Geographic Disadvantage and the Composition of Trade

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PRELIMINARY DRAFT

Abstract

The particular transportation frictions to which landlocked and island countries are differentially exposed shape the composition of these regions' trade flows. Product characteristics associated with the method and cost of international transportation - together with an indicator of products' proximity to final demand - explain cross-country variation in trade composition. Landlocked countries and small islands export products with relatively low weight-to-value ratios. Products suitable for container shipping are disproportionately represented in landlocked countries' imports and small islands' exports. Small islands' exports contain relatively more final products than the exports of similar reference countries. Cross-country differences in trade composition also depend on countries' population, per-capita income, geographic remoteness, and WTO member status. The effects of the product characteristics we study on trade composition are heterogeneous within the groups of landlocked countries and small islands, and depend on the other country characteristics.

Keywords: Landlocked countries, islands, revealed comparative advantage, transportation costs, upstreamness

JEL Codes: F10, F14

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1 Introduction

The growth of global supply chains over recent decades has created new opportunities for economic development through international trade (Baldwin, 2012). Rather than competing in a global market for finished products, developing countries are able to enter international markets by producing the particular stages of production for which they are well suited. Unfortunately, countries that are geographically separated from global production may be unable to take full advantage of these opportunities.

In this paper, we study the ways in which countries' landlocked or island status affects the composition of both their exports and imports. Many studies using the gravity model of trade include dummy variables that identify one or both country types, so the consequences of geography for the level of trade in these countries is well studied, though not exhaustively so. We study the composition - rather than the level - of trade in landlocked countries and small islands, examining the ways in which certain product characteristics are over- or under-represented in their export and import bundles, relative to the world as as whole. We use the concept of Revealed Comparative Advantage (RCA) to summarize trade composition, and apply it to imports as well as exports. The product characteristics we study include several that relate to variation in the product's reliance on particular kinds of transport. We also separate products into sets of final and upstream products, in order to focus on the way in which industries' vertical position in global supply chains intersects with geography to determine countries' RCA. The product characteristics we study seem particularly relevant for understanding how geography affects countries' participation in global supply chains.

Our intent is simply to document some new stylized facts, but we believe the insights may offer lessons that are helpful to policymakers. Island countries likely face public financing decisions about the relative merits of capacity investments in sea ports vs. airports. Landlocked countries also face infrastructure choices regarding transport (e.g., increased air transport capacity versus greater coordination with neighbors that have access to the sea). Our results are also potentially useful for efforts to identify sectors that might benefit from targeted efforts to increase exports, as in Reed (2024). Sectors that face transport-related constraints on either exports or imported inputs may be poor choices for such investments.

The paper that is most useful for understanding our contribution is Venables and Limao (2002), which develops a theory about how products' transport intensity and countries' geographic location jointly determine countries' export specialization.[1] Our approach is empirical rather than theoretical, and our focus is on differential effects felt by landlocked and small island countries, rather than the effects of geographic remoteness generally. As a by-product of our work, we also produce empirical estimates of the effects of geographic remoteness on trade composition, the question that motivates Venables and Limao (2002).[2]

Our empirical methods are closely related to a literature that seeks to better understand the determinants of countries' comparative advantage. Romalis (2004) examines how factor proportions determine countries' production structure and trade composition. Nunn (2007), Levchenko (2007) and Debaere (2014) use the method to study the effects on comparative advantage of countries' contract enforcement, institutions, and water endowments, respectively. These papers regress industry-level trade on interactions between industry- and country- characteristics, conditional on country- and industry- fixed effects. We use trade data at the HS6-digit level, and focus on interactions between product- and country- characteristics, conditional on country- and product- fixed effects. Because we are interested in the role of transport-related frictions we eschew language about uncovering the determinants of comparative advantage. For us RCA is simply a useful quantitative framework for summarizing differences in trade composition. Since we are interested in participation in global supply chains, we study the composition of imports as well as exports, which are the focus of the existing literature on RCA. Another difference with the existing RCA literature is that we use a Poisson Pseudo Maximum Likelihood (PPML) estimator, an approach that has important advantages over the log-linear OLS tools that are more commonly employed.

[1] In a different theoretical setting, Antràs and de Gortari (2020) show how geography defines specialization within particular supply chains. A key prediction is that final production stages are located in large/geographically central markets. Early stages are produced in the periphery.

[2] Anderson and Van Wincoop (2003) develop the implications of geographic remoteness for the level of trade. An influential literature focuses on the implications of remoteness for per capita income. See, for example, Redding and Venables (2004), Hanson (2005), Redding and Sturm (2008), Head and Mayer (2011) and Bosker and Garretsen (2012). Duranton et al. (2014) show the effects of US highways on both the level and composition of trade in US cities. Their result that cities with good highway access trade heavier goods is the most similar to our findings.

A prominent recent literature has sought to understand comparative advantage through pooled product-level gravity regressions that are motivated by Ricardian models of trade.[3] These efforts study variation in product-level export supplies, conditional on the distribution of bilateral trade costs and product-level demands. The variation in export composition observed in these studies is interpreted through the lens of models that posit an exogenous spatial distribution of demand; they do not take into account the ways in which specialization and trade are affected by firms' decisions to avoid trade costs via the co-location of sequential production, thus changing the spatial distribution of demands, as in Krugman and Venables (1996), Krugman and Venables (1995) or Antràs and de Gortari (2020). Joint location of sequential production is important for understanding specialization and trade within agglomerations, but it also has important implications for the geographic periphery, the focus of our study here. We do not study joint location decisions explicitly. Rather we seek to understand specialization without conditioning on the existing spatial distribution of supply/demand. While the patterns we uncover are, of course, dependent on the particular trade equilibrium in which they are studied, we view the relationships we uncover to be largely robust to changes in the spatial pattern of bilateral trade costs (such as changes that might cause a reallocation of supply chains across space). We therefore view an estimation of the determinants of RCA that is not conditioned on the spatial pattern of product-level demands as useful, so we link the composition of total (not bilateral) exports and imports to country characteristics that are not likely to be substantially changed if/when the geographic pattern of bilateral trade costs is changed by, for example, a tariff war.[4]

The empirical gravity-model-of-trade literature provides a large number of estimates of the effect of landlocked and/or island status on the level of trade. Landlocked countries' trade appears to be more heavily affected by their particular geographies than islands' trade, so landlocked countries have received a larger share of the literature's attention. Limao and Venables (2001) demonstrate that landlocked countries pay an extremely large burden in terms of excess transport costs. They estimate that these higher transport costs (together with other implicit trade costs) produce an

[3] See for example, Costinot et al. (2012), Chor (2010), Hanson et al. (2015), Levchenko and Zhang (2016) or French (2016).

[4] We include in our study per capita GDP, population and market access variables, which would not be completely unchanged, of course, if bilateral trade costs changed. Our point is that countries' relative positions in the distribution of such country characteristics would only be marginally affected by changes in specific bilateral trade costs.

outcome in which the level of landlocked countries' trade is 60 percent lower than in otherwise equivalent countries with access to the sea. Using the most current empirical methods, Gyawali (2023) estimates that landlocked status generates a 67 percent reduction in the level of trade. Both of these estimates of the landlocked penalty are broadly consistent with the findings in a number of other papers.[5] Several authors link the trade penalty associated with landlocked status to poor policy choices in the landlocked countries themselves, especially policies regarding transport.[6] All of the estimates in the papers above relate to the *level* of landlocked countries' trade, while we study the composition of trade using the lens of RCA.[7]

The effects of island status on trade are not as well studied as the effects of landlocked status, and are less clear-cut.[8] The most important paper regarding islands' trade is Langat et al. (2022), who conduct a metanalysis over 95 papers that report a total of 2,044 estimates of the effects of island status on the level of trade. Their estimates from the meta-analysis point to a positive and statistically significant effect of island status on the level of trade flows.[9] Our paper differs from those studied in Langat *et al.*, because we focus on the composition rather than the level of trade. We also study countries' total imports and exports, rather than bilateral trade flows usually studied in the gravity model of trade.

A closely related paper is **?**, which uses several of the same product characteristics to estimate an effect of U.S. cabotage restrictions on Puerto Rico's trade with the United States mainland. These authors find evidence that Puerto Rico's imports of final products are biased against US

[5]See e.g., Radelet and Sachs (1998), Limao and Venables (2001), Raballand (2003), Faye et al. (2004), Arvis et al. (2010), and Moore (2018), Paudel and Cooray (2018), and Pham and Sim (2020).

[6]See e.g., Macchi and Raballand (2009), Arvis et al. (2010), Hallaert et al. (2011), and Borchert et al. (2012).

[7]Felbermayr and Kohler (2006) study intensive and extensive (product) margins of trade, a step in the direction of the trade composition questions we ask. They find less trade along both intensive and extensive margins of trade for both landlocked and island countries. Our estimates show ways in which compositional adjustments to landlocked status relate to product characteristics.

[8]One complicating factor we discover is that it can be difficult to define the sample of island countries. We find reasons to consider alternate definitions of island status. Several island countries (e.g., Japan, Philippines) are large enough to be of questionable relevance to our research question. Singapore is an island with land bridges that allow overland trade with Malaysia. Many countries that might come to mind as island nations actually share at least one land border with a neighbor (e.g., Haiti/Dominican Republic, UK/Ireland, Papua New Guinea/Indonesia/Timor Leste). We are most interested in small islands where transport costs are compounded by a lack of scale. We construct the island dummy to capture small islands, putting countries like Japan, the Philippines and Singapore in the reference group.

[9]Prominent papers used in this meta-analysis include Estevadeordal et al. (2003), Ghosh and Yamarik (2004), Rose (2004), Klein and Shambaugh (2006), Tomz et al. (2007), Eicher and Henn (2011) and Grant and Boys (2012).

sources when they are sea-shipped, physically heavy and not commonly shipped in containers. Among upstream products, the authors find a strong bias against sea-shipped products, regardless of sourcing. One possible explanation for these results is that the high costs of waterborne trade with the U.S. has reduced the range of industries that can successfully locate in Puerto Rico. One goal of this paper is to understand the degree to which the outcomes observed in Puerto Rico are general to islands.

Our empirical study of cross-country variation in RCA shows that products' transport characteristics and countries' geography play an important joint role in shaping the composition of countries' imports and exports. Looking first at interactions involving the country control variables, we find that more geographically remote countries have trade bundles that are biased against products that are more commonly air-shipped or shipped in containers. Geographical remoteness is also associated with physically lighter imports and physically heavier exports. Other country control variables - population, per capita income and World Trade Organization (WTO) member status - also relate to trade composition in largely intuitive ways.

Relative to the set of reference countries, we find the following results for landlocked and island countries: 1) Products with low weight-to-value ratios are over-represented in landlocked countries' imports and exports. 2) Landlocked countries conduct relatively more trade in products transported in shipping containers, though this effect is only statistically significant for imports. 3) Small island countries' exports are biased towards final products and products shipped in containers. 4) Small islands' imports are biased against both containerized freight and air-shipped products, an outcome that appears to arise because small islands' imports contain a disproportionate share of fuels. Finally, 5) the effects we observe for islands and landlocked countries are heterogeneous within the two groups of countries, varying with per capita income, population, geographic remoteness and WTO member status in largely intuitive ways.

The remainder of the paper is organized as follows. Section 2 describes different theories of economic geography and trade, and relates them to predictions about the composition of exports and imports. Section 3 outlines the estimating framework. Section 4 describes our data. Section 5 report results. Section 6 concludes.

2 Predictive theories

The objective of this paper is to better understand how the composition of countries' exports and imports depends upon product characteristics that relate to the method and cost of transporting the product, and to the product's position in vertical supply chains. There are a number of theories that are useful in informing these questions. Rather than specify a particular theory, we discuss several that seem most relevant to our questions.

