on distance at PhP 1.7 per kilo (approximately USD 0.034), which translates to a 28% reduction in price gap to farmgate price ratio. The lower price gap comes from higher farmgate prices in RRTS supplying provinces, without the corresponding differential increase of retail prices in RRTS consumer provinces.

We exploit weather shocks as exogenous sources of price increase to differentiate between the effects of the RRTS on the marginal costs of trade and its impact on markups of intermediary and shipping service providers. Weather shocks present an opportunity for farmers in unaffected provinces to raise prices. Our results show revenue gains in RRTS supply provinces that are not affected by the weather shock are three times as large compared to the revenue increase in unaffected non-RRTS suppliers. At the same time, the change in retail prices are statistically similar in RRTS and non-RRTS consumer provinces. These price movements correspond to price gaps that are on average PhP 3.56 (USD 0.07) per kg narrower in RRTS province pairs. These findings suggest lower markups that accrue to intermediaries and shipping services, consistent with RRTS-induced competition.

The findings from the three empirical chapters confirm that the RRTS had significant effects on trade costs. The combined effect of the streamlined trade process, the smaller size of RORO ships, their advantage in servicing short distances, and the lane meter charging feature have reduced the fixed costs of trade. The overall effect has been greater trade flows and improved competitiveness in shipping in intermediation that has generally been welfare enhancing for the agricultural sector.

This thesis initiated an empirical investigation of the trade effects of the RRTS. Ideally, the next step would be to map out how the trade outcomes we uncovered translate into welfare effects through impacts on production and consumption patterns. However, we leave this for future work in light of its more demanding identification requirements. Our work contributes to the growing literature that studies the importance of intranational trade costs in regional development.

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Appendices

Table A-1: RORO route priority and actual development

Groups	Evaluated links	Point marks	Actual devt.
1st Priority	Batangas City - Calapan, Mindoro Or	79	1983
	Toledo, Cebu - San Carlos, Negros Occ	78	2007
	Matnog, Sorsogon - Allen, Northern Samar	78	2003
	Cebu City - Tagbilaran, Bohol	78	2003
	Iloilo City - Bacolod, Negros Occ	77	2003
	Liloan, Southern Leyte - Lipata, Surigao Norte	71	1991
	Cebu City - Tubigon, Bohol	39	2003
	Cebu City - Ormoc, Leyte	67.5	2003
	Escalante, Negros Occ - Tuburan, Cebu	67.5	2007
	Tandayag, Cebu - Bato, Leyte	65.5	2006
	Guihulngan, Negros Occ - Dumanjug, Cebu	65	2008
2nd Priority	Dumaguete (Sibulan), Neg Occ - Santander, Cebu	62.5	2008
	Iloilo City - Jordan, Guimaras Island	60.5	1998
	Tubod, Cebu - Tangub, Misamis Occ	60	*
	Dumaguete, Neg Occ - Dapitan, Zamboanga	59.5	2003
	Iloilo City - Pulupandan, Negros Occ	58.5	*
	Batangas City - Abra de Ilog, Mindoro Occ	58	1994
	Jagna, Bohol - Cagayan de Oro	55	2007
	Lucena City, Quezon - Balanacan, Marinduque	49	1993
	Zamboanga City – Basilan	48.5	2005
	Zamboanga City – Jolo	48.5	2008
	Benoni, Camiguin - Balingoan, Camiguin	48	2003
	Tobaco, Albay - Virac, Catanduanes	47	2006
	Bulan, Sorsogon - Masbate, Masbate	45.5	2009
	Cebu - Talibon, Bohol	45.5	2007
3rd Priority	Ajuy, Iloilo - Manapla, Negros Occ	43	*
	Ternate, Cavite City - Mariveles, Bataan	43	*
	Matnog, Sorsogon - Masbate	43	*
	Davao - Babak, Samal Islands, Davao	42.5	2009
	San Jose (Occ Mindoro)- New Washington, Aklan	39.5	*
	Culasi, Roxas - New Washington, Aklan	39	2003
	Argao, Cebu - Loon, Bohol	38	2003
	Carmen (Danao), Cebu – Isabel, Leyte	38	1993
	Lucena City, Quezon - Sta. Cruz	38	1993
	Ubay, Bohol - Maasin, Southern Leyte	38	2007
	Dumaguete, Negros Occ - Larena, Siquijor	37.5	2008
	Roxas, Or Mindoro- Odiongan, Romblon	32	2006
	Jagna, Bohol - Mambajao, Camiguin	31	2009
	Milagros, Masbate - Estancia, Iloilo	31	*

Source: JICA (2002) and data compiled by author
Note: "*" indicate routes that are not developed as of 2014.

Deriving intraprovince trade

1. Maritime trade by origin and destination

   The analysis is limited to a set of agricultural commodities effectively covering 101,159 monthly flows. About 5% of these exhibit highly improbable derived unit values suggesting encoding errors. More formally, provincial retail and farmgate prices are used as upper and lower bounds of unit values to check for outliers. In such cases, more weight is given to the volume record as advised by the PSA, and values were adjusted according to the average unit price of the exports from the port of the nearest available month before and after the 'outlier' observation.

2. Interprovince land trade

   Interprovince land trade flows were derived using Marketing Cost Structure Studies (MCSS) prepared by the Bureau of Agricultural Statistics (BAS) for a number of products in selected years. These studies identify the main supply and destination provinces for certain commodities. The difference between production and consumption of a supply province is assumed to be the amount available for export to demand provinces.

   The derivation of imports of a demand province is straightforward when an importing province only has one source province. In cases where a demand province sources from multiple suppliers, such as the case of Metro Manila, the supplying provinces are weighted according to the sample proportions in the survey. For example, Metro Manila sources onions from Ilocos Norte, Pangasinan, and Nueva Ecija. Following the sample proportion of traders in each supply province, it is assumed that 26% of Metro Manila imports came from Ilocos Norte, 34% from Pangasinan, and 39% from Nueva Ecija.

   The exports of supplying provinces are capped at the difference between production and consumption. In cases where supplying provinces are unable to fill the requirements in all demand provinces, importing provinces are prioritized by importance of markets as indicated by their sample proportion, and by the availability of production information. These imputations were checked against coastwise trade data to avoid double counting. A summary of the geographic flow for each of the commodity in the study is described in Table A-2.

In cases where only two provinces sit on the same island (i.e. the eastern and western halves of Mindoro and Negros), land trade between the two neighboring provinces can also be derived.

Trade between east (E) and west (W) was derived as follows:

$$X_{EW} = Prod_E - \Sigma^n_{E \neq W} X_E j + \Sigma^n_{E \neq W} M_{Ej} - C_E$$

Where C is the consumption in the (E)ast, X_{Ej} are the exports of the eastern province to provincial and international trading partners, and M_{Ej} are its imports. Exports from the west to the east are similarly derived.

3. Transshipment

   Products exported through Metro Manila have two potential sources - other provinces from mainland Luzon, and international imports, IM. If $MM_c \geq IM$, it is assumed that international imports are all consumed in Manila and whatever is exported is originally sourced from other provinces that are part of the Luzon mainland. An implicit assumption is that there are no quality discrimination for destination markets. It turns out that $MM_c \geq IM$ for all products except for corn, which exceed consumption in Manila by at least nine thousand metric tons during the period of study. Presumably, this is because they are used as inputs to the feed milling industry, the majority and largest of which are located in Manila and the nearby Central Luzon provinces (Cruz, 1997). This simplifies the problem since processed feeds move to another product classification. The re-accounting of source provinces is summarized in Table A-3.

4. Production data

Table A-2: Supply and demand provinces for land trade

Product	Supply province	Demand province
Calamansi	Nueva Ecija	NCR
	NCR	Laguna, Rizal
Cassava	Apayao, Quirino	Isabela
	Isabela	Cagayan
	Bukidnon	D. del Sur, Mis. Oriental, Sarang.
	South Cotabato	Lanao del Sur
	Batangas, Quezon, Pampanga	NCR
	NCR	Bulacan, Cavite, Rizal, Tarlac
Corn	Bukidnon, Lanao del Sur	Misamis Oriental
	South Cotabato	Davao del Sur, Misamis Oriental
	North Cotabato	Davao del Sur, Misamis Oriental
	Isabela	Batangas, Bulacan, Ilocos N., NCR
	Cagayan	Batangas, Bulacan, Ilocos N., NCR
	Ilocos Norte	Benguet, Bulacan, Pangasinan
Hog	Bulacan	Batangas, NCR, N. Ecija
	Dav. del Norte, Saranggani, S. Cotabato	Davao del Sur
Mango	Bulacan, Panagasinan, Zambales	NCR
	NCR	Cavite, Laguna, Rizal
	Ilocos Sur, La Union, Nueva Ecija, Tarlac	Pangasinan
	North Cotabato, South Cotabato	Davao del Sur
	Sultan Kudarat	South Cotabato
Onion	Ilocos Norte	Cagayan, Isabela, Pangasinan
	Pangasinan	Al.,Batang,Bul.,Pampga,Zamb.
	Nueva Ecija	Batang,Cavite,Laguna, Quez, Rizal
Potato	Benguet	NCR, Pangasinan
	Benguet, Pangasinan	Nueva Ecija
	Mountain Province	Benguet
	Bukidnon	Misamis Oriental
Rice	Cagayan, Isabela, N. Ecija, Pangasinan, Tarlac	NCR
	Cagayan	Benguet, La Union
	Nueva Ecija	Bulacan, Pampanga, Rizal
	Bukidnon	Misamis Oriental
Tomato	Pangasinan	NCR
	Bukidnon	Misamis Oriental, Zamboanga City
	Misamis Oriental	Zamboanga City
	Nueva Vizcaya	Pangasinan

Table A-3: Attribution of exports from Metro Manila

Product	MCSS	Provinces
Banana	No	Isabela (100%)
Cabbage	No	Benguet (100%)
Calamansi	Yes	Nueva Ecija (100%)
Carrots	No	Benguet (100%)
		Batangas (7%)
Cassava	Yes	Pampanga (9%)
		Quezon (84%)
Corn	Yes	Cagayan (15%)
		Isabela (85%)
		Bulacan (2%)
Mango	Yes	Pangasinan (94%)
		Zambales (4%)
		Ilocos Norte (33%)
Onion	Yes	Nueva Ecijca (52%)
		Pangasinan (15%)
Pineapple	No	Cavite (100%)
Pork	Yes	Bulacan (100%)
Potato	Yes	Benguet (100%)
		Cagayan (15%)
		Isabela (40%)
Rice	Yes	Pangasinan (19%)
		Nueva Ecija (13%)
		Tarlac (13%)
Tomato	Yes	Pangasinan (100%)

Source: Author

Adjustment factors for products are summarized in Table A-4.

Production information on hogs and chicken are not available at the provincial level for the entire period of the study. We rely on quarterly inventories of animals to come up with the production data. The quarter with the largest inventory is chosen for each year. This is then converted to live weight equivalent using 80kg for hogs and 1.45kg for chickens. Finally, live weight is converted into carcass weight by a ratio of 0.70 and 0.77 respectively.

A modified method of imputation is necessary for products that have a large share that is processed because these are not picked up by the provincial consumption data. Corn, as the main feedstock ingredient for feeds in the Philippines, have over 50% of production destined for feeds and non-food use (PSA, 2016). The hog and chicken consumption of provinces is accounted for by the feed conversion ratios for livestock and poultry documented in (Sison, 2014) and the ratio of backyard to commercial farm inventory from the PSA (2016). This is the same methodology that the Department of Agriculture employs in estimating annual demand for corn. A full grown hog of 80 kilos is assumed to have consumed 91.3 kg to 345.0 kg of feeds over its life cycle, while the numbers are 15.3 kg to 28.8 kg for chickens. The lower values refer to backyard animals while higher values refer to animals in commercial farms.

Substantial shares of other products also go into processing: pineapple (45%), banana (25%), potato (25%), and tomato (15%). Nonetheless, knowledge of their processing locations allow us to impute consumption in areas where processing activities do not exist.

5. Intraprovince trade

   The derivation of intraprovince trade rests on being able to map a concordance of products across data sets on consumption and production, prices, and trade. The concordance developed in this paper is presented in Table A-5.

Table A-4: Adjustment factors by product

Product	Adjustment factor
Banana	6% as feed and waste
Cabbage	8% as feed and waste
Calamansi	6% as feed and waste
Carrot	8% as feed and waste
Cassava	6% as feed and waste
Chicken	
Liveweight	Number dressed x 1.45 kg
Dressweight	total liveweight x 0.77
Corn	kg of corn yields x 0.65
Mango	6% as feed and waste
Onion	8% as feed and waste; 7% as seed
Pineaple	6% as feed and waste
Pork	
Liveweight	Number slaughtered x 80 kg
Dressweight	total liveweight x 0.70
Potato	5% as feed and waste
Rice	kg of Paddy x 0.65
Tomato	7% as feed and waste

Source: PSA Technical Notes on Agriculture (2016)

Table A-5: Concordance mapping for PSCC, prices, production, and consumption

PSCC	commodity description	Price (monthly)			Production (annual)	Per capita cons (annual)
		Farmgate	Wholesale	Retail		
1221	meat of swine, fresh or chilled	hogs for slaughter	hogs for slaughter	meat with bones, lean meat, front leg	# of heads (inventory)	pork
1222	meat of swine, frozen					
1231	poultry, not in pieces, fresh	native/improved	native/improved	fully dressed	# of birds (inventory)	chicken
1232	poultry, not in pieces, frozen					
1234	poultry cuts & offal (ex. liver), fresh or chilled					
1235	poultry cuts & offal (ex. liver), frozen					
4210	rice in the husk (paddy /rough rice)	paddy fancy, paddy other variety	paddy fancy, paddy other variety	special, premium, well milled regular milled	paddy	rice
4231	rice, semi or wholly milled (ex. broken rice)					
4410	maize seed (ex. sweet corn), unmilled	corngrain (white & yellow)	corngrain (white & yellow)	corngrits (white & yellow)	yellow, white	corn
4490	other maize (ex. sweet corn), unmilled					
5410	potatoes, fresh or chilled (ex. sweet potatoes)	white	white	white	white	white
5440	tomatoes (fresh or chilled)	tomato	tomato	tomato	tomato	tomato
5451	Onions and shallots, fresh or chilled	shallot, red creole, granex	shallot, red creole, granex	red creole, granex	onion	onion
5453	cabbage & edible brasicas	cabbage	cabbage	cabbage	cabbage	cabbage
5455	carrots and other edible roots	carrots	carrots	carrots	carrots	carrots
5481	manioc (cassava), fresh or dried	dried chips, fresh tubers	dried chips, fresh tubers		cassava	cassava
5729	citrus fruit, N.E.S., fresh or dried	calamansi	calamansi	calamansi	calamansi	calamansi
5730	bananas (incl. plantains)	latundan, saba	lakatan, latundan, saba		lakatan, saba	all variety
5795	pineappeles, fresh or dried	hawaiian	hawaiian	hawaiian	pineapple	pineapple
5797	avocados, guavas, mangoes	carabao, indian, piko	carabao, indian, piko	carabao	carabao	ripe

Source: Author

Table A-6: Covariates for product, time, and province varying borders

Dependent variable: Value of trade	Product (1)	Year (2)	Province (3)	Prov-yr (4)
Log distance	-0.375***	-0.408***	-0.462***	-0.747***
	(0.0922)	(0.0820)	(0.0768)	(0.0791)
Language	0.268	0.198	-0.171	-0.665**
	(0.192)	(0.185)	(0.243)	(0.277)
Land	4.301***	4.373***	4.019***	3.853***
	(0.213)	(0.189)	(0.218)	(0.231)
Observations	40,650	40,650	40,650	40,650

Estimator: Poisson QMLE.
Robust standard errors in parentheses, clustered at province pairs.
Regressions include origin-yr, destination-yr, product-yr FEs.
*** p<0.01, ** p<0.05, * p<0.1

Table A-7: RRTS and covariates for product, time, province varying borders

Dependent variable: Value of trade	Product (1)	Year (2)	Province (3)
Log distance	-0.296***	-0.699***	-0.498***
	(0.0929)	(0.0884)	(0.0862)
Language	0.466***	-0.238	0.243
	(0.177)	(0.266)	(0.254)
Land	4.658***	4.053***	4.213***
	(0.229)	(0.197)	(0.254)
Observations	36,600	36,600	36,600

Estimator: Poisson QMLE.
Robust s.e. in parentheses, clustered at province pairs.
Regressions include origin-yr, dest-yr, product-yr FEs.
*** p<0.01, ** p<0.05, * p<0.1