The most important ideas in what follows are: 1) there is important variation in the physical properties of traded goods (size, weight, etc.), and these characteristics are important determinants of both the means by which products are transported and the cost of transporting them; 2) observable transport-related choices in a large, relatively efficient international transport market (U.S. imports) reflect optimized choices about the most efficient ways to transport each product; 3) these observable characteristics are therefore predictive about the cross-product distribution of the costs of transporting products in different settings, as well as the degree to which trade in certain products is constrained by lack of access to certain kinds of transportation; 4) the incidence of transport frictions associated with different product characteristics varies across countries in ways that depend upon observable country-characteristics;[10] and 5) international supply chains are organized to minimize transport and other frictions, and the effects of those decisions should be evident in trade data.

The joint implication of these five ideas is that the interactions of product- and country-characteristics can help explain cross-country differences in the composition of both imports and exports. Our empirical exercises seek to evaluate the effect of these joint implications on the composition of countries' trade flows.

2.1 Cross-product variability in transportability

A central component of the gravity model of trade is the iceberg trade cost, which posits that trade costs are proportional to the value of trade. The size of trade costs is taken to be rising in distance and other geographic frictions (such as those that affect islands and landlocked countries), but the

[10]For example, the business models of bulk and container ships is different, leading the relative supply of the two services to vary across the globe. We expect the relative cost of trading bulk and containerized products to vary accordingly.

trade friction is generally treated as common across products.

In this paper we seek to focus on the implications of cross-product variation in trade costs, especially costs related to transportation. In order to do this we simplify the geographic elements of trade costs, using market access variables to summarize the overall burden each region faces in trading with global markets. We focus instead on the implications of cross-product variation in transport frictions, and in products' production line position.

We take the view that most products are best suited to being transported by particular modes of transport. Many products can be efficiently shipped in containers, while others cannot. Some products depend on timely delivery, and are shipped by air over distances of sufficient length. Because some modes of shipment are locally unavailable in some places, or prohibitively expensive, we might expect to see that products most easily shipped in that mode may not be traded at all, or traded very little. We include in our metrics the share of air shipment and the share of goods shipped in containers, which we take from U.S. import data.

Since there is important variation in the costs of shipping goods within each mode, we include a measure of the product's weight-to-value ratio. We expect heavier products to face higher average freight costs. The incidence of higher freight costs on trade flows may be larger or smaller in islands or landlocked countries, relative to the reference group of countries.

2.2 von Thünen specialization

Following the logic of von Thünen (1826), Venables and Limao (2002) propose a factor proportions model of trade in which products have different trade costs, and countries differ in both their factor endowments and their proximity to the geographic core. The key lesson of the paper is that cross-product differences in the costs of transportation can overwhelm comparative advantage among countries in the geographic periphery. Geographically remote countries will have difficulty exporting products that have high transportation costs, and may end up specializing in products that are not their comparative advantage.

The implications for our paper is that the transport characteristics we study might be expected to have predictive power for RCA in exports. In particular we might expect to see geographically remote countries specializing in products with relatively low transport frictions. Landlocked and small island countries might be differentially burdened by transport frictions, and so may be more likely to have their trade composition determined by them. This particular model assumes constant returns to scale and homothetic preferences, so has only limited implications for the composition of imports.

2.3 Intermediate goods trade and agglomeration

Krugman and Venables (1995) propose a model with similar geographical relationships, in this case the 'North' takes the role of the geographic core, and the 'South' the role of periphery. There are two sectors of production: agriculture and manufactured goods. Manufactured goods face transport costs and agriculture does not. The manufacturing sector also features increasing returns to scale in production and trade in intermediate products. The model has multiple equilibria, but at intermediate trade costs the manufacturing firms agglomerate in the North. Agglomeration allows firms to reduce the costs of trading intermediate goods by avoiding them. Krugman and Venables (1996) propose a closely related model in which the joint location of up- and down-stream production leads two identical countries to specialize in one of two identical industries. Hillberry and Hummels (2002) argue that the joint location decisions of successive production stages has trade effects that are different - both in kind and in magnitude - than those predicted by standard gravity models of trade. Hillberry and Hummels (2008) find that the distance elasticity of U.S. freight movements is enormous over very short distances, and that this outcome is at least partially driven by the co-location of sequential stages of production.

In this framework differences in industry specialization can emerge without cross-commodity differences in trade costs. Larger and more geographically central countries will tend to be the hosts of industry agglomerations. Such countries will tend to see their RCA biased in favor of the agglomerated sectors, when compared to world trade as a whole. Countries that host manufacturing will have import composition that is biased towards upstream inputs.

If landlocked and small island countries suffer additional trade costs on both imports and exports, we would expect their trade patterns to look like those of geographically remote countries in the Krugman and Venables (1995) framework. The primary implication is that both imports and exports will have a smaller role for products that are upstream of final consumption.

2.4 The spatial organization of supply chains

Antràs and de Gortari (2020) propose a theory of spatial supply chain organization. There are costs of trading between stages and across countries. In this theory, supply chains process goods in multiple stages using a constant returns to scale technology. The model predicts that the final stages of production will occur near final demand, because the will be produced near large sources of final demand, in order to minimize the costs of trading final stage production.

In general this model predicts that large, geographically central markets will host later stage production. The implications are that countries with good market access will export relatively more final products and import relatively more upstream products. Although there is important variation within the groups of landlocked and small island countries, in general these economies are smaller and more remote than the typical country. This would imply a tendency towards exporting upstream products and importing final products among these sets of countries.

2.5 Home market effects

One implication of increasing returns to scale models are home market effects, as in Krugman (1980). In these models, idiosyncratically large demand in a country generates idiosyncratically large supply. One might expect home market effects to cause countries that are geographically central and countries with large populations to export final products (as with the supply chain models). In the case of non-homothetic final demands, home market effects in final products may also follow this pattern, at different levels of per capita income. Under the presumption that landlocked and island countries are smaller and less geographically central than the reference countries, they may be less likely to specialize in exporting products susceptible to home market effects.[11]

2.6 Other considerations

Although they are not linked to particular trade theories, we offer here some other considerations likely to affect our findings.

First, the supply of international transportation services may be thicker in parts of the globe where

[11] We do not have a measure of products' susceptibility to home market effects, but expect home market effects to manifest themselves primarily in final products. The co-location of sequential sectors in supply chains has implications that are similar to those of home market effects, but these implications arise through different mechanisms. Industry co-location has stronger implications for trade in upstream products.

more trade in goods occurs. The relative supplies of different transport services may also vary with geography. We conjecture that air transport and containerized shipping may be especially amenable to network effects that favor geographically central countries. Given the cross-subsidy from passenger traffic, a tendency of air passenger demand to favor shorter routes should cross-subsidize air freight shipments on shorter routes, raising the air share of international freight in more centrally located places. Container shipping follows a hub-and-spoke model that should reduce the costs of serving all ports with container shipping services, but the geographically central countries are likely to be better served than more than geographically remote countries.[12] Brancaccio et al. (2020) describe the global market for shipping bulk products, which would favor exporting bulk products in countries that are near a large source of demand for bulk products, and favor importing bulk products when a large source of bulk exports is nearby.

Second, transportation possibilities depend on infrastructure investments, and may also depend on complementary investments by nearby trading partners. Countries with larger populations and/or higher incomes may have greater capacity to make large investments in transport capacity. Countries with better market access may also make more of such investments, because such investments may be more advantageous when trading possibilities are greater. The specific geographies of landlocked and island countries may require relatively more or less of specific kinds of transport investments. Investments in rail capacity may be particularly important for landlocked countries, but not important for small island countries. Islands require investments in sea ports. Air transport is important for timely delivery in both country types, but perhaps more so in islands, given the impossibility of overland transport with neighbors. The ability of landlocked countries and islands to make such investments may depend on other country characteristics such as their size, per capita income and geographic position.

Third, countries' general trade policy orientation may affect the composition of both their imports and exports. As a broad measure of trade policy orientation, we include countries' World Trade Organization (WTO) member status as a country characteristic. Because WTO members are likely to have lower costs of trading, they should be more likely than non-members to participate in supply chains. We might also expect their general policy orientation to lead them to make

[12] **?** describe this system, and point to the presence of scale economies that arise when routes are thick.

investments oriented towards international transportation. WTO member status may shift the composition of trade through these mechanisms, but the composition of trade may also affect countries' WTO status. We treat interactions with the WTO dummy as controls, not as predictors of causal relationships.

Fourth, we offer a joint hypothesis that, all else equal, freight rates are rising in products' weight-to-value ratio, and that this causes remote countries to substitute away from producing and consuming products with large weight-to-value ratios. Hummels (1999) links within-product variation in value-to-weight ratios to freight charges, while Hallak (2006) - among many others - links within-product variation in value-to-weight ratios to product quality in bilateral trade. Here our claim is that cross-product variation in weight-to-value ratios generates cross-product variation in trade shares. The most likely mechanism operates through transport costs, and responses of production and trade to transport costs. We take our product-level measures of weight-to-value ratio from U.S. import data and use this common measure to study trade shares in all countries. In this way, we avoid the problem of endogenous cross-country differences in weight-to-value ratios that arises from differences in export supplies, import demands or other trade frictions. **?** link cross-product variation in Puerto Rico's preference for US over foreign products to product-level estimates of the weight-to-value ratio in U.S. imports. They conjecture that the effects they observe emerge from a positive relationship between weight-to-value ratios and freight charges.

Finally, we note that it is likely that the export bundles of many small island nations may be disproportionately biased towards services, most notably tourism. This has two implications for our results. First, we only study trade in goods, so islands' RCA in any given product may be overstated by our measures. Second, much air freight is carried in the bellies of passenger planes, so air passenger traffic related to tourism may cross-subsidize trade in air-shipped products. Both these effects may be more common in geographically central islands, because air transport markets are likely to be thicker when other markets are more proximate.

3 Revealed comparative advantage and the PPML regression

Our analytical framework is that of RCA, first proposed by Balassa (1965). Country i's RCA in product k is the share of product k in country i's exports divided by the share of product k in world exports. Our notation is:

$$RCA_i^k = \frac{X_i^k}{\overline{X}_i} \Big/ \frac{X_w^k}{\overline{X}_w} \tag{1}$$

where X_i^k is exports of product k from region i, $\overline{X}_i$ is the total value of exports of region i, and X_w^k and $\overline{X}_w$ are counterparts for the world. While the description of the index as a measure of "comparative advantage" is less appropriate in the case of imports, our interest in supply chains makes countries' differential purchases of imported products also a question of interest. We calculate a similar index for imports, replacing X_i^k with M_i^k, and so on.

The literature on the determinants of comparative advantage typically seeks to understand variation in (1) by taking the log of the formulation, and estimating with a linear combination of industry- and country-fixed effects, together with the interaction of industry and country characteristics. Our approach is conceptually equivalent, except that we replace industry characteristics with characteristics of HS6-digit products as defined in the international trade statistics. A common regression specification in the literature would appear as:

$$ln(RCA_i^k) = ln(X_i^k) - ln(\overline{X}_i) - ln(X_w^k) + ln(\overline{X}_w) = \alpha_i + \alpha^k + \mathbf{C}_i \mathbf{Z}^k \mathbf{\Gamma} + u_i^k \tag{2}$$

where α_i and α^k are country- and sector- fixed effects, $\mathbf{C}_i$ a vector of country characteristics, $\mathbf{Z}^k$ a vector of product characteristics, $\mathbf{\Gamma}$ a vector of coefficients on the country-sector interactions, and u_i^k a log-linear error term.

Our estimation specification is similar, though we argue that the properties of Poisson-Pseudo Maximum Likelihood (PPML) estimator is better suited to this kind of exercise. Our PPML specification is as follows:

$$X_i^k = exp\left[\alpha_i + \alpha^k + \mathbf{C}_i \mathbf{Z}^k \mathbf{\Gamma}\right] + \epsilon_i^k \tag{3}$$

where everything is as above, except that ϵ_i^k is a mean zero error term.

3.1 Country characteristics

The country characteristics $\mathbf{C}_i$ we study include logged per capita gross domestic product (GDP) and logged population, as in Hummels and Klenow (2005). Since our focus is on landlocked and island countries, we use these country characteristics as control variables, rather than objects of interest.[13] We include four more country characteristics in our regressions, two more control variables along with our two variables of interest. One control variable is market access. We use aggregate trade flows to construct sellers' market access and buyers' market access variables for each country, and enter their logged values in the export or import regressions, respectively.[14] We also include, as a country control, a dummy variable indicating membership in the WTO.