Table A-8: Province-specific border effects

Dependent variable: Value of trade			
Province	Border	Province	Border
Agusan del Norte	3.922***	Misamis Occidental	4.929***
Albay	2.177***	Misamis Oriental	0.376
Basilan	3.679***	Negros Occidental	2.310***
Bataan	5.513***	Negros Oriental	3.090***
Batangas	4.793***	Northern Samar	6.144***
Benguet	3.636***	Nueva Ecija	5.811***
Bohol	4.513***	Occidental Mindoro	3.869***
Bulacan	3.843***	Oriental Mindoro	0.0676
Cagayan	7.135***	Palawan	4.470***
Camarines Sur	5.218***	Pampanga	5.127***
Camiguin	8.193***	Pangasinan	1.740***
Catanduanes	6.598***	Quezon	7.873***
Cavite	4.098***	Romblon	10.02***
Cebu	-0.137	Samar	7.134***
Davao del Sur	2.822***	Sarangani	0.145
Davao Oriental	9.241***	Siquijor	6.281***
Ilocos Norte	0.188	Sorsogon	8.205***
Ilocos Sur	9.495***	South Cotabato	3.541***
Iloilo	3.053***	Southern Leyte	5.107***
La Union	5.282***	Sulu	4.034***
Laguna	4.253***	Surigao del Norte	3.124***
Lanao del Norte	6.113***	Surigao del Sur	4.650***
Lanao del Sur	2.983**	Tarlac	5.350***
Leyte	5.554***	Tawi-Tawi	5.229***
Maguindanao	8.544***	Zambales	5.995***
Marinduque	-2.091	Zamboanga del Norte	6.659***
Masbate	6.297***	Zamboanga del Sur	2.985*

Estimator: Poisson QMLE.
Robust standard errors in parentheses, clustered at province pairs.
Regressions include origin-time, destination-time, product-time FEs.
*** p<0.01, ** p<0.05, * p<0.1

Table A-9: Province border effects and RRTS

Dependent variable: Value of trade		
Province	Border	Smprov x RRTS
Agusan del Norte	3.742***	0.102
Albay	2.653***	2.465***
Basilan	1.423*	3.590***
Batangas	6.170***	-1.427***
Bohol	4.555***	0.511*
Camiguin	6.461***	2.889**
Cebu	0.250	-0.158
Iloilo	2.485***	0.588*
Lanao de l Norte	6.022***	0.440
Leyte	4.535***	1.102**
Marinduque	-0.584	-1.717*
Masbate	5.269***	0.747
Misamis Occidental	3.392***	2.077***
Misamis Oriental	0.922	-0.129
Negros Occidental	2.706***	-0.327
Negros Oriental	3.734***	-0.315
Occidental Mindoro	4.336***	-0.504***
Oriental Mindoro	1.859	-0.677***
Palawan	4.443***	0.813**
Quezon	7.198***	1.008
Romblon	9.680***	0.492
Samar	6.239***	2.832***
Siquijor	6.803***	-0.00864
Sorsogon	6.285***	3.242***
Southern Leyte	5.168***	0.249
Sulu	3.116***	1.673***
Surigao del Norte	2.867***	0.0946
Tawi-Tawi	3.832***	3.168**
Zamboanga del Norte	6.719***	0.306
Zamboanga del Sur	1.839*	0.935***

Estimator: Poisson QMLE.
Robust standard errors in parentheses, clustered at province pairs.
Regressions include origin-time, destination-time, product-time FEs.
*** p<0.01, ** p<0.05, * p<0.1

Table A-10: 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-11: 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-12: 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-13: RRTS effect on probability of new export markets by product group

Dependent variable: Exporting to new non-RRTS destinations, 1 or 0

Product group	**Port-pair FE**			**Gravity covariates**			Obs.
	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-14: RRTS and lumpiness, by product group with port-pair fixed effects

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
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	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
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 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
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

Table A-15: RRTS and lane meter charging (with gravity covariates)

Dependent variable: Value of trade, number of products, probability of exporting to new destinations, frequency	All		Value (Intensive)		No. of products		Prob. new partner		Frequency	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
RRTS	0.415*	0.251	0.629***	0.251	1.465***	1.975***	-0.0010	-0.000839	0.831***	0.857***
	(0.214)	(0.393)	(0.234)	(0.449)	(0.178)	(0.271)	(0.00103)	(0.00172)	(0.126)	(0.212)
RRTS x Q2	0.0146	-0.112		-0.0520	-0.0788***	-0.410	0.0007	1.22e-05	-0.0214	-0.0735
	(0.183)	(0.349)		(0.394)	(0.0135)	(0.404)	(0.00048)	(0.00100)	(0.0265)	(0.0889)
RRTS x Q3	0.309	-0.340		-0.329*	-0.101***	-0.321	0.0006	-0.000466	-0.0482	-0.00641
	(0.476)	(0.214)		(0.191)	(0.0197)	(0.336)	(0.00058)	(0.00150)	(0.0338)	(0.0885)
RRTS x Q4	0.377	-0.489		-0.419	-0.133***	-0.0948	0.0015***	0.000465	0.00256	0.0320
	(0.333)	(0.380)		(0.391)	(0.0190)	(0.240)	(0.00060)	(0.00133)	(0.0298)	(0.0716)
RRTS x Short		0.249		0.478		-0.381		-0.00114		-0.0355
		(0.415)		(0.474)		(0.298)		(0.00177)		(0.225)
RRTS x Short x Q2		0.150	-0.0678	-0.00402		0.410		0.00112		0.0583
		(0.354)	(0.153)	(0.391)		(0.476)		(0.000950)		(0.0903)
RRTS x Short x Q3		0.696	0.418	0.800		-0.0710		0.00161		-0.0402
		(0.494)	(0.520)	(0.536)		(0.422)		(0.00150)		(0.0918)
RRTS x Short x Q4		0.923***	0.421	0.896**		0.381		0.00155		-0.0275
		(0.334)	(0.355)	(0.372)		(0.279)		(0.00136)		(0.0732)
Short		-0.321		-0.277	0.288**	0.288**		-1.70e-05		-0.0413
		(0.215)		(0.214)	(0.117)	(0.117)		(0.00103)		(0.0835)
Q1	-0.108	0.509	-0.0133	0.291	-4.139***	-5.766***	0.0052*	0.0220***	-3.551***	-2.843***
	(0.652)	(0.559)	(0.562)	(0.601)	(0.557)	(0.462)	(0.0027)	(0.00437)	(0.734)	(0.390)
Q2	-0.467	0.140	-0.384	-0.0833	-4.046***	-5.073***	0.0042	0.0208***	-3.809***	-3.102***
	(0.670)	(0.573)	(0.577)	(0.612)	(0.559)	(0.458)	(0.0027)	(0.00435)	(0.735)	(0.391)
Q3	-0.488	0.122	-0.407	-0.105	-4.029***	-4.487***	0.0054**	0.0220***	-4.024***	-3.317***
	(0.673)	(0.580)	(0.579)	(0.618)	(0.559)	(0.463)	(0.0027)	(0.00436)	(0.735)	(0.393)
Q4	-0.333	0.271	-0.242	0.0571	-3.961***	-4.091***	0.0022	0.0189***	-4.273***	-3.566***
	(0.688)	(0.576)	(0.586)	(0.609)	(0.560)	(0.456)	(0.0026)	(0.00433)	(0.735)	(0.392)
Log distance	-0.0889	-0.138**	-0.107*	-0.150**	0.0605	0.138***	0.00011	0.000148	0.0238	0.0136
	(0.0579)	(0.0623)	(0.0568)	(0.0642)	(0.0420)	(0.0468)	(0.00029)	(0.000374)	(0.0282)	(0.0329)
Language	-0.240	-0.144	-0.349*	-0.246	-0.176	-0.156	-0.0009	-0.00152	-0.0172	-0.0219
	(0.202)	(0.201)	(0.199)	(0.203)	(0.151)	(0.147)	(0.00126)	(0.00129)	(0.104)	(0.103)
Liner	1.295***	1.313***	1.230***	1.246***	0.799***	0.789***	0.0056***	0.00546***	0.527***	0.539***
	(0.252)	(0.249)	(0.248)	(0.248)	(0.153)	(0.152)	(0.00144)	(0.00148)	(0.0908)	(0.0942)
Observations	2,052,195	2,052,195	1,889,419	1,889,419	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).
All regressions have origin-year, destination-year, and product-year FEs.
Robust standard errors in parentheses clustered at city-pairs.
*** p<0.01, ** p<0.05, * p<0.1

Table A-16: RRTS and time-sensitive goods (with gravity covariates)