The country characteristics that are our primary interest are dummy variables indicating landlocked or small island status. We describe our approach to generating the indicators for these variables in section 4.

3.2 Product characteristics

The product characteristics $\mathbf{Z}^k$ are of two types. Three are associated with the methods and/or cost of transporting a product. A fourth characteristic is an indicator variable that measures production-line position. We take product characteristics from U.S. data, applying them to all trade flows.[15]

The first transportation-related characteristic we consider is the share of products' U.S. imports that arrive by air.[16] This is a continuous variable, but for most products it takes values near zero or near one. Since air shipment is expensive, products shipped primarily by air are typically those that require timely delivery. Given the cost, air-shipped products also tend to have relatively low weight-to-value ratios. Air-shipment is plausibly important for islands and landlocked countries, because it allows them to trade directly with many countries in the world; high income countries in

[13]The sum of these two logged measures is the log of gross-domestic product. We separate them in order to separately investigate the consequences of income and population size. Interactions with per capita GDP may reflect some combination of underlying comparative advantage, non-homotheticities in demand, and home market effects. Population is a measure of country-size that is independent of per capita income. Observed effects on RCA may reflect scale economies in either transportation or production (e.g. home market effects). Large population countries may also be suitable for end-stage production via mechanisms like those described in Antràs and de Gortari (2020).

[14]We describe our calculations for constructing the two market access variables in Section 4.

[15]We use U.S. data for several reasons. First, the U.S. has broad cross-product coverage of imports, giving us indicators for nearly every HS6 product. Second, the scale of U.S. imports is large. Scale generates efficiencies in transportation that we suppose makes mode choices in U.S. imports at least as efficient as in any other comparable source of trade data. Third, the unique geography of the U.S., one which rules out overland trade with nearly all its major trading partners, is useful for linking demands for timeliness to the air share of shipments. Fourth, the rich input-output tables available for the U.S. allow it to serve as the best source of data on product's position in the production network.

[16]Like Hummels and Schaur (2013), we construct this measure in U.S. imports net of imports from Canada and Mexico.

particular. Among landlocked countries and islands, it may be easier to trade air-shipped products when the country is located near thick air transport markets. Relatedly, international tourism may cross-subsidize trade in air-shipped products, because a significant share of air freight travels in the bellies of passenger aircraft.[17]

Although the air share of product k's shipment is a crude indicator of products' weight-to-value ratio, we expect product's weight-to-value ratio to generate independent variation in transport costs across products. It is likely that products that are physically heavier, relative to their value, pay transport costs that are higher as a share of the value of the product. All else equal, regions that are exposed to higher costs of reaching world markets might be expected to trade less in high weight-to-value products. One of our product k indicators is thus the products' weight-to-value ratio, measured in U.S. import data.[18]

The third transport-related indicator we consider is the degree to which the product is shipped in containers. Most products can be shipped efficiently in containers, but a variety cannot be because of their size, weight or other physical characteristics. Many bulk commodities and fuels are usually shipped in bulk, tanker or liquid sea vessels, or by pipeline. Such products are rarely if ever containerized. At the other end of the spectrum, high value products that are not at all bulky tend not to be shipped in containers (e.g. watches, diamonds, newspapers). Completed motor vehicles are also rarely containerized, though their components may be. We use as our indicator product k's share of container traffic in U.S. (air and sea) imports. Products that can be shipped efficiently in containers may be relatively easier for landlocked countries to trade, because containers may be easily transferred between sea- and land-based modes of transportation. We expect network effects in international shipping to create variation in the supply of container shipping relative to shipping by other vessels, and that this variation generates different constraints on islands' participation in international goods markets, depending on their geographic position.[19]

[17] In a detailed description of the role of intermediaries in the air cargo supply chain, Popescu et al. (2010) indicate that more than 50 percent of world air cargo moves on the belly of passenger aircraft according to data from the air cargo industry.

[18] We also take this measure from the sample of US imports that excludes those sourced from Canada and Mexico. As Hummels and Schaur (2013) explains, the shipping weight of overland flows is not observed in U.S. import data. The weight data from trade flows excepting Canada and Mexico is therefore a better source for calculating products' weight-to-value ratio.

[19] Brancaccio et al. (2020) explain that the international market for bulk shipping is similar to that of an urban

Since we are interested in possibilities for participating in international supply chains, we also include an indicator of each product's production line position as a product characteristic measure. Specifically, we use the upstreamness measure of Antràs et al. (2012) to create a dummy variable that separates final and upstream goods.[20] Antràs and de Gortari (2020) propose a theory suggesting that the final stages of production are more likely to be produced in large, geographically central markets. This theory has direct implications for the population and market access variables we study, because it predicts that final-stage production should be less common in remote and/or small countries. Conditional on income and remoteness, we might expect to see islands and landlocked countries even less engaged in exporting final products, especially those that require importing inputs for further processing. On the import side, a lack of participation in supply chains may result in a tendency to import relatively more final products, rather than upstream products that require further processing.

3.3 Within-group heterogeneity among islands and landlocked countries

Although we are primarily interested in uncovering the average effects of landlocked/island status on the composition of trade, it seems likely that there is important heterogeneity within each group of countries. The effects of small island status on trade composition may be very different in the South Pacific and in the Caribbean. Landlocked countries in Europe likely have different trade bundles than landlocked countries in Africa, Latin America or Central Asia.

In order to explore these possibilities we add to our previous specifications triple interactions involving a) the small island or landlocked dummy, b) the product characteristics we study, and c) the other four country characteristics that we include as control variables. For example, one interaction used in the export regressions would be the product of small island status, the air share of product k's shipments, and the seller market access variable. The coefficient on this interaction would measure the degree to which variation in small islands' exports of air shipped goods depends on their geographic location. If Caribbean islands are better able to export air-shipped products

taxi market, with shippers booking a bulk vehicle to deliver to a specific destination, where it begins the process of searching for another cargo. **?** explains that container ships operate more like buses, stopping at several ports along a given route. This together with a hub-and-spoke model may mean that containers call more regularly in small islands than do bulk ships, which may make exports of containerized products relatively more viable there.

[20]Following **?** we code the final product dummy by assigning a 1 if the upstreamness measure is less than or equal to 1.3, and assigning zero for products with upstreamness scores above 1.3. We experimented with a continuous measure but found the results difficult to interpret. In a regression exploiting cross-product variation, the continuous measure of upstreamness conflates industries' position within chains and cross-chain variation in chain length.

than islands in the South Pacific, this coefficient would be positive.

Our triple interaction specifications (for exports) appear as

$$X_i^k = exp\left[\alpha_i + \alpha^k + \mathbf{C}_i\mathbf{Z}^k\mathbf{\Gamma} + \overline{\mathbf{C}}_i\mathbf{Z}^k LL_i\mathbf{\Omega_{LL}} + \overline{\mathbf{C}}_i\mathbf{Z}^k ISL_i\mathbf{\Omega_{ISL}}\right] + \epsilon_i^k \tag{4}$$

where $\overline{\mathbf{C}}_i$ is the subset of the country control variables that excludes the landlocked and island dummies, $\mathbf{\Omega}_{LL}$ and $\mathbf{\Omega}_{ISL}$ are the coefficients to be estimated on triple interactions involving landlocked countries and islands, respectively.

3.4 Advantages of the PPML specification

The PPML specification, which is commonly used to estimate the gravity model of trade, has a number of advantages over other specifications commonly used in studies of RCA, especially the log-linear form. The advantages of PPML are widely recognized in the empirical gravity literature. These advantages also apply to estimation of RCA indices. We briefly discuss them here.

First, the PPML specification allows the inclusion of zero values of trade in the estimation. Most studies in the literature on the determinants of comparative advantage estimate with log-linear specifications like that in (2). These specifications drop products that are not exported from a given country, an outcome that likely generates selection bias. Selection bias may be an especially important problem in landlocked and small island countries, because the overall volumes of trade are small and because participation in many supply chains is precluded by trade costs in each direction.

Second, fixed effects in the PPML specification impose important adding up conditions, conditions which are quite useful in the specific context of estimating RCA indices. Fally (2015) shows that, in PPML estimation, parameters associated with dummy variables take values such that the sum of the fitted values associated with the dummy variable equal the sum of the data associated with the dummy variable. This property gives the estimated fixed effects important meaning in the context of estimation of RCA. Using (3) as an example, the $\widehat{\alpha}_i$ terms take values such that $\sum_k \widehat{X}_i^k = \overline{X}_i$, and the $\widehat{\alpha}^k$ terms take values such that $\sum_i \widehat{X}_i^k = X_w^k$. In the context of a cross country RCA estimation, these adding up conditions imply that each country's $\widehat{\alpha}_i$ term effectively controls for country i's total participation in exporting $\overline{X}_i$ (or importing $\overline{M}_i$), while each product's $\widehat{\alpha}^k$ efficiently controls for it's role in world exports X_w^k (or imports M_w^k). In this way, the explained variation in the trade flows $\left(exp\left[\mathbf{C}_i\mathbf{Z}^k\widehat{\mathbf{\Gamma}}\right]\right)$ matches the variation in the RCA index, since the variation due to $\overline{X}_i$ and X_w^k have been exactly purged by estimation that satisfies adding up. These adding-up conditions of the PPML specification do not obtain for the log-linear regressions commonly used in the RCA literature, because of Jensen's inequality.

A (related) property of PPML estimation recognized in Fally (2015) is that PPML specifications act (implicitly) as weighted regressions, with weights proportional to the dollar values of $\widehat{X}_i^k$. Fally explains that log-linear regressions implicitly apply weights of $\widehat{ln(X)}_i^k$. Log-linear specifications overweight small trade flows (relative to their contribution to world trade), and underweight large flows, generating bias. While any weighting scheme has it's plusses and minuses, weights that are proportional to the dollar value of trade are particularly useful in our exercise, since our specifications consider both within-product (cross-country) variation and within-country (cross-product) variation. PPML's consistent US-dollar weighting insures country-size variation and product-size variation are treated consistently in the estimation.[21]

4 Data and Summary Statistics

Our exercises rely on data that includes 1) global trade flows at the product level, 2) country characteristics such as per capita GDP, population, market access, and World Trade Organization (WTO) member status, 3) indicators of countries' landlocked or small island status, 4) product-level information on the method of transport and the weight-to-value ratio in U.S. imports, and 5) a measure of industries' production line position mapped onto HS6-digit trade categories.

4.1 Trade Data

Our data on export and import flows come from the BACI database - sourced from CEPII (2024). This database reports the value (in USD) and weight (in kg.) for all trade flows at the year, HS6 digit product code, exporter and importer country level. We use this database to calculate imports and exports for each product-country pair, using the sample of data available for the year 2017. Our estimating sample contains 204 regions/countries. This is the set of regions for which all trade

[21]This will weight Switzerland's trade more heavily than Bolivia's in determining the effect of landlocked status on trade, a potential drawback for interpretation of the coefficients. But, by the same logic, PPML will weight appropriately those products that are larger in Bolivia's trade than those products that are smaller, a quite beneficial property of the PPML estimator.

flows are observed and all country controls are available.[22]

4.2 Country characteristics

4.2.1 Landlocked and island dummies

Our primary variables of interest at the country level are the dummy variables identifying landlocked countries and small islands. Construction of the landlocked dummy is fairly straightforward; we simply observe whether or not the country has coastline on the sea.

Constructing the island dummy involves more judgement calls. We view the small islands that interest us as facing different international transportation constraints than large island nations such as Japan or Australia. In our primary set of estimates we also exclude islands with GDP of US$200 billion dollars or more.[23] Further exploration of the issue also identifies the need for some definitional decisions. Countries such as the Dominican Republic or Papua New Guinea are located on islands, but also share a land border with another country. With the exception of Cuba (which has a small land border with Guantanamo Bay), we exclude all countries with a land border from the set of islands we consider.

4.2.2 GDP per capita and Population

Two country characteristics that we include as control variables are GDP per capita and population. In most cases we take these from CEPII, but replace missing observations with data from the World Development Indicators, International Monetary Fund or United Nations, as available. We use 2015 data for both measures, so that they may be taken as exogenous for our 2017 trade flows.

4.2.3 Market Access Measures

Our measure of geographic position is market access, a weighted average distance from world markets, where the weights are trade flows. In order to construct this measure we use aggregate trade flow data from CEPII, estimating

$$X_{ij} = \exp\left(\omega_i + \omega_j + \phi \ln(Dist_{ij})\right) + \epsilon \tag{5}$$

[22]Because of our interest in island trade we include, where possible, regions such as Greenland that are not independent states, but for which BACI reports trade data. For some islands in this category (e.g. U.S. territories), BACI does not report trade with the parent country. We drop these because RCA cannot be calculated correctly with a large share of trade missing.

[23]In practice this exercise removes Australia, Indonesia, Ireland, Japan, New Zealand, Philippines, Singapore, Taiwan and UK from the set of islands.

where X_{ij} is the (aggregate) value of bilateral trade exports from i to j, ω_i and ω_j are origin- and destination- fixed effects capturing the scale of region i's exports and region j's, respectively, $Dist_{ij}$ the distance between i and j, ϕ the distance elasticity of trade, and ϵ is a mean zero error term. We estimate $\widehat{\phi} = -0.785$ in this exercise. Using the standard methods, we apply the estimate to calculate the buyers' market access and sellers' market access variables, and log them for use in our RCA analysis.[24]

4.2.4 WTO Country Membership

As a measure of trade openness we use the WTO dummy from CEPII's database. This variable equals 1 when a country appears as a WTO member and 0 otherwise. We notice that CEPII codes territories as zero, even when they are territories of countries that are, in fact, WTO members. Greenland, a territory of Denmark, is one example. We update the value of the WTO dummy to 1 in such cases.[25]

4.3 Product Characteristics

Our measures of product characteristics are taken from U.S. sources. Products' transport characteristics are taken from U.S. imports data for the year 2017.[26] Because land transportation makes measurement and interpretation of some characteristics difficult, we measure our indicators in U.S. imports after removing imports from Canada and Mexico. Each record in the remaining data contains the value (in USD) and weight (in kg) of every US import flow as well as the mode of transport. Goods arriving by sea are either coded as arriving in containerships or in other vessels. We aggregate the data to the HS6-digit product level, the level for which the BACI data reports trade flows. Similar to **?**, we use these data to calculate three variables: a) the value share of each imported product that is shipped by air; b) the share of shipments that arrive in container vessels; and 3) the log weight-to-value ratio of the product.

As a fourth product characteristic we include a measure of product's production line position. Antràs et al. (2012) develop a continuous measure called "upstreamness," which captures the value weighted number of production stages between each industry and final demand. As in **?**, we convert this into a dummy variable that takes the value of 1 if products' have upstreamness scores less than

[24]Buyers' market access in region j is calculated as $BMA_j = \sum_i X_i \, (Dist_{ij})^{-0.785}$, where X_i is aggregate goods exports in region i. Sellers' market access replaces X_i with each region's aggregate goods imports, M_i.

[25]Table B1 in Appendix B lists the territories that were recorded in this way, along with their parent country.

[26]All US import data are retrieved from Peter Shott's website: `https://sompks4.github.io/sub_data.html.`

or equal to 1.3. All products with upstreamness scores greater than 1.3 are coded as "upstream" products.

4.4 Summary Statistics

The final sample we use to estimate all our models includes information from a universe of 5,044 HS6-digit products. This sample also includes information from a total of 204 countries/regions. 38 of these are landlocked countries (19 percent of the sample) and 43 are coded as island countries (21 percent). In this section, we examine all variables included in our models as product characteristics. We also do a similar exercise for the variables we include as country controls.

4.4.1 Product Characteristics

Table 1 reports summary statistics for the cross-commodity distribution of product characteristics. The distribution of products' air share of shipment value is skewed left, with a mean of 0.22 and a median of 0.07. Most products rarely travel by air, even in U.S. import data.

When we consider the container share variable, we find that it is skewed in the other direction. At the mean, the container share of shipments is 0.70. The median product has 83 percent of its value shipped in containers.

There is considerable variation across products in the weight-to-value ratio. Since we will be considering thought experiments that move the log weight-to-value ratio from its value at the 25^{th} percentile to its value at the 75^{th} percentile we report these statistics here. The log weight-to-value ratio is -2.87 at the 25^{th} percentile and 0.86 at the 75^{th}. Our thought experiments change the weight-to-value ratio from 0.06 kg/$ to 0.40 kg/$.

The final stage production dummy takes only zero or one values. The reported mean in Table 1 implies that only 16 percent of the products are treated as final-stage production. The rest are upstream products.

To facilitate understanding of the relationships among the product characteristic variables, we report simple correlations among them in Table 2. This exercise shows that products' air share of shipment is negatively correlated with the container share of shipments ($\rho = -0.79$) and with the products' logged weight-to-value ratio ($\rho = -0.72$). There is a weaker but still sizable positive correlation between the share of product shipments that are containerized and the logged weight to value ratio ($\rho = 0.46$). The final-stage production dummy is negatively correlated with logged weight to value ratio ($\rho = -0.21$). This is the outcome one would expect if successive production stages add more value than weight.

4.4.2 Country Controls

Next we turn to describing variation in the variables we describe as country characteristics. Table 3 shows that 19 percent of the countries in the sample are landlocked, 21 percent small islands, and 84 percent members of the WTO.

Because our thought experiments will focus on moving countries from the 25^{th} to the 75^{th} percentile of the continuous country characteristic variables, we report these statistics here. The logged GDP per capita variable is 7.48 (US$1,771) at the 25^{th} percentile and 9.73 (US$16,737) at the 75^{th} percentile. A similar move in the distribution of the log of population goes from 14.09 (1.3 million people) to 17.02 (24.7 million). Our market access variables are more difficult to interpret, so we note that moving from the 25^{th} to the 75^{th} percentile of the logged buyers' market access variable moves a country from the location of Saint Vincent and the Grenadines to the location of Libya. The sellers' market access variable is highly correlated with buyers' market access, so the thought experiment implies a similar change in location when we change sellers' market access.

Table 4 reports correlations among the country characteristic variables. The landlocked countries in our sample have somewhat lower incomes than other countries. Otherwise, the landlocked countries are broadly similar to the rest of the sample. Correlations with the small island dummy show that these countries have much smaller populations and have much lesser market access scores than other countries in the sample. The other notable correlations in the data are the positive correlations between the market access variables and the logged GDP per capita and population variables.

5 Results

Our exercises produce a large number of coefficient estimates, posing a challenge for reporting results. The country characteristics we study have different purposes: some as control variables and some as objects of interest. Since the results from interactions of product characteristics with the country controls are novel, we find it useful to report them. The large number of interactions we consider poses a challenge, since it is useful for reporting purposes to include the triple interactions for landlocked countries along with their initial results. We therefore take the unusual step of reporting estimates from individual regressions across multiple tables, grouping results for country controls, landlocked countries and islands in different tables.

5.1 Product characteristics and country controls

Before turning to the effects of small island and landlocked status on the composition of trade, we first report coefficient estimates associated with the interactions of the country control variables and the product characteristics. We report these results in Table 5. None of the estimates include the triple interaction variables included in (4).

We estimate the same specifications of (3) for exports and imports, respectively. For both exports and imports we estimate on two different sets of controls separately, and then the complete set of controls. The results with the complete set of controls are largely similar to those with subsets of the controls so we focus our discussion on those results, which appear in column 3 for exports and column 6 for imports.

The first four rows of Table 5 consider interactions of the product characteristics with per capita income. These relationships should probably be understood as merely descriptive. They are likely be driven more by the forces of comparative advantage (and non-homothetic demands) than by responses to transportation frictions. There may be some role for frictions (high income countries may have the means to invest in better transport infrastructure), but we view these results as driven primarily by other forces. Column 3 shows that higher income countries' exports are less often shipped in containers, physically lighter, and less likely to be final goods than are exports of lower income countries. Moving from the 25^{th} to the 75^{th} percentile of per capita income reduces exports of fully containerized products by nearly 40 percent, and exports of final products by 32 percent. High income countries' imports are physically lighter and more likely to be final goods than are low income countries' imports. Moving from the 25^{th} to the 75^{th} percentile of per capita income raises imports of final products by 70 percent. The coefficient on the air share of shipments is negative for both exports and imports, though not statistically significant in either case.

The next four rows of Table 5 consider interactions of product characteristics with countries' logged population size. Since we are controlling elsewhere for per capita income, we might expect countries with larger populations to be capable of making larger infrastructure investments. On the export side we find evidence supporting this argument, as we find that large population countries' RCAs are biased towards products that are shipped by air or in containers. The estimated effects are large. Moving from the 25^{th} to the 75^{th} percentile of log population raises the contribution of air-shipped trade to RCA by 85 percent and the container share by nearly 117 percent. Following the intuition of Antràs and de Gortari (2020), we might expect the final stages of production chains to be located in large markets for such products. Countries with large populations have large domestic markets, and column 3 evidence points to their RCAs in exporting to be biased towards final goods. Moving from the 25^{th} to 75^{th} percentile of log population raises RCA in final-stage products by 35 percent. We do not find strong evidence of any bias in large population countries' imports, though the air shipment coefficient is significant at the ten percent level, and of the same sign as the coefficient on exports.

We next turn to the market access variables, using sellers' market access in the export regressions and buyers' market access in the import regressions. Markets that are nearer the center of global trade flows might be expected to be more engaged in international trade, and therefore to make greater investments in trade-related transportation infrastructure. We might also expect geographically central countries to host later stages of production chains. Column 3 results show that more geographically central countries are much more likely to export products that are often containerized, physically lighter, and final products. The sign patterns on the sellers' market access interactions match those of the interactions with population, consistent once again with the intuition of Antràs and de Gortari (2020). The effects are quite large. Moving from the 25^{th} to 75^{th} percentile of sellers' market access raises the contribution of fully containerized products to RCA by 89 percent, and that of final products by 24 percent.

On the import side, column 6 shows that more geographically central regions import more air-shipped products, more containerized products and products that are physically heavier. These effects are also quantitatively large. Moving from the 25^{th} to 75^{th} percentile of sellers' market access raises trade in air- shipped products by 48 percent and in container-shipped products by 16 percent. It seems likely that infrastructure investments necessary to support air freight and containerized shipments are more useful for geographically central regions. The import of somewhat heavier products and export of lighter products by geographically central countries may also suggest that value is being added in these countries, with production stages organized to move goods from remote to more central regions as more value is added.

The interactions with the WTO dummy show that WTO members' trade is quite different than that of non-members. WTO members' exports are much more likely to move by air, to be containerized, to be physically light, and to be final products. The magnitudes of these effects are quite large. Conditional on the other country characteristics, the estimates imply that WTO members' exports of air shipped goods are 462 percent higher than non-members' exports, containerized products 407 percent higher, and final products 158 percent higher. The weight-to-value ratio of exports is 25 percent lower among WTO members than among non-members.

On the import side, we find air shipment much more common among WTO members, with air shipped products approximately 163 percent higher in WTO members' imports. Infrastructure investments and or other aspects of trade policy (such as higher performing customs) may support the larger share of air shipments among WTO members. WTO members' imports are less often final products than those of non-WTO members, with approximately 31 percent lower imports of final products. The opposing signs on the coefficient on the interaction between the final stage dummy and WTO membership in the export and import regressions, respectively, suggests net trade between members and non-members, with non-members selling upstream products to WTO members in exchange for final products.

5.2 Main results

While the results for the country control variables are interesting (and seemingly novel), they are not our primary focus. We turn next to results of interactions of the product characteristics with landlocked and small island status. Although the results in both tables are taken from the same specifications, we report them in separate tables. We report results for landlocked countries' in Table 6 and small islands in Table 7. Columns 1-4 of both tables are from estimating (3), while columns 5-6 include the triple interactions described in (4). In columns 1 (for exports) and 3 (for imports) we report results for a specification of (3) that includes only transport characteristics in the interactions. In columns 2 and 4 we also include interactions with a dummy variable indicating that the product is a final product.