Dependent variable: Value of trade, number of products, probability of exporting to new destinations, frequency										
Variables	All		Value (Intensive)		No. of products		Prob. new partner		Frequency	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
RRTS	0.547***	0.0492	0.824***	0.0600	1.424***	1.710***	-0.0002	-0.000150	0.561***	0.759***
	(0.193)	(0.389)	(0.209)	(0.428)	(0.161)	(0.262)	(0.0009)	(0.00142)	(0.103)	(0.215)
RRTS x TS	-0.583*	-0.0690	-0.507	-0.00519	0.0675	0.104	0.0015**	-0.00154	0.203***	0.209**
	(0.335)	(0.331)	(0.359)	(0.347)	(0.0657)	(0.179)	(0.0007)	(0.00102)	(0.0426)	(0.103)
TS	0.140	0.169	0.0943	-0.856*	-1.113***	-1.051***	-0.0015	0.0341***	-0.355***	0.0692
	(0.549)	(0.553)	(0.726)	(0.487)	(0.0900)	(0.0809)	(0.0019)	(0.0118)	(0.109)	(0.0790)
RRTS x Short		0.692*		0.910**		-0.214		-0.000412		-0.0964
		(0.403)		(0.443)		(0.289)		(0.00158)		(0.229)
RRTS x SH x TS		-0.543*		-0.527		-0.0462		0.00326***		-0.0207
		(0.291)		(0.331)		(0.188)		(0.00110)		(0.104)
Short		-0.276		-0.257		-0.299**		0.00279***		-0.320***
		(0.199)		(0.201)		(0.123)		(0.000969)		(0.0852)
Log distance	-0.102**	-0.121**	-0.130**	-0.146**	-0.0666*	-0.123***	0.0003	0.00148***	-0.0753***	-0.123***
	(0.0515)	(0.0571)	(0.0547)	(0.0590)	(0.0354)	(0.0358)	(0.0002)	(0.000324)	(0.0255)	(0.0262)
Language	-0.331*	-0.132	-0.386*	-0.252	-0.490***	-0.433***	-0.0005	-0.000282	-0.235**	-0.164*
	(0.189)	(0.203)	(0.200)	(0.203)	(0.141)	(0.148)	(0.0012)	(0.00124)	(0.106)	(0.0972)
Liner	1.244***	1.296***	1.253***	1.236***	1.081***	1.104***	0.0054***	0.00447***	0.632***	0.681***
	(0.248)	(0.249)	(0.250)	(0.247)	(0.171)	(0.172)	(0.0014)	(0.00145)	(0.103)	(0.0971)
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 QMLE; LPM for columns (7) and (8)
All regressions have origin-year, destination-year, and product-year FEs.
Robust standard errors in parentheses clustered at city pairs.
*** p<0.01, ** p<0.05, * p<0.1

Table A-17: Product-price mapping

Farmgate product	**PSA Product Code**	**Retail product**
Banana Lakatan, green	5730	Banana Lakatan, green
Banana Saba (plantain), green	5730	Banana Saba (plantain), green
Cabbage	5453	Cabbage
Calamansi	5729	Calamansi
Carrots	5455	Carrots
Chicken egg, commercial	2510	Chicken egg
Coconut matured	5771	Coconut matured
Corngrain [Maize] White, matured	4490	Corn, white
Corngrain [Maize] Yellow, matured	4490	Corn, yellow
Mango Carabao, green	5797	Mango Carabao, ripe
Onion native (red shallot), multiplier	5451	Red creole
Onion Red Creole (Bermuda Red)	5451	
Palay [Paddy] Other Variety, dry (conv. to 14% mc)	4210	Rice, regular milled
	4210	Rice, well milled
Pineapple Hawaiian	5795	Pineapple, Hawaiian
Pineapple Native	5795	
Tomato	5440	Tomato
White/Irish Potato	5410	White/Irish Potato

Table A-18: RRTS and unit values - gravity covariates

Dependent variable: Price wedge level	All		Without Eggs	
	(1)	(2)	(3)	(4)
RRTS	3.991***	3.662***	4.145	4.467
	(0.945)	(0.928)	(3.384)	(3.217)
$RRTS \times Uval$	-0.0797**	-0.0693*	-0.0887	-0.0244
	(0.0359)	(0.0357)	(0.251)	(0.267)
$RRTS \times Uval \times Short$		-0.0291		-0.234**
		(0.0400)		(0.105)
Uval	1.009**	1.031**	0.987**	1.019***
	(0.423)	(0.424)	(0.391)	(0.388)
Short		-3.464***		-3.317***
		(1.197)		(1.215)
Log distance	2.122***	0.154	2.341***	0.263
	(0.683)	(1.008)	(0.714)	(1.046)
Language	-1.012	-1.031	-0.691	-0.639
	(0.843)	(0.824)	(0.813)	(0.784)
Constant	-65.76**	-54.66*	-11.08	1.708
	(32.32)	(32.47)	(6.966)	(8.175)
Observations	69,071	69,071	64,535	64,535
R-squared	0.658	0.660	0.675	0.678

Estimator: OLS.
Regressions include product-month, origin-year, and destination-year FEs.
Robust standard errors in parentheses clustered at province pairs.
*** p<0.01, ** p<0.05, * p<0.1

Table A-19: Price wedge ratio by product

Dependent variables: Price wedge ratio			
Product	RRTS	RRTS	RRTS Short
	(1)	(2a)	(2b)
Banana	-0.110***	0.121***	-0.767***
	(0.039)	(0.045)	(0.070)
Cabbage	-0.477***	-0.422*	-0.0827
	(0.136)	(0.226)	(0.269)
Calamansi	0.844***	0.922***	-0.178
	(0.122)	(0.124)	(0.227)
Carrots	-0.261	-0.034	-0.976**
	(0.302)	(0.381)	(0.441)
Coconut	0.507**	0.507***	-0.931***
	(0.126)	(0.126)	(0.141)
Corn	-0.0323		
	(0.038)		
Eggs	-0.013**	-0.023***	0.032***
	(0.006)	(0.006)	(0.009)
Mango	0.0852	0.186***	-0.385***
	(0.052)	(0.061)	(0.078)
Onion	0.129	0.118	0.033
	(0.108)	(0.147)	(0.198)
Pineapple	-0.595***	2.123***	-3.876***
	(0.191)	(0.244)	(0.283)
Potato	-0.125**	0.072	-0.346***
	(0.058)	(0.105)	(0.119)
Rice	-0.0107	-0.023***	0.031***
	(0.008)	(0.009)	(0.014)
Tomato	-0.0833	-0.465**	0.746***
	(0.116)	(0.166)	(0.210)

Estimator: OLS.
All regressions include pair, year, and month FEs.
Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table A-20: Price wedge components by product

Dependent variables: Price wedge ratio, farmgate price, and retail price

	Farmgate			Retail			Obs.	No. of panel
Product	RRTS (1)	RRTS (2a)	RRTSxShort (2b)	RRTS (3)	RRTS (4a)	RRTSxShort (4b)	(5)	(6)
Banana	-0.706***	-1.346***	2.123***	-1.620***	-1.683***	0.209*	8,358	49
	(0.086)	(0.093)	(0.151)	(0.087)	(0.100)	(0.113)		
Cabbage	1.452***	0.692	1.146	0.772*	0.483	0.437	3,930	22
	(0.413)	(0.717)	(0.817)	(0.464)	(0.731)	(0.841)		
Calamansi	-1.206***	-0.0903	-2.545***	0.672	1.836**	-2.655**	6,059	36
	(0.454)	(0.502)	(0.895)	(0.642)	(0.708)	(1.235)		
Carrots	1.658**	0.408	5.375***	6.819***	9.162***	-10.07***	5,072	34
	(0.731)	(0.835)	(1.543)	(1.340)	(1.639)	(2.262)		
Coconut	-0.170	-0.170	1.010***	0.322	0.322	-0.275	1,913	13
	(0.118)	(0.118)	(0.147)	(0.222)	(0.222)	(0.253)		
Corn	0.510**			-0.130			785	14
	(0.211)			(0.279)				
Eggs	3.151***	3.530***	-1.248***	2.784***	2.978***	-0.639	4,536	29
	(0.239)	(0.268)	(0.400)	(0.333)	(0.392)	(0.560)		
Mango	-0.699**	-2.671***	7.534***	1.021	1.914**	-3.409***	4,308	30
	(0.341)	(0.365)	(0.720)	(0.644)	(0.807)	(1.149)		
Onion	-0.106	-0.320	-0.320	0.999	1.509	-1.476	8,590	78
	(0.762)	(1.005)	(1.005)	(1.108)	(1.333)	(2.301)		
Pineapple	0.0379	-4.323***	6.219***	4.737**	6.623***	-2.689***	1,981	15
	(0.286)	(0.351)	(0.424)	(0.418)	(0.680)	(0.708)		
Potato	1.865***	-1.036	5.091***	1.846**	1.958	-0.197	5,325	25
	(0.527)	(0.809)	(1.010)	(0.764)	(1.199)	(1.505)		
Rice	0.065**	0.183***	-0.302***	-0.376***	-0.351***	-0.0657	13,710	84
	(0.034)	(0.044)	(0.058)	(0.072)	(0.089)	(0.125)		
Tomato	-0.296	-0.0603	-0.461	-1.590***	-2.513***	1.806*	4,504	30
	(0.297)	(0.402)	(0.522)	(0.520)	(0.712)	(0.942)		

Estimator: OLS.

All regressions include pair FEs, year FEs, and month FEs.

Short distance RRTS effects for corn could not be estimated due to lack of variation.

Robust standard errors in parentheses.

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

Table A-21: Spatial price relationships between supplying provinces

Dependent variable: Farmgate price	Levels		Differences	
	(1)	(2)	(3)	(4)
$Price_j$ (other suppliers)	0.108***	0.093***	0.122***	0.116***
	(0.0212)	(0.0217)	(0.0109)	(0.0102)
$Price_j \times RRTS$		0.153***		0.0922**
		(0.0436)		(0.0464)
RRTS		-1.409***		0.00327
		(0.492)		(0.0253)
Constant	65.97***	67.00***	-0.225	-0.228
	(2.163)	(2.172)	(0.265)	(0.265)
Observations	214,357	214,357	191,917	191,917
R-squared	0.816	0.817	0.119	0.119

Estimator: OLS.
All regressions include product-month and year fixed effects.
Robust standard errors in parentheses clustered at supplier province pairs.
*** p<0.01, ** p<0.05, * p<0.1

Table A-22: Reduced form equation for $\Delta P_{ot} \times RRTS_{ij,t} \times Short$

Dependent variable: $\Delta P_{ot} \times RRTS_{ij,t} \times Short$	All unaffected	No grains	No hubs	No grains & hubs
	(1)	(2)	(3)	(4)
RRTS	0.0158	-0.0296	0.0361	0.0185
	(0.0329)	(0.0491)	(0.0383)	(0.0608)
Rain	5.68e-06	0.000106**	1.75e-05	9.69e-05
	(3.68e-05)	(5.16e-05)	(4.22e-05)	(6.16e-05)
RRTS x Rain	-0.000913	-0.00760	-0.0261	-0.0347
	(0.00681)	(0.00801)	(0.0253)	(0.0348)
RRTS x Rain x Short	0.899***	0.871***	0.638***	0.527***
	(0.0386)	(0.0439)	(0.0992)	(0.135)
RRTS x Short	0.00155	-0.00716	0.0131	0.0247
	(0.0130)	(0.0177)	(0.0168)	(0.0223)
Constant	-0.108	0.0606	-0.0232	0.0312
	(0.0664)	(0.0564)	(0.0549)	(0.0648)
R-Squared	0.128	0.128	0.048	0.042
Observations	52,682	38,787	33,290	22,942

Estimator: OLS.
All regressions include province-pair, product-month, and year FE.
Robust standard errors in parentheses clustered at province pairs.
*** p<0.01, ** p<0.05, * p<0.1