Consider first the results for landlocked countries, which are reported in Table 6. Columns 1-4 show that the sign pattern on interactions involving the transport characteristics is consistent across both exports and imports. Although not all coefficients are statistically significant, the sign pattern suggests that landlocked countries' exports and imports both consist of products that are less likely to travel by air, are more likely to be containerized, and less physically heavy than in the trade of reference countries. Coefficients on the weight-to-value ratio are negative and statistically significant for both exports and imports, with exports twice as responsive to product weight as imports. Landlocked countries' imports are more likely to be containerized. Imports of products that are fully containerized are 37 percent higher than products that are not typically containerized. The fact that both imports and exports of physically heavy products are relatively more burdened in landlocked countries appears to be a novel insight for the literature on the burdens of landlocked status for trade. The importance of containerization for imports suggests that physical infrastructure to support such freight is important for landlocked countries.

Inclusion of the final-stage product dummy does not change the sign or significance of the transport variables, except that the interaction with weight-to-value becomes significant only at the 10 percent level. We find no statistically significant effect of products' production line position on the composition of landlocked countries' trade.

Turning to the results for small island countries in Table 7, we find that their exports are more likely to be containerized than in the reference country, and more likely to be final products. The coefficients imply that small islands' exports of products that are always shipped in containers are 176 higher than products that are not shipped in containers and their exports of final goods 84 percent higher than upstream products. The coefficients on the interaction with products' air share of shipments and weight-to-value ratios are negative, though not statistically significant.[27] We note that the same sign pattern for these variables exists on the import side.

On the import side, the coefficients on air share and container share in columns 3 and 4 are large,

[27] The coefficient on the interaction with weight-to-value is significant when we do not include the final product dummy, but becomes insignificant when we include the dummy

negative and statistically significant. These results show that islands' purchase a disproportionate amount of sea-shipped, non-containerized freight. In order to understand this result we investigate further, and find that a disproportionate share of small islands' imports are fuels.[28] After controlling for air shipment and containerized products, we find no statistically significant effects of product weight or production line position on small islands' imports. The key lesson for small islands seems to be that sea freight is relatively more important than air freight, and that port facilities for both containerized and non-containerized freight are necessary.

5.3 Triple interactions

We next turn to triple interactions that consider the joint effect of two country coefficients and one product characteristic. We interact the landlocked and small island dummies, respectively, with crosses between the product characteristics that we consider and the other country characteristics. The purpose of this exercise is to explore variation in the composition of trade that occurs within the landlocked and small island country groups, respectively. Of particular importance are the interactions with the market access variables, for these describe how geographic position can exacerbate/offset countries' landlocked or small island status. Interactions involving the WTO status dummy are also of interest, since membership is a policy choice that can be used to offset other disadvantages.

The results associated with triple interactions involving the landlocked dummy appear in columns 5 and 6 of Table 6. These results reveal important cross-country differences in trade composition within the group of landlocked countries. Landlocked countries with higher incomes have exports that are more oriented towards products that are air shipped in U.S. imports. This outcome may reflect either home market effects, infrastructure or both. Low-population landlocked countries are more heavily specialized in final products. On the import side, higher-population landlocked countries import more air-shipped products. The sign on the same interaction is positive for exports (though slightly less significant). These effects might arise because larger countries are able to invest more heavily in infrastructure that supports air freight.[29]

[28] Pooling all fuel and related products as those with HS2 digit code equal to 27, our data shows that the average share of fuel in small islands' imports is 19.1 percent. In contrast, this share is 13.3 percent in global imports.

[29] Larger populations might also support larger supplies of domestic air transport, which may produce spillovers for international traffic, and thus more trade in air-shipped products.

Turning to interactions of the landlocked dummy with the market access variable, we find that landlocked countries with a high degree of market access are much more likely to export containerizable and final products than are landlocked countries that are more remote. Better infrastructure for containerized freight among geographically central landlocked countries may be important in the first case. Proximate access to geographically central consumers may help explain the case of final goods exports. On the import side, we find relatively little variation in the characteristics of trade within the group of landlocked countries, except that the import bundles of geographically central countries contain relatively less imports of final products.

Turning to interactions with WTO status, we find that landlocked WTO members' exports are less air-shipped, less often containerized, and less often final products than are the exports of non-WTO members. These results are difficult to interpret directly, and are likely an outcome of very particular export specializations among the quite small set of countries that are not WTO members.[30] On the import side, landlocked countries that are WTO members import relatively more containerized freight and final products than do their non-member counterparts.

Columns 5 and 6 of Table 7 report results from triple interactions involving the small island dummy. The coefficient estimates there indicate that small islands with higher populations or higher average incomes tend to export products that are heavier, on average, than do smaller population, lower income islands. Islands with larger populations are also more likely to export final goods. We do not have a preferred interpretation of these results, though perhaps they describe the effects of an extensive margin of trade that operates with country size. We find that larger population islands import relatively more air-shipped, containerized, and physically heavy products. This would be consistent with larger population islands having better trade-oriented transport infrastructure than their low population counterparts.

Turning to interactions involving the market access variables we find that small islands with good market access have export bundles that are less oriented towards final products than islands that are geographically remote. It seems likely that this arises because geographically central islands

[30] The set of landlocked countries that are non-WTO members are Azerbaijan, Bhutan, Ethiopia, Turkmenistan and Uzbekistan. Ethiopia, for example, is a large exporter of cut flowers, which would contribute to the observed outcome.

are in a better geographic position to participate in global supply chains. A related factor may be that transportation markets are thicker in geographically central regions. On the import side there is only weak evidence that the effects of small island status varies with market access.

Islands that are WTO members export much less containerized freight as a share of exports, and a smaller share of final products than non-members.[31] On the import side, islands that are WTO members purchase more air-shipped products, more containerized freight, heavier products and more final products than non-member islands.

5.4 Robustness

We conduct two robustness exercises to understand the consequences of different research choices for our results. First, we include a broadly defined island dummy, including both the countries with GDP's over $200 billion and those such as Dominican Republic or Papua New Guinea that are located on islands but have an international land border. Second, we reproduce our study using log-linear OLS tools more common in the RCA literature.

5.4.1 Alternate definition of islands

Our work so far has focused on the implications of transport constraints for islands that have small economies and do not share land borders with a neighboring country. Our focus on small islands reflects the view that small islands suffer from the combination of relatively infrequent arrival of international transport and a high level of dependence on international trade. Islands that are large enough to warrant frequent international transport to multiple destinations, and/or large enough to host sequential stages of production may be less susceptible to transport-related constraints. But large islands do suffer some constraints nonetheless. Some kinds of international transport, most notably pipelines, are not typically available to islands, even large ones.

Our broad definition of island countries also adds those countries that are located on islands, but also share a land border with at least one other country. The set of countries that change status with this definition are Dominican Republic, Haiti, Brunei, and Papua New Guinea. These countries have the opportunity to engage in some overland trade, though in many cases it is likely that such trade is relatively unimportant.

[31] For reference, the set of islands that are not WTO members in our data are: Bahamas, Comoros, Kiribati, Marshall Islands, Micronesia, Nauru, Palau, Sao Tome and Principe, and Tuvalu.

Our recoding of the island dummy represents a rather ambitious robustness check. We are removing countries from the reference group, now including their trade as potentially affected by island status.[32] In the case of island countries with land borders, it is likely that these effects are not too large. But the inclusion of countries with large economies represents and important change, especially given our use of the PPML estimator. It is likely that large economies are able to host multiple stages of production, and to satisfy many of their own demands without relying on imports. Given the dollar weighting feature of PPML, the trade flows of the larger countries may swamp the effects observed among the small island countries, which are more constrained by transport frictions.

The results of this exercise (reported in Table C1) largely validate this intuition. Our change in the definition of island status weakens the results we observe among the set of tightly-defined small islands. On the export side, islands' trade is no longer observed to be biased towards products that travel in containers. The tendency to export relatively more final goods - observed in the set of small islands - is no longer present in the set of islands defined more broadly.

On the import side, the interactions between the small island dummy and the air share and container share of shipments, respectively, produced negative and statistically significant coefficients, a result consistent with our subsequent finding that small islands purchase a disproportionate share of fuels. In our broader definition of islands we get results that are weaker (in magnitude and in significance) for the interaction with container share of shipments, and a reversal of the sign on the air share of shipments. Changing to a broader definition of islands makes the interaction of island status with weight-to-value become statistically significant. The sign on that interaction is positive, indicating that islands (broadly-defined) tend to import products that are physically heavier than the reference country. Our conclusion from this exercise is that small islands' trade is fundamentally more constrained by transport costs than are the larger islands.

5.4.2 OLS estimator and log-linear specification

In our second robustness exercise we return to the definition of island status used in our main results, and re-estimate the empirical models proposed in the main text. The only difference with

[32] The countries newly coded as islands because of the relaxed size restriction are Australia, Indonesia, Ireland, Japan, New Zealand, Philippines, Singapore, Taiwan and the UK.

those exercises is that we estimate using log-linear OLS regressions rather than PPML. We do this because log-linear OLS is commonly used in papers that attempt to understand the sources of comparative advantage. We view the PPML estimator as more appropriate, but include log-linear OLS to demonstrate the differences between the two estimators in the context of RCA.

The change in estimator reduces the sample size because log-linear OLS drops all the observations with zero trade. These represent a large number of observations because there are many zeroes at the product-country level. The use of log-linear OLS also changes the implicit weighting scheme, giving relatively more weight to small trade flows, whether they be small because the country's trade is small, or because there is relatively little trade in the product.

The results of these exercises are reported in Tables C2-C4. The main lesson from this exercise is that the log-linear regressions generate many more statistically significant coefficients. This would seem to be a result of the different weighting scheme, as the reduced number of observations due to dropped zero flows should otherwise reduce the power of the estimator.

When considering the country controls we group our discussion into interactions involving each of country characteristics, comparing Table C2 with Table 5. In terms of sign and statistical significance, results involving per capita income are largely consistent across PPML and OLS specifications. When considering interactions with population, changing the form of the estimator produces changes in the sign and statistical significance levels on several variables. The signs on the interactions involving market access are largely robust to the change in the form of the estimator, although several coefficient estimates change their levels of statistical significance. Interactions involving the WTO dummy act similarly, retaining the same signs as in the PPML regression, but changing levels of significance.

Moving to the landlocked countries we find that all the interaction terms become statistically significant when considering exports (column 2). Only the weight-to-value ratio coefficient is significant in the PPML estimates. The OLS estimator produces changes in levels of statistical significance in several of the variables considered in column 4. When considering triple interactions there are several cases where the sign and significance level are robust to the use of OLS, but there are enough changes to give pause.

Looking at interactions with the small island dummy, we find similar coefficients across the two estimators, but different levels of significance when considering exports. The import regressions seem much more sensitive to the form of the estimator.

Our general conclusion from this exercise is that the form of the estimator is quite important for interpreting regressions involving RCA indices. We discuss the conceptual benefits of the PPML estimator above. Viewed from that perspective, the main lesson learned in this exercise seems to be that log-linear OLS specifications are likely to frequently produce spurious conclusions and results that take different signs than estimation via PPML. Although it lies outside the scope of this paper, it seems important to revisit the literature on comparative advantage using newer PPML methods.

6 Conclusion

We estimate the relationship between countries' geographic location and the product composition of their exports and imports. Our hypothesis is that the trade of landlocked countries and small islands are disproportionally burdened by transport frictions, and we ask if RCA indices of both exports and imports for these countries depend upon cross-product variation in transport-related characteristics. Since countries that face unusually high transport frictions are particularly disadvantaged in a world of multi-stage production, we also investigate the question of whether landlocked countries and small islands trade less in upstream products than do other countries.

We find that both the imports and exports of landlocked countries are biased against products with high weight-to-value ratios. Products normally shipped in containers are over-represented in landlocked countries' imports and small islands' exports. The exports of small island countries' also exhibit a bias towards final-stage products. Small islands' imports are biased against air-shipped and containerized freight, an outcome driven in part by the disproportionately large share of fuels in small islands' imports. The effects of transport-related product characteristics on the composition of imports and exports are heterogeneous within landlocked countries and within small islands. There is substantial variation within each country group that can be explained by countries' per capita income, population, geographic location, and WTO member status.

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7 Tables

Table 1: Summary Statistics - Product Transportation Characteristics

	# Obs.	Mean	Std. Dev	Min	Perc. 25	Median	Perc. 75	Max
Air share^k	5,044	0.22	0.29	0.00	0.01	0.07	0.31	1.00
Ctnr share^k	5,044	0.70	0.32	0.00	0.49	0.83	0.96	1.00
$\ln(WV^k)$	5,044	-1.98	1.73	-14.50	-2.87	-1.93	-0.93	4.29
Dummy Final^k	5,044	0.16	0.37	0	0	0	0	1

Note: Air share^k is the share of every product k shipped by air. *Ctnr share*^{k} is the share of every product k shipped in a container. $\ln(WV^k)$ is the natural log of the weight-to-value ratio of every product k. Dummy Final^k is a dummy variable equal to 1, if a product k is a final good, and to 0 if it is an upstream product.

Table 2: Correlation - Product Transportation Characteristics

	Air share^k	*Ctnr share*^{k}	$\ln(WV^k)$	Dummy Final^k
Air share^k	1.00			
Ctnr share^k	-0.79	1.00		
$\ln(WV^k)$	-0.72	0.46	1.00	
Dummy Final^k	0.06	-0.01	-0.21	1.00

Note: Air share^k is the share of every product k shipped by air. *Ctnr share*^{k} is the share of every product k shipped in a container. $\ln(WV^k)$ is the natural log of the weight-to-value ratio of every product k. Dummy Final^k is a dummy variable equal to 1, if a product k is a final good, and to 0 if it is an upstream product.

Table 3: Summary Statistics - Country Control Variables

	# Obs.	Mean	Std. Dev	Min	Perc. 25	Median	Perc. 75	Max
LL_i	204	0.19	0.39	0	0	0	0	1
ISL_i	204	0.21	0.41	0	0	0	0	1
$\ln(GDP\ pc)_i$	204	8.60	1.44	5.72	7.48	8.64	9.73	11.53
$\ln(Pop)_i$	204	15.41	2.34	9.21	14.09	15.80	17.02	21.04
$\ln(SMA)_i$	204	23.67	0.45	22.26	23.36	23.55	23.95	24.75
$\ln(BMA)_j$	204	23.68	0.43	22.72	23.38	23.57	23.95	24.75
WTO_i	204	0.84	0.37	0	1	1	1	1

Note: LL_i is a dummy variable equal to 1, if a country i is landlocked, and to 0 otherwise. ISL_i is a dummy variable equal to 1, if a country i is an island, and to 0 otherwise. $\ln(GDPpc)_i$ is the natural log of the country's i GDP percapita. $\ln(Pop)_i$ is the natural log country's i population. SMA stands for Seller Market Access and BMA for Buyer Market Access of country i. WTO_i is a dummy variable equal to 1, if a country i is a WTO member nation, and to 0 otherwise.

Table 4: Correlation - Country Control Variables

	LL_i	ISL_i	$\ln(GDP\ pc)_i$	$\ln(Pop)_i$	$\ln(SMA)_i$	$\ln(BMA)_j$	WTO_i
LL_i	1.00						
ISL_i	-0.25	1.00					
$\ln(GDP\ pc)_i$	-0.27	0.14	1.00				
$\ln(Pop)_i$	0.11	-0.69	-0.22	1.00			
$\ln(SMA)_i$	0.08	-0.44	0.39	0.32	1.00		
$\ln(BMA)_j$	0.09	-0.43	0.37	0.31	0.98	1.00	
WTO_i	-0.03	-0.07	0.15	0.18	0.05	0.02	1.00

Note: LL_i is a dummy variable equal to 1, if a country i is landlocked, and to 0 otherwise. ISL_i is a dummy variable equal to 1, if a country i is an island, and to 0 otherwise. $\ln(GDPpc)_i$ is the natural log of the country's i GDP percapita. $\ln(Pop)_i$ is the natural log country's i population. SMA stands for Seller Market Access and BMA for Buyer Market Access of country i. WTO_i is a dummy variable equal to 1, if a country i is a WTO member nation, and to 0 otherwise.

Table 5: Composition of Export Supply and Import Demand

		X_i^k			M_i^k	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Air share^k × ln(GDPpc)$_i$	-0.00661		-0.0582	-0.0280		-0.0891
	(0.138)		(0.147)	(0.119)		(0.125)
Ctnr share^k × ln(GDPpc)$_i$	-0.0390		-0.224***	-0.00304		-0.0121
	(0.0776)		(0.0761)	(0.0555)		(0.0590)
ln(WV^k) × ln(GDPpc)$_i$	-0.0667***		-0.0446**	-0.0429**		-0.0487**
	(0.0217)		(0.0225)	(0.0188)		(0.0202)
Dummy Final^k × ln(GDPpc)$_i$	-0.120***		-0.169***	0.218***		0.236***
	(0.0456)		(0.0531)	(0.0313)		(0.0324)
Air share^k × ln(Pop)$_i$	0.222***		0.210**	0.0866		0.123*
	(0.0849)		(0.0904)	(0.0728)		(0.0691)
Ctnr share^k × ln(Pop)$_i$	0.245***		0.264***	-0.0508		-0.0323
	(0.0491)		(0.0486)	(0.0416)		(0.0416)
ln(WV^k) × ln(Pop)$_i$	-0.0156		-0.0219*	0.0144		0.0195*
	(0.0113)		(0.0127)	(0.0113)		(0.0115)
Dummy Final^k × ln(Pop)$_i$	0.0940***		0.103***	-0.0143		-0.0185
	(0.0363)		(0.0382)	(0.0266)		(0.0273)
Air share^k × ln(MA)$_i$		-0.163	0.154		0.525**	0.689***
		(0.356)	(0.409)		(0.218)	(0.214)
Ctnr share^k × ln(MA)$_i$		0.633***	1.077***		0.301**	0.252*
		(0.180)	(0.195)		(0.122)	(0.131)
ln(WV^k) × ln(MA)$_i$		-0.165***	-0.155***		0.0411	0.0845***
		(0.0508)	(0.0600)		(0.0282)	(0.0308)
Dummy Final^k × ln(MA)$_i$		0.0756	0.366**		0.000242	-0.114
		(0.123)	(0.157)		(0.0712)	(0.0756)
Air share^k× WTO$_i$		1.860***	1.726***		1.004***	0.966***
		(0.634)	(0.650)		(0.369)	(0.366)
Ctnr share^k × WTO$_i$		1.541***	1.624***		-0.167	-0.0945
		(0.420)	(0.455)		(0.166)	(0.178)
ln(WV^k) × WTO$_i$		-0.365***	-0.288***		0.00979	0.0566
		(0.0749)	(0.0730)		(0.0446)	(0.0474)
Dummy Final^k× WTO$_i$		0.825***	0.948***		-0.0129	-0.366***
		(0.298)	(0.312)		(0.113)	(0.117)
Constant	14.74***	2.005	-10.11***	19.31***	15.16***	17.03***
	(0.997)	(3.318)	(3.680)	(0.581)	(1.917)	(2.229)
Observations	1,028,976	1,028,976	1,028,976	1,028,976	1,028,976	1,028,976
Pseudo R2	0.774	0.775	0.782	0.869	0.866	0.870

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Models (1)-(3) have as LHS variable the exports X_i^k of country i and HS6 digit product k. Models (4)-(6) have as LHS variable the imports M_i^k of country i and HS6 digit product k. *Ctnr share*^{k} is the containerized share of product k. (WV^k) is the ratio (Weight/Value)^k of product k. ln(GDPpc)$_i$ is the natural log of country's i GDP percapita. ln(Pop)$_i$ is the natural log of country's i population. $(MA)_i$ is the Market Access measure of country i. All models are estimated with country and year fixed effects using the PPML estimator over a database of import and export flows respectively in 2017 at the country-product level.

Table 6: Composition of landlocked countries' export and import flows

	X_i^k		M_i^k		X_i^k	M_i^k
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Air share^k × LL_i	-0.0955	-0.230	-0.212	-0.145	-48.38	1.241
	(0.417)	(0.426)	(0.248)	(0.229)	(36.45)	(14.63)
Ctnr share^k × LL_i	0.311	0.271	0.317***	0.333***	-31.08*	-11.51*
	(0.259)	(0.268)	(0.123)	(0.123)	(17.76)	(6.441)
$\ln(WV^k) \times LL_i$	-0.120**	-0.137**	-0.0691**	-0.0600*	-9.283	0.804
	(0.0519)	(0.0546)	(0.0321)	(0.0329)	(7.843)	(2.605)
Dummy Final^k × LL_i		-0.149		0.0628	-33.26***	16.18***
		(0.161)		(0.0915)	(9.990)	(3.753)
Air share^k × LL_i × ln(GDPpc)$_i$					1.278***	0.222
					(0.415)	(0.208)
Ctnr share^k × LL_i × ln(GDPpc)$_i$					-0.267	-0.162*
					(0.227)	(0.0958)
$\ln(WV^k) \times LL_i$ × ln(GDPpc)$_i$					0.0490	-0.0109
					(0.0497)	(0.0261)
Dummy Final^k × LL_i × ln(GDPpc)$_i$					-0.297	-0.0423
					(0.201)	(0.0857)
Air share^k × LL_i × ln(Pop)$_i$					0.716*	0.516**
					(0.403)	(0.230)
Ctnr share^k × LL_i × ln(Pop)$_i$					-0.429	0.146
					(0.310)	(0.107)
$\ln(WV^k) \times LL_i$ × ln(Pop)$_i$					0.138*	0.0215
					(0.0835)	(0.0386)
Dummy Final^k × LL_i × ln(Pop)$_i$					-0.273**	0.0283
					(0.132)	(0.0738)
Air share^k × LL_i × ln(MA)$_i$					1.138	-0.480
					(1.485)	(0.577)
Ctnr share^k × LL_i × ln(MA)$_i$					1.741**	0.429
					(0.840)	(0.265)
$\ln(WV^k) \times LL_i$ × ln(MA)$_i$					0.273	-0.0459
					(0.286)	(0.0939)
Dummy Final^k × LL_i × ln(MA)$_i$					1.712***	-0.688***
					(0.467)	(0.176)
Air share^k × LL_i × WTO$_i$					-4.356***	-0.155
					(1.163)	(0.452)
Ctnr share^k × LL_i × WTO$_i$					-1.741**	0.681***
					(0.781)	(0.264)
$\ln(WV^k) \times LL_i$ × WTO$_i$					-0.238	0.0219
					(0.175)	(0.0592)
Dummy Final^k × LL_i × WTO$_i$					-1.508***	0.655***
					(0.492)	(0.157)
Constant	-7.355**	-10.01***	18.20***	18.54***	-9.426**	18.80***
	(3.617)	(3.771)	(2.341)	(2.318)	(3.925)	(2.431)
Observations	1,028,976	1,028,976	1,028,976	1,028,976	1,028,976	1,028,976
Pseudo R2	0.781	0.782	0.869	0.870	0.783	0.871

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Models (1),(2) and (5) have as LHS variable the exports X_i^k of country i and HS6 digit product k. Models (3), (4) and (6) have as LHS variable the imports M_i^k of country i and HS6 digit product k. *Ctnr share*^{k} is the containerized share of product k. (WV^k) is the ratio (Weight/Value)^k of product k. ln(GDPpc)$_i$ is the natural log of country's i GDP percapita. ln(Pop)$_i$ is the natural log of country's i population. $(MA)_i$ is the Market Access measure of country i. LL$_i$ is a dummy variable equal to 1, if a country i is landlocked, and to 0 otherwise. All models are estimated with country and HS6 product fixed effects using the PPML estimator over a database of import and export flows respectively in 2017 at the country-product level. All variables from Table 5 are also included, as well as the same double and triple interacted variables shown above but for island countries.