Figure A-1: Price gap ratio – Bananas

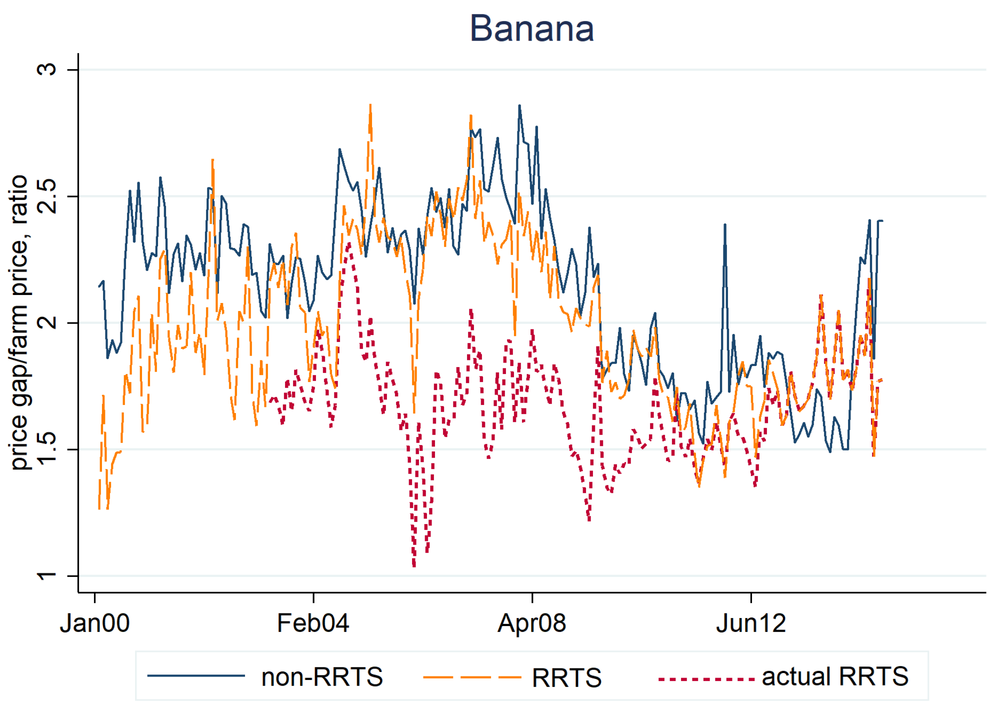

Figure A-2: Price gap ratio – Cabbage

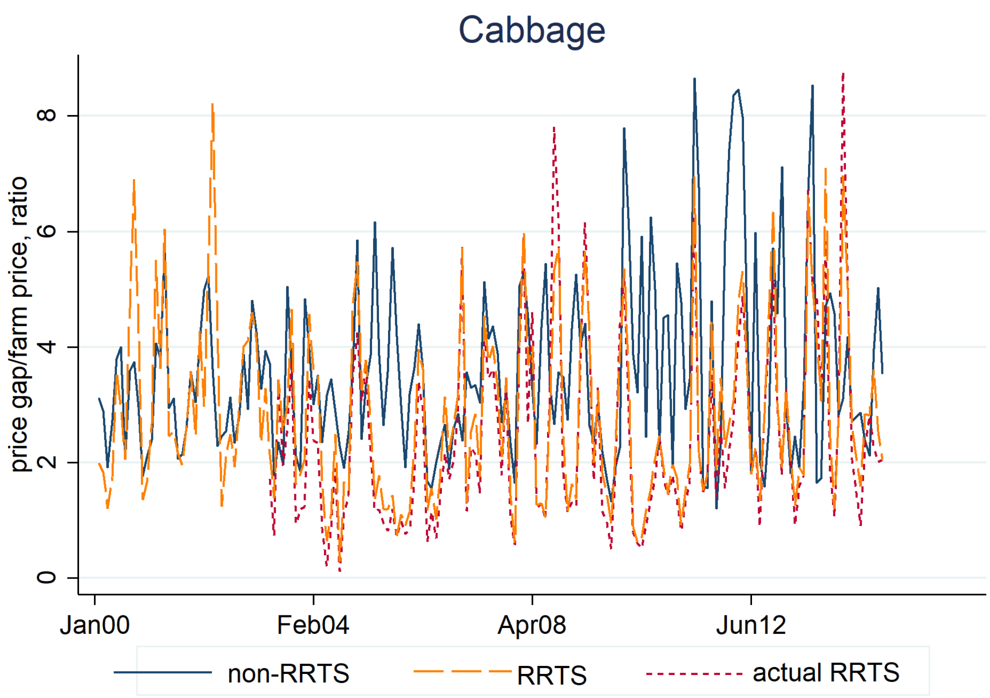

Figure A-3: Price gap ratio – Calamansi

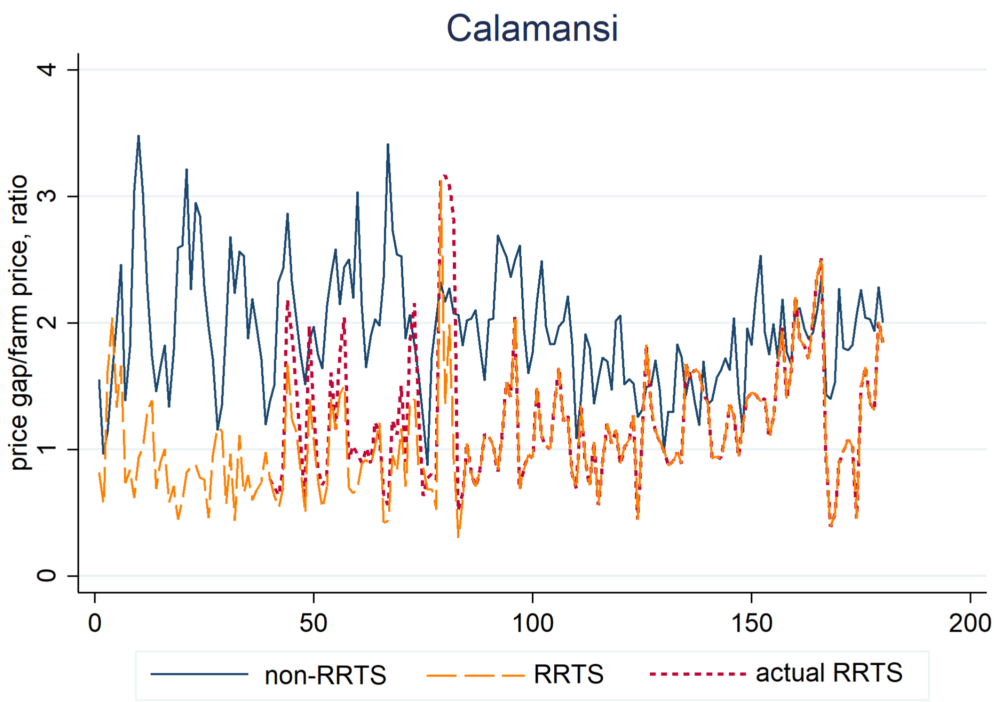

Figure A-4: Price gap ratio – Carrots

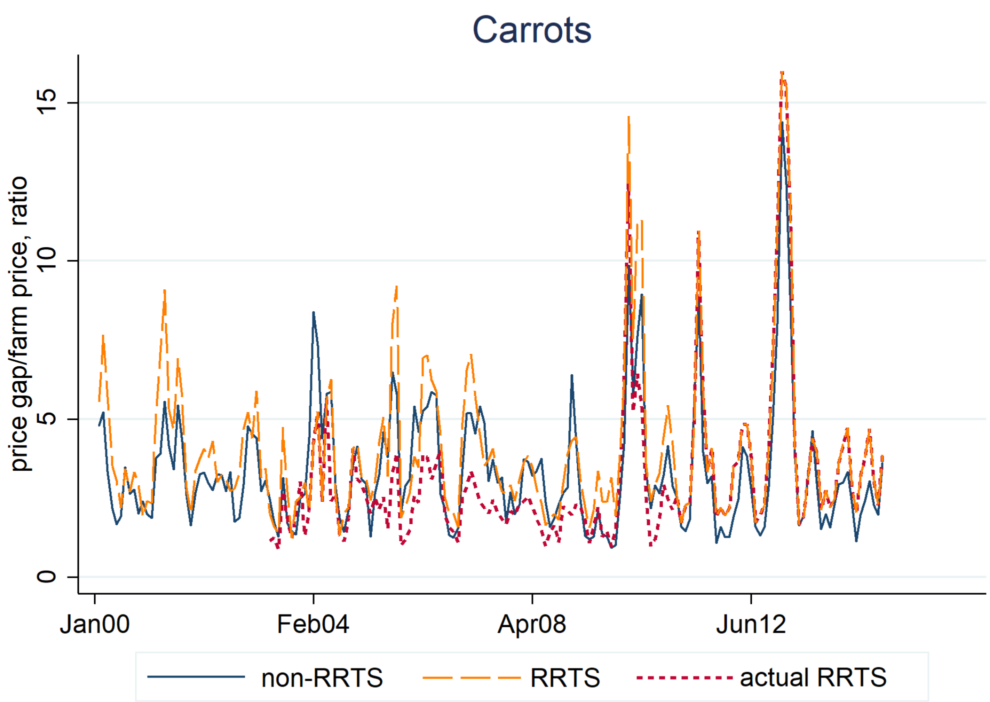

Figure A-5: Price gap ratio – Coconut