Table 7: Composition of islands' export and import flows

	X_i^k		M_i^k		X_i^k	M_i^k
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Air share^k $\times$ ISL_i	-1.254	-0.628	-1.952***	-2.048***	-60.65	53.65
	(0.809)	(0.802)	(0.556)	(0.697)	(44.03)	(35.14)
Ctnr share^k $\times$ ISL_i	0.866**	1.017***	-0.926***	-0.948***	38.74*	29.49**
	(0.354)	(0.360)	(0.243)	(0.276)	(19.86)	(13.37)
$\ln(WV^k) \times ISL_i$	-0.259**	-0.169	-0.0592	-0.0727	-2.013	7.919*
	(0.119)	(0.121)	(0.0720)	(0.0930)	(5.322)	(4.469)
Dummy Final^k $\times$ ISL_i		0.610***		-0.0723	25.12*	4.595
		(0.230)		(0.278)	(13.50)	(12.63)
Air share^k $\times$ ISL_i $\times$ ln(GDPpc)$_i$					0.00731	1.182*
					(0.774)	(0.615)
Ctnr share^k $\times$ ISL_i $\times$ ln(GDPpc)$_i$					-0.217	0.120
					(0.375)	(0.214)
$\ln(WV^k) \times ISL_i$ $\times$ ln(GDPpc)$_i$					0.287***	0.160**
					(0.0994)	(0.0741)
Dummy Final^k $\times$ ISL_i $\times$ ln(GDPpc)$_i$					0.163	-0.288
					(0.243)	(0.312)
Air share^k $\times$ ISL_i $\times$ ln(Pop)$_i$					0.879	1.003***
					(0.692)	(0.380)
Ctnr share^k $\times$ ISL_i $\times$ ln(Pop)$_i$					0.0968	0.385***
					(0.245)	(0.136)
$\ln(WV^k) \times ISL_i$ $\times$ ln(Pop)$_i$					0.228***	0.105**
					(0.0817)	(0.0452)
Dummy Final^k $\times$ ISL_i $\times$ ln(Pop)$_i$					0.241*	-0.0672
					(0.145)	(0.168)
Air share^k $\times$ ISL_i $\times$ ln(MA)$_i$					2.083	-3.632**
					(1.722)	(1.663)
Ctnr share^k $\times$ ISL_i $\times$ ln(MA)$_i$					-1.485	-1.638***
					(0.924)	(0.629)
$\ln(WV^k) \times ISL_i$ $\times$ ln(MA)$_i$					-0.180	-0.483**
					(0.224)	(0.210)
Dummy Final^k $\times$ ISL_i $\times$ ln(MA)$_i$					-1.159*	-0.127
					(0.637)	(0.639)
Air share^k $\times$ ISL_i $\times$ WTO$_i$					-2.210	6.029***
					(2.953)	(2.198)
Ctnr share^k $\times$ ISL_i $\times$ WTO$_i$					-1.991**	2.121***
					(0.996)	(0.762)
$\ln(WV^k) \times ISL_i$ $\times$ WTO$_i$					0.166	0.586**
					(0.325)	(0.232)
Dummy Final^k $\times$ ISL_i $\times$ WTO$_i$					-2.217***	2.228**
					(0.706)	(1.034)
Constant	-7.355**	-10.01***	18.20***	18.54***	-9.426**	18.80***
	(3.617)	(3.771)	(2.341)	(2.318)	(3.925)	(2.431)
Observations	1,028,976	1,028,976	1,028,976	1,028,976	1,028,976	1,028,976
Pseudo R2	0.781	0.782	0.869	0.870	0.783	0.871

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Models (1),(2) and (5) have as LHS variable the exports X_i^k of country i and HS6 digit product k. Models (3), (4) and(6) have as LHS variable the imports M_i^k of country i and HS6 digit product k. *Ctnr share*^{k} is the containerized share of product k. (WV^k) is the ratio (Weight/Value)^k of product k. ln(GDPpc)$_i$ is the natural log of country's i GDP percapita. ln(Pop)$_i$ is the natural log of country's i population. $(MA)_i$ is the Market Access measure of country i. ISL$_i$ is a dummy variable equal to 1, if a country i is an island, and to 0 otherwise. All models are estimated with country and product fixed effects using the PPML estimator over a database of import and export flows respectively in 2017 at the country-product level. All variables from Table 5 are also included, as well as the same double and triple interacted variables shown above but for landlocked countries.

Appendixes

A Summary Statistics

Table A1: Country Controls for Island and Landlocked Countries

Panel A. Island Countries								
	# Obs.	Mean	Std. Dev	Min	Perc. 25	Median	Perc. 75	Max
$\ln(\text{GDP pc})_i$	43	8.99	1.08	6.00	8.25	9.13	9.76	10.83
$\ln(\text{Pop})_i$	43	12.28	1.89	9.21	11.20	12.17	13.28	17.00
$\ln(\text{SMA})_i$	43	23.28	0.36	22.26	23.02	23.31	23.46	24.20
$\ln(\text{BMA})_j$	43	23.32	0.32	22.72	23.09	23.36	23.46	24.11
WTO_i	43	0.79	0.41	0	1	1	1	1

Panel B: Landlocked Countries								
	# Obs.	Mean	Std. Dev	Min	Perc. 25	Median	Perc. 75	Max
$\ln(\text{GDP pc})_i$	38	7.79	1.51	5.72	6.59	7.67	8.61	11.53
$\ln(\text{Pop})_i$	38	15.94	1.08	13.25	15.51	16.09	16.68	18.42
$\ln(\text{SMA})_i$	38	23.74	0.46	23.08	23.36	23.64	23.87	24.75
$\ln(\text{BMA})_j$	38	23.76	0.46	23.14	23.41	23.68	23.88	24.75
WTO_i	38	0.82	0.39	0	1	1	1	1

Note: $\ln(\text{GDPpc})_i$ is the natural log of country's i GDP percapita. $\ln(\text{Pop})_i$ is the natural log country's i population. SMA stands for Seller Market Access and BMA for Buyer Market Access. WTO_i is a dummy variable equal to 1, if a country i is a WTO member nation, and to 0 otherwise.

B Countries in CEPII database with WTO membership updated

Table B1: Countries with updated WTO membership and related WTO countries

Country with updated WTO membership	Related WTO Country
ABW	NLD
BES	NLD
COK	NZL
CUW	NLD
GRL	DNK
MSR	GBR
NCL	FRA
PYF	FRA
SHN	GBR

Note: All codes correspond to the ISO country codes. Column titled Country with updated WTO membership lists all countries not completely independent from a WTO member classified in the CEPII database as a non-WTO member. So their WTO membership is updated. Column titled Related WTO Country reports the WTO member to which countries in column titled Country with updated WTO membership are related.

C Robustness exercises

C.1 Liberal classification of island countries

Table C1: Composition of islands' export and import flows

	X_i^k		M_i^k		X_i^k	M_i^k
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Air share$^k \times ISL_i$	0.466	0.206	0.379*	0.350*	32.80	0.781
	(0.416)	(0.407)	(0.207)	(0.194)	(22.09)	(10.43)
$Ctnr\ share^k \times ISL_i$	0.0650	-0.00454	-0.252*	-0.258*	29.56***	-9.168
	(0.237)	(0.243)	(0.133)	(0.137)	(11.47)	(6.211)
$\ln(WV^k) \times ISL_i$	-0.0580	-0.0944	0.0983***	0.0941***	3.936	2.672*
	(0.0566)	(0.0598)	(0.0303)	(0.0324)	(3.516)	(1.564)
Dummy Final$^k \times ISL_i$		-0.294*		-0.0332	8.481	-11.55***
		(0.163)		(0.0838)	(7.719)	(4.228)
Air share$^k \times ISL_i \times$ ln(GDPpc)$_i$					-0.459	0.339*
					(0.421)	(0.202)
$Ctnr\ share^k \times ISL_i \times$ ln(GDPpc)$_i$					-0.139	-0.0186
					(0.202)	(0.116)
$\ln(WV^k) \times ISL_i \times$ ln(GDPpc)$_i$					-0.0117	0.0571*
					(0.0752)	(0.0323)
Dummy Final$^k \times ISL_i \times$ ln(GDPpc)$_i$					0.158	-0.0356
					(0.147)	(0.0714)
Air share$^k \times ISL_i \times$ ln(Pop)$_i$					-1.024***	0.125
					(0.237)	(0.140)
$Ctnr\ share^k \times ISL_i \times$ ln(Pop)$_i$					-0.384**	0.295***
					(0.163)	(0.0894)
$\ln(WV^k) \times ISL_i \times$ ln(Pop)$_i$					-0.0215	0.0180
					(0.0308)	(0.0220)
Dummy Final$^k \times ISL_i \times$ ln(Pop)$_i$					0.200*	0.0855
					(0.112)	(0.0589)
Air share$^k \times ISL_i \times$ ln(MA)$_i$					-0.686	-0.579
					(1.003)	(0.465)
$Ctnr\ share^k \times ISL_i \times$ ln(MA)$_i$					-0.866*	0.108
					(0.485)	(0.277)
$\ln(WV^k) \times ISL_i \times$ ln(MA)$_i$					-0.188	-0.172**
					(0.166)	(0.0700)
Dummy Final$^k \times ISL_i \times$ ln(MA)$_i$					-0.443	0.386**
					(0.343)	(0.174)
Air share$^k \times ISL_i \times$ WTO$_i$					6.581***	7.814***
					(2.012)	(2.269)
$Ctnr\ share^k \times ISL_i \times$ WTO$_i$					-0.735	1.343
					(1.130)	(0.899)
$\ln(WV^k) \times ISL_i \times$ WTO$_i$					0.991***	0.654***
					(0.224)	(0.229)
Dummy Final$^k \times ISL_i \times$ WTO$_i$					-3.363***	1.140
					(0.886)	(1.266)
Constant	-8.722**	-11.00***	17.63***	17.98***	-14.00***	22.04***
	(3.697)	(3.884)	(2.248)	(2.211)	(4.611)	(2.843)
Observations	1,028,976	1,028,976	1,028,976	1,028,976	1,028,976	1,028,976
Pseudo R2	0.782	0.783	0.869	0.870	0.787	0.872

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Models (1),(2) and (5) have as LHS variable the exports X_i^k of country i and HS6 digit product k. Models (3), (4) and(6) have as LHS variable the imports M_i^k of country i and HS6 digit product k. $Ctnr\ share^k$ is the containerized share of product k. (WV^k) is the ratio (Weight/Value)^k of product k. ln(GDPpc)$_i$ is the natural log of country's i GDP percapita. ln(Pop)$_i$ is the natural log of country's i population. $(MA)_i$ is the Market Access measure of country i. ISL$_i$ is a dummy variable equal to 1, if a country i is an island, and to 0 otherwise. All models are estimated with country and product fixed effects using the PPML estimator over a database of import and export flows respectively in 2017 at the country-product level. All variables from Table 5 are also included, as well as the same double and triple interacted variables shown above but for landlocked countries.