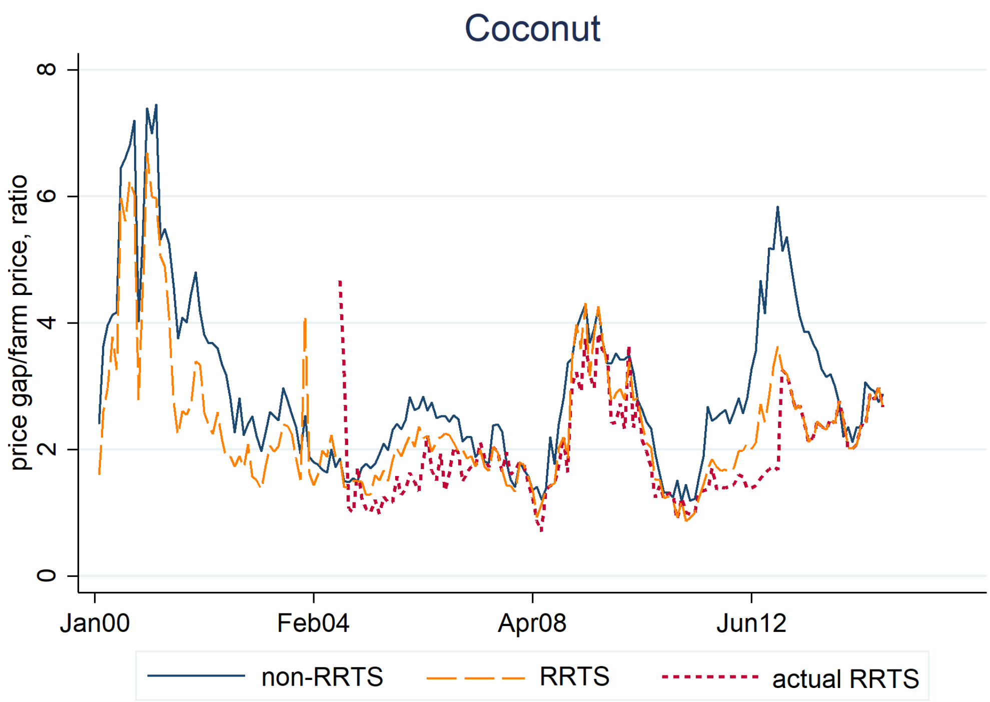

Figure A-6: Price gap ratio – Corn

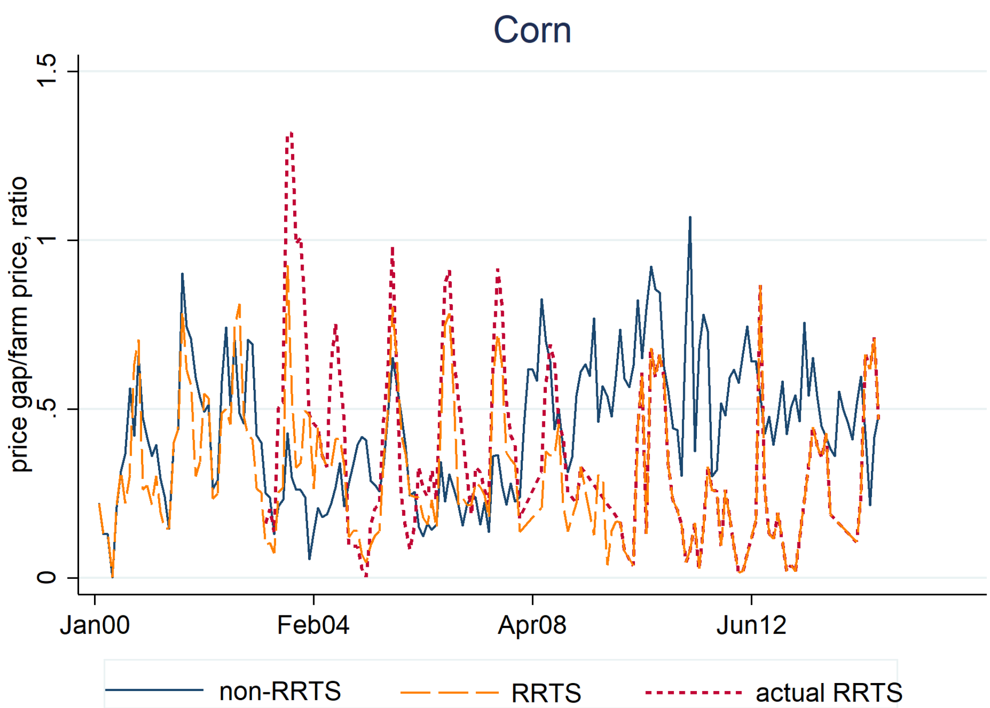

Figure A-7: Price gap ratio – Eggs

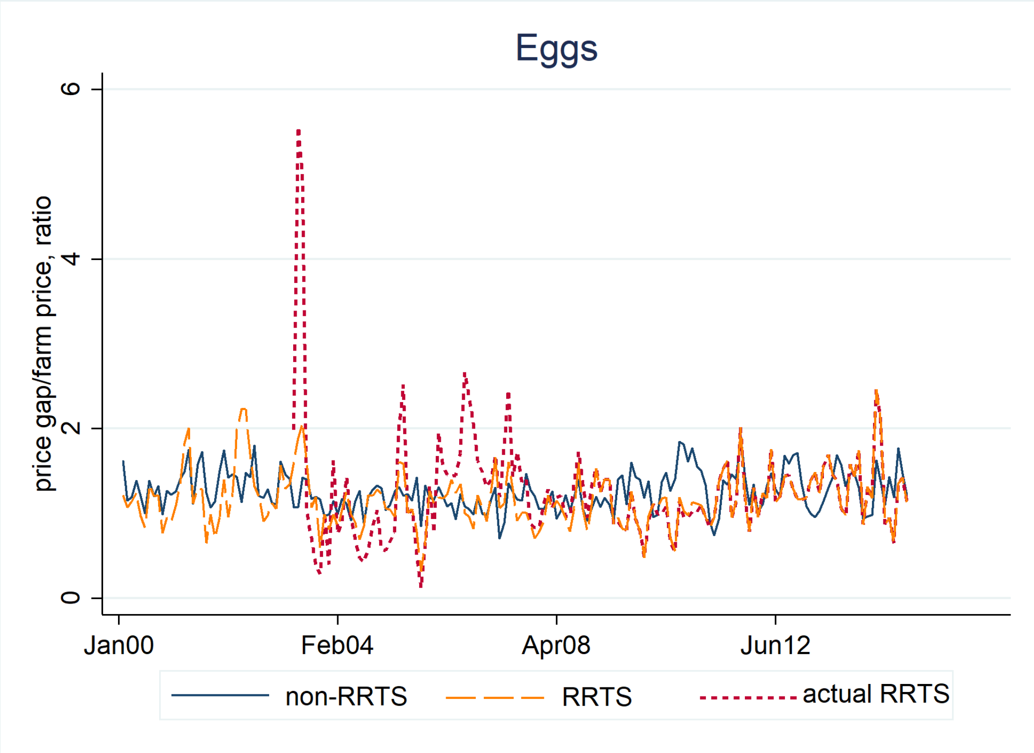

Figure A-8: Price gap ratio – Mango

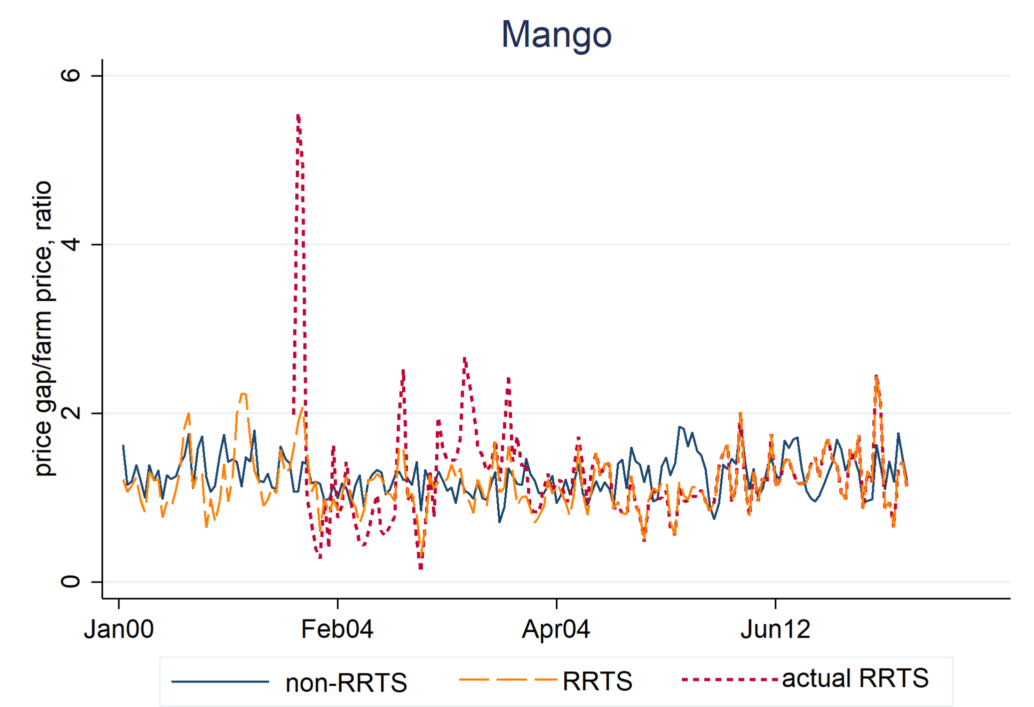

Figure A-9: Price gap ratio – Pineapple

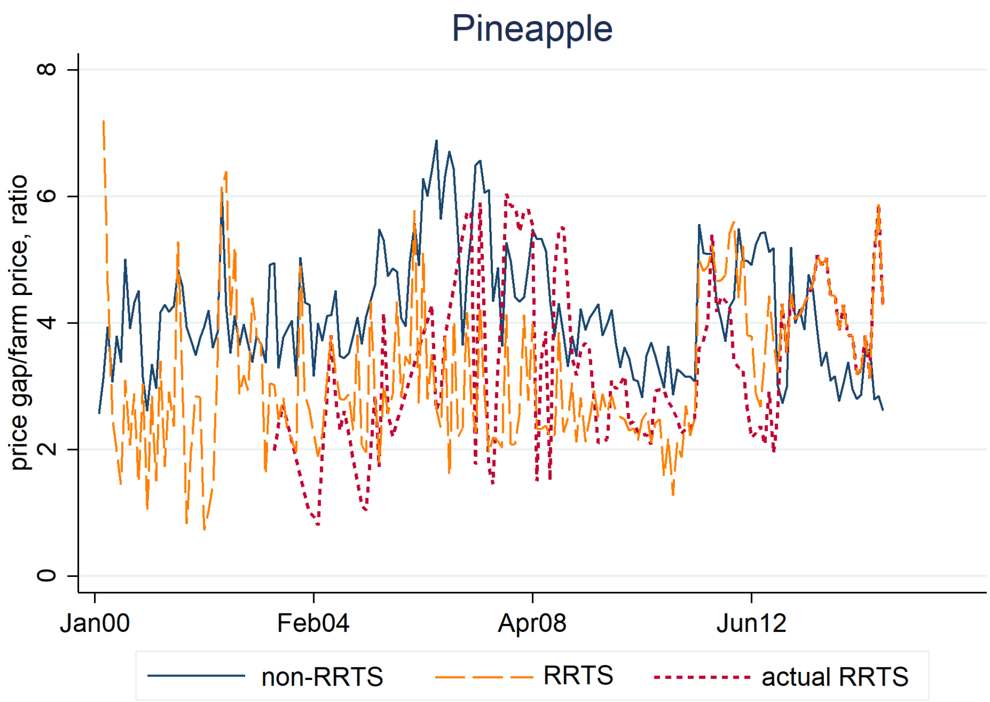