C.2 OLS estimator and log-linear specification

Table C2: Composition of Export Supply and Import Demand

		$\ln(X_i^k)$			$\ln(M_i^k)$	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Air share^k × ln(GDPpc)$_i$	-0.184***		-0.269***	0.107***		0.0185
	(0.0247)		(0.0279)	(0.0140)		(0.0161)
Ctnr share^k × ln(GDPpc)$_i$	0.0631***		-0.0747***	0.0191*		-0.00563
	(0.0182)		(0.0208)	(0.00999)		(0.0116)
ln(WV^k) × ln(GDPpc)$_i$	-0.111***		-0.104***	-0.0235***		-0.0351***
	(0.00319)		(0.00354)	(0.00171)		(0.00195)
Dummy Final^k × ln(GDPpc)$_i$	-0.160***		-0.260***	0.0659***		0.0614***
	(0.00686)		(0.00797)	(0.00393)		(0.00453)
Air share^k × ln(Pop)$_i$	-0.155***		-0.156***	-0.273***		-0.307***
	(0.0179)		(0.0180)	(0.00997)		(0.0105)
Ctnr share^k × ln(Pop)$_i$	0.0288**		0.0175	-0.211***		-0.221***
	(0.0135)		(0.0135)	(0.00725)		(0.00765)
ln(WV^k) × ln(Pop)$_i$	-0.0238***		-0.0220***	-0.0391***		-0.0436***
	(0.00220)		(0.00221)	(0.00120)		(0.00126)
Dummy Final^k × ln(Pop)$_i$	-0.0946***		-0.121***	-0.144***		-0.145***
	(0.00473)		(0.00484)	(0.00263)		(0.00278)
Air share^k × ln(MA)$_i$		0.204***	0.530***		0.401***	0.611***
		(0.0705)	(0.0783)		(0.0437)	(0.0504)
Ctnr share^k × ln(MA)$_i$		0.689***	0.786***		-0.0265	0.153***
		(0.0520)	(0.0587)		(0.0314)	(0.0365)
ln(WV^k) × ln(MA)$_i$		-0.147***	-0.0116		-0.00281	0.0806***
		(0.00884)	(0.00965)		(0.00530)	(0.00607)
Dummy Final^k × ln(MA)$_i$		0.244***	0.614***		-0.0499***	0.0292**
		(0.0193)	(0.0220)		(0.0117)	(0.0134)
Air share^k× WTO$_i$		-0.192	0.142		-0.144**	0.0352
		(0.127)	(0.131)		(0.0621)	(0.0639)
Ctnr share^k × WTO$_i$		0.511***	0.561***		-0.0635	0.0732
		(0.0972)	(0.100)		(0.0448)	(0.0462)
ln(WV^k) × WTO$_i$		-0.256***	-0.154***		-0.0507***	0.00340
		(0.0154)	(0.0159)		(0.00753)	(0.00774)
Dummy Final^k× WTO$_i$		0.0282	0.297***		-0.0683***	0.00601
		(0.0334)	(0.0345)		(0.0175)	(0.0180)
Constant	9.464***	-9.949***	-8.873***	14.09***	11.00***	12.27***
	(0.263)	(1.110)	(1.203)	(0.136)	(0.656)	(0.706)
Observations	530,426	530,426	530,426	801,840	801,840	801,840
R-squared	0.600	0.599	0.601	0.695	0.693	0.695

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Models (1)-(3) have as LHS variable the natural log of exports $\ln(X_i^k)$ of country i and HS6 digit product k. Models (4)-(6) have as LHS variable the natural log of imports $\ln(M_i^k)$ of country i and HS6 digit product k. *Ctnr share*^{k} is the containerized share of product k. (WV^k) is the ratio (Weight/Value)^k of product k. ln(GDPpc)$_i$ is the natural log of country's i GDP percapita. ln(Pop)$_i$ is the natural log of country's i population. $(MA)_i$ is the Market Access measure of country i. All models are estimated with country and year fixed effects using the OLS estimator over a database of import and export flows respectively in 2017 at the country-product level.

Table C3: Composition of landlocked countries' export and import flows

	$\ln(X_i^k)$		$\ln(M_i^k)$		$\ln(X_i^k)$	$\ln(M_i^k)$
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Air share$^k \times LL_i$	-0.606***	-0.686***	0.0657	0.0741	-31.37***	13.06***
	(0.0955)	(0.0965)	(0.0542)	(0.0546)	(6.374)	(3.458)
Ctnr share$^k \times LL_i$	-0.761***	-0.768***	-0.0754*	-0.0763*	-31.57***	4.847*
	(0.0717)	(0.0717)	(0.0393)	(0.0393)	(4.796)	(2.497)
$\ln(WV^k) \times LL_i$	-0.0516***	-0.0722***	-0.0166**	-0.0127*	-0.953	1.224***
	(0.0118)	(0.0122)	(0.00654)	(0.00674)	(0.817)	(0.429)
Dummy Final$^k \times LL_i$		-0.215***		0.0730***	0.301	1.712*
		(0.0269)		(0.0154)	(1.729)	(0.931)
Air share$^k \times LL_i \times \ln(\text{GDPpc})_i$					-0.271***	-0.201***
					(0.101)	(0.0547)
Ctnr share$^k \times LL_i \times \ln(\text{GDPpc})_i$					-0.222***	0.0330
					(0.0733)	(0.0391)
$\ln(WV^k) \times LL_i \times \ln(\text{GDPpc})_i$					-0.0116	-0.0259***
					(0.0130)	(0.00685)
Dummy Final$^k \times LL_i \times \ln(\text{GDPpc})_i$					-0.114***	-0.0402***
					(0.0275)	(0.0156)
Air share$^k \times LL_i \times \ln(\text{Pop})_i$					0.305***	-0.139**
					(0.0954)	(0.0549)
Ctnr share$^k \times LL_i \times \ln(\text{Pop})_i$					0.113	-0.0350
					(0.0710)	(0.0395)
$\ln(WV^k) \times LL_i \times \ln(\text{Pop})_i$					0.0142	-0.0223***
					(0.0120)	(0.00685)
Dummy Final$^k \times LL_i \times \ln(\text{Pop})_i$					-0.138***	0.0747***
					(0.0262)	(0.0154)
Air share$^k \times LL_i \times \ln(\text{MA})_i$					1.177***	-0.399**
					(0.291)	(0.158)
Ctnr share$^k \times LL_i \times \ln(\text{MA})_i$					1.298***	-0.208*
					(0.217)	(0.114)
$\ln(WV^k) \times LL_i \times \ln(\text{MA})_i$					0.0301	-0.0286
					(0.0371)	(0.0198)
Dummy Final$^k \times LL_i \times \ln(\text{MA})_i$					0.133*	-0.124***
					(0.0788)	(0.0429)
Air share$^k \times LL_i \times \text{WTO}_i$					-0.0797	0.424***
					(0.300)	(0.153)
Ctnr share$^k \times LL_i \times \text{WTO}_i$					-0.268	0.377***
					(0.228)	(0.111)
$\ln(WV^k) \times LL_i \times \text{WTO}_i$					0.0370	0.0148
					(0.0369)	(0.0188)
Dummy Final$^k \times LL_i \times \text{WTO}_i$					-0.657***	0.528***
					(0.0824)	(0.0434)
Constant	-12.44***	-13.77***	11.07***	11.47***	-5.858***	14.21***
	(1.314)	(1.316)	(0.781)	(0.779)	(1.445)	(0.920)
Observations	530,426	530,426	801,840	801,840	530,426	801,840
R-squared	0.601	0.602	0.694	0.695	0.602	0.696

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Models (1),(2) and (5) have as LHS variable the natural log of exports $\ln(X_i^k)$ of country i and HS6 digit product k. Models (3), (4) and (6) have as LHS variable the natural log of imports $\ln(M_i^k)$ of country i and HS6 digit product k. *Ctnr share*^{k} is the containerized share of product k. (WV^k) is the ratio (Weight/Value)^k of product k. $\ln(\text{GDPpc})_i$ is the natural log of country's i GDP percapita. $\ln(\text{Pop})_i$ is the natural log of country's i population. $(MA)_i$ is the Market Access measure of country i. LL_i is a dummy variable equal to 1, if a country i is landlocked, and to 0 otherwise. All models are estimated with country and HS6 product fixed effects using the OLS estimator over a database of import and export flows respectively in 2017 at the country-product level. All variables from Table 5 are also included, as well as the same double and triple interacted variables shown above but for island countries.

Table C4: Composition of island countries' export and import flows

	$\ln(X_i^k)$		$\ln(M_i^k)$		$\ln(X_i^k)$	$\ln(M_i^k)$
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Air share^k $\times$ ISL_i	0.189	0.339**	0.275***	0.188**	-39.28***	-16.88***
	(0.143)	(0.144)	(0.0756)	(0.0759)	(9.742)	(4.820)
$Ctnr\ share^k \times ISL_i$	0.167	0.177	0.112**	0.109**	-28.71***	-19.90***
	(0.112)	(0.112)	(0.0552)	(0.0550)	(7.508)	(3.611)
$\ln(WV^k) \times ISL_i$	-0.154***	-0.115***	-0.00406	-0.0305***	2.250*	1.012*
	(0.0171)	(0.0176)	(0.00896)	(0.00923)	(1.159)	(0.559)
Dummy Final^k $\times$ ISL_i		0.396***		-0.351***	-3.723	-21.30***
		(0.0381)		(0.0200)	(2.367)	(1.157)
Air share^k $\times$ $ISL_i \times \ln(\text{GDPpc})_i$					-0.426***	0.0418
					(0.165)	(0.0669)
$Ctnr\ share^k \times ISL_i \times \ln(\text{GDPpc})_i$					-0.445***	0.0266
					(0.129)	(0.0494)
$\ln(WV^k) \times ISL_i \times \ln(\text{GDPpc})_i$					0.0248	0.0175**
					(0.0210)	(0.00790)
Dummy Final^k $\times$ $ISL_i \times \ln(\text{GDPpc})_i$					-0.128***	0.00295
					(0.0420)	(0.0173)
Air share^k $\times$ $ISL_i \times \ln(\text{Pop})_i$					0.386***	0.142***
					(0.0898)	(0.0410)
$Ctnr\ share^k \times ISL_i \times \ln(\text{Pop})_i$					0.318***	0.0779***
					(0.0700)	(0.0298)
$\ln(WV^k) \times ISL_i \times \ln(\text{Pop})_i$					0.00644	0.0170***
					(0.0112)	(0.00494)
Dummy Final^k $\times$ $ISL_i \times \ln(\text{Pop})_i$					0.133***	0.148***
					(0.0231)	(0.0105)
Air share^k $\times$ $ISL_i \times \ln(\text{MA})_i$					1.507***	0.616***
					(0.468)	(0.226)
$Ctnr\ share^k \times ISL_i \times \ln(\text{MA})_i$					1.136***	0.770***
					(0.361)	(0.170)
$\ln(WV^k) \times ISL_i \times \ln(\text{MA})_i$					-0.125**	-0.0603**
					(0.0561)	(0.0262)
Dummy Final^k $\times$ $ISL_i \times \ln(\text{MA})_i$					0.139	0.792***
					(0.115)	(0.0546)
Air share^k $\times$ $ISL_i \times \text{WTO}_i$					2.674***	0.412**
					(0.489)	(0.191)
$Ctnr\ share^k \times ISL_i \times \text{WTO}_i$					1.727***	0.715***
					(0.377)	(0.140)
$\ln(WV^k) \times ISL_i \times \text{WTO}_i$					0.285***	-0.00543
					(0.0654)	(0.0224)
Dummy Final^k $\times$ $ISL_i \times \text{WTO}_i$					0.185	0.363***
					(0.113)	(0.0500)
Constant	-12.44***	-13.77***	11.07***	11.47***	-5.858***	14.21***
	(1.314)	(1.316)	(0.781)	(0.779)	(1.445)	(0.920)
Observations	530,426	530,426	801,840	801,840	530,426	801,840
R-squared	0.601	0.602	0.694	0.695	0.602	0.696

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Models (1),(2) and (5) have as LHS variable the natural log of exports $\ln(X_i^k)$ of country i and HS6 digit product k. Models (3), (4) and (6) have as LHS variable the natural log of imports $\ln(M_i^k)$ of country i and HS6 digit product k. $Ctnr\ share^k$ is the containerized share of product k. (WV^k) is the ratio (Weight/Value)^k of product k. $\ln(\text{GDPpc})_i$ is the natural log of country's i GDP percapita. $\ln(\text{Pop})_i$ is the natural log of country's i population. $(MA)_i$ is the Market Access measure of country i. ISL$_i$ is a dummy variable equal to 1, if a country i is an island, and to 0 otherwise. All models are estimated with country and HS6 product fixed effects using the OLS estimator over a database of import and export flows respectively in 2017 at the country-product level. All variables from Table 5 are also included, as well as the same double and triple interacted variables shown above but for landlocked countries.