Figure A-10: Price gap ratio – Potato

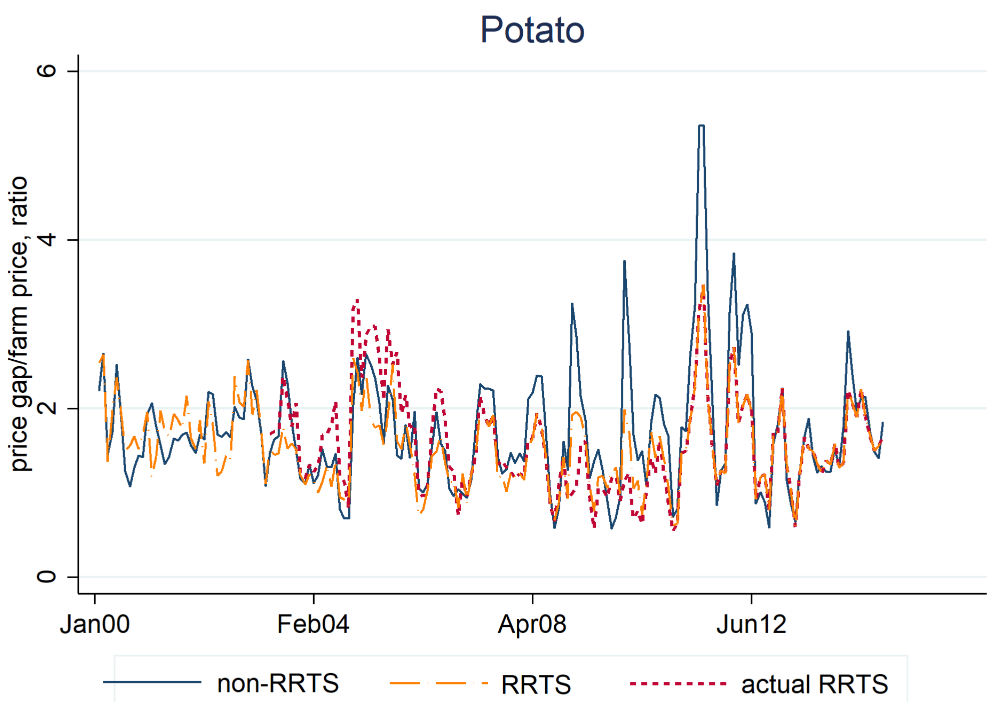

Figure A-11: Price gap ratio – Onion

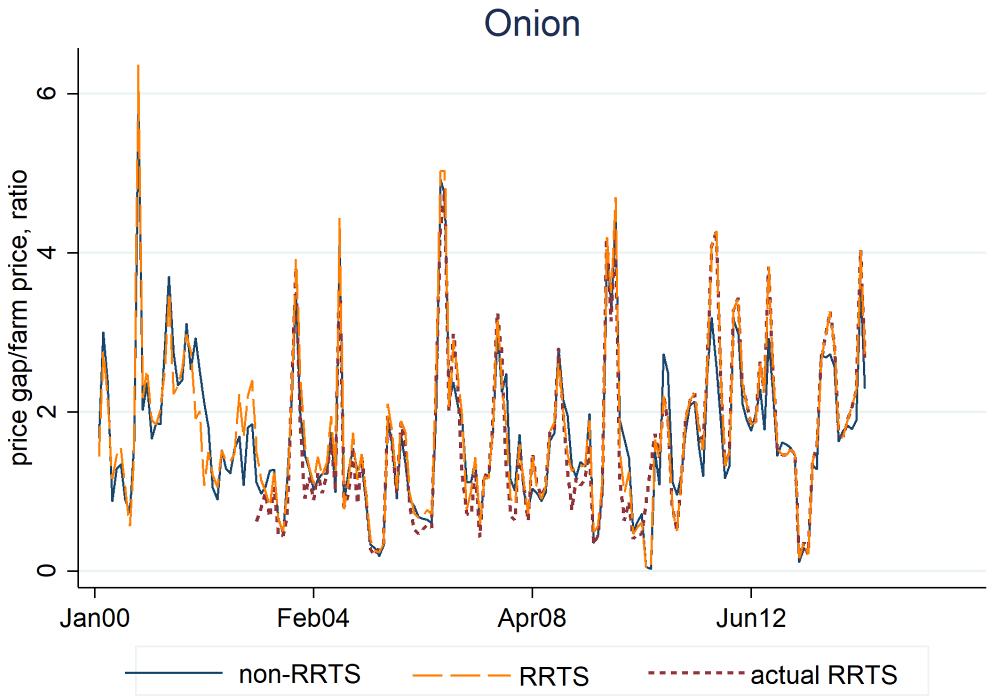

Figure A-12: Price gap ratio – Rice

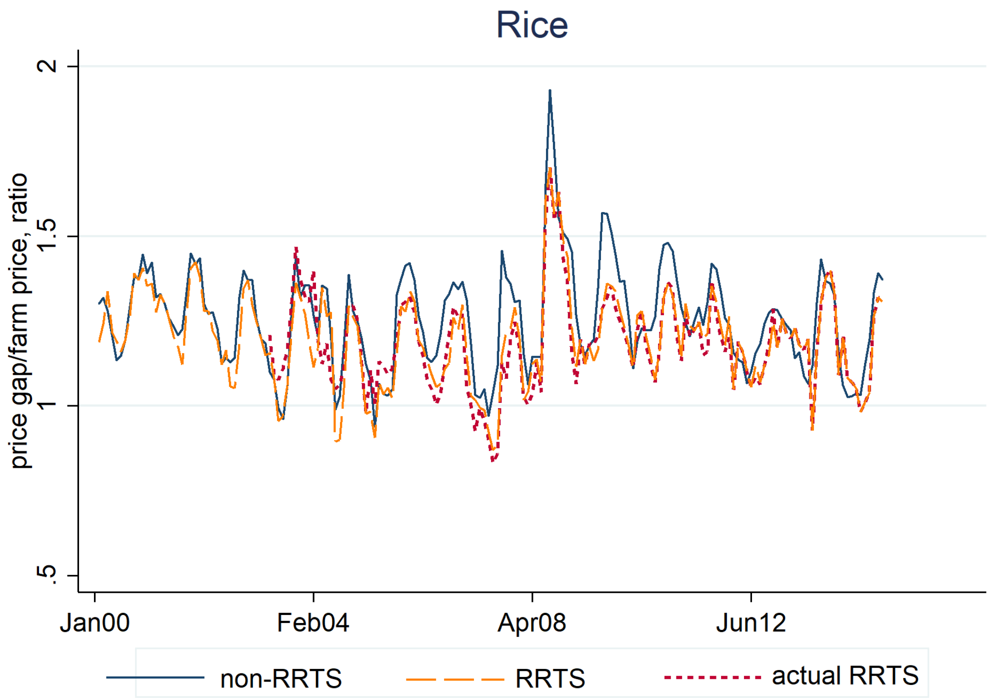

Figure A-13: Price gap ratio – Tomato

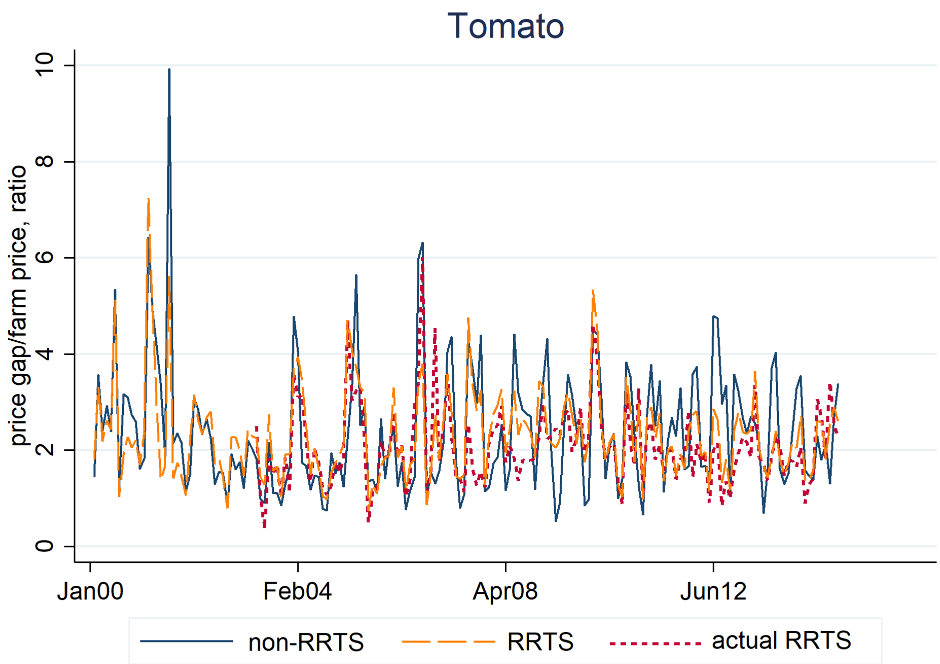

Figure A-14: Average farm and retail prices by product