Geographic Disadvantage and the Composition of Trade

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Abstract

Landlocked countries and small islands face transport-related constraints on their ability to trade goods internationally. Such constraints can limit their ability to participate in international supply chains and to develop through international trade. This paper seeks to shed light on the effects of transport-related constraints by relating the composition of countries' exports and imports to characteristics associated with the method and cost of transoceanic transportation and to an indicator of products' proximity to final demand. We adopt an estimating strategy used to study levels of trade, but use it to study the composition of exports and imports. Estimated coefficients on the interactions between product- and country-characteristics reveal the way in which revealed comparative advantage varies with country characteristics. Relative to comparison countries, small islands' and landlocked countries' trade flows are biased towards products with particular transport characteristics. Among several new stylized facts, we find that both country-types' imports and landlocked countries' exports have below average weight-to-value ratios. Landlocked countries' trade is biased against air-shipped products, and towards products that move in container vessels. Small islands' imports are biased against products that move by air transport and by container vessels, a finding suggesting that small islands have comparative advantage in processing imported raw materials, most notably fuels. There is important heterogeneity of these and other such effects within each type of geography. The results offer broad lessons that can be informative for governments making transport infrastructure investments or other trade policies that favor one sector over another.

Keywords: Landlocked countries, islands, revealed comparative advantage, transportation, upstreamness
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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, 2013). 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. The particular trade frictions faced by landlocked countries or islands may limit these regions' ability to participate in globalized production and to develop through international trade.

In this paper, we study the ways in which landlocked or small island status affects the composition of an economy's export and import bundles.[1] Many studies using the gravity model of trade include dummy variables that identify one or both country types, so the consequences of these geographies for the level of trade 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 a whole. We use the concept of Revealed Comparative Advantage (RCA) to summarize trade

[1] We use the phrase "small islands" to indicate that we exclude from our sample islands with large economies, so that we might focus on trade impacts of the particular constraints facing smaller island economies. Our set of small islands excludes New Zealand and all those with even larger economies, because islands with large economies might face fewer constraints on their transport possibilities and be more able to host multiple stages of production within supply chains. The set of landlocked countries with comparably large GDPs is much smaller, so we retain the entire set of landlocked countries. The set of landlocked countries has considerable heterogeneity in its trade composition, and we explore this heterogeneity using interactions of the landlocked dummy with country- and product-characteristics.

composition, and apply it to imports as well as exports. The product characteristics we study include several that relate to the cost and preferred mode of transporting the product between continents. In order to focus on the way in which industries' vertical position in global supply chains intersects with geography to determine countries' RCA, we also separate products into sets of final and upstream products. The product characteristics we study are 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 governments face public financing decisions about the relative merits of capacity investments in sea ports vs. airports. Governments of 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 exercises that use RCA to identify products in which policy support for increased exports may be likely to succeed, as in Reed (2024). Products that face transport-related constraints on either exports or imported inputs may be poor choices for policy support of either kind.

Our paper is most similar to Hillberry et al. (2025), which develops a general equilibrium model of specialization and trade that follows the intuition of von Thünen (1826), but does so for global trade and production rather than for the regional outcomes that motivate von Thünen.[2] The theory has a monopolistically competitive market structure and

[2]Venables and Limao (2002) propose an earlier theoretical von Thünen model of international location and trade, but offer no empirics.

consumers with a taste for variety, a structure that allows the model to avoid the assumed central location that is responsible for total consumption in von Thünen (1826) and Venables and Limao (2002). Hillberry et al. (2025) use a Poisson Pseudo-Maximum Likelihood (PPML) estimator to uncover relationships between product- and country-characteristics in trade composition. Their product-characteristics of interest include the products' transport mode shares in U.S. imports, which - jointly with a measure of market access - are significant predictors of countries' export composition. Products' production line position enter as a control variable, and reveal that products that are upstream in production chains predominate in geographically remote countries, as predicted by Antràs and de Gortari (2020). This paper applies the Hillberry et al. (2025) strategy to investigate the specific consequences of small island and landlocked status for the composition of both exports and imports. The key variables of interest in Hillberry et al. (2025) enter as control variables in this paper, allowing a focus on the conditional implications of landlocked and small island status for the composition of trade. We seek to understand the degree to which product characteristics related to the cost/method of transportation and products' position in supply chains co-vary with island and landlocked status. Our estimates should not be seen as a test of a particular theory, but rather as a descriptive representation of trade composition among landlocked countries and small islands.

Our empirical methods are closely related to a literature that seeks to better understand the determinants of countries' comparative advantage.[3] These papers regress industry-

[3] 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.

level exports on interactions between industry- and country- characteristics, conditional on industry- and country-fixed effects. We use trade data at the HS6-digit level, and focus on interactions between product- and country- characteristics, conditional on product- and country- fixed effects. Since we are interested in participation in global supply chains, we study the composition of imports as well as exports. Another difference with the existing RCA literature is that we use PPML, an approach to estimation that has important advantages over the log-linear OLS tools that are more commonly employed in this literature. These advantages are put forward by Hillberry et al. (2025), but we briefly review them below.

A prominent literature has sought to understand comparative advantage through pooled product-level gravity regressions that are motivated by Ricardian models of trade.[4] In most of these papers, the elasticity of trade costs to distance is taken to be common across products, an assumption that is not suitable for this exercise. Data on mode shares at the product-level reveal wide differences in products' tendency to travel on different kinds of transport, and both the level of transport costs and their elasticity with respect to distance vary substantially over transport modes.[5] More significantly, estimates of RCA that use gravity models of trade condition on the spatial distribution of product-level demands, which is taken to be exogenous. The theoretical models that motivate these regressions 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, a long-run response to trade

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

[5] The latter results appear in Hillberry et al. (2025), which estimates these relationships in U.S. import data.

costs that changes the spatial distribution of demand (as in Krugman and Venables (1995) and Krugman and Venables (1996)).[6] Joint location of sequential production is important for understanding specialization and trade within agglomerations, but it also has important implications for the geographic periphery. We do not study joint location decisions explicitly. Rather, we summarize trade composition without conditioning on the existing spatial distribution of supply/demand.[7] In this way our paper is like Hummels and Klenow (2005), who study relationships between export composition, country size and per capita income without conditioning on the geography of trade. We also show empirically that the spatial distribution of import demand is shaped by products' transport characteristics and production line position.

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 bear an extremely large burden in terms of excess transportation costs, and estimate that landlocked countries' trade is 60 percent lower than in otherwise equivalent countries with access to the sea. Using the

[6]Hillberry and Hummels (2002) use the Krugman and Venables (1996) model to highlight the degree to which conventional gravity models understate responses of trade in intermediate products to bilateral trade costs because they do not account for the co-location channel. Hillberry and Hummels (2008) provide evidence that joint location of sequential production is important for understanding the effects of distance on U.S. freight movements.

[7]While the patterns we uncover are, of course, dependent on the particular bilateral trade equilibrium in which they are studied, we view as useful a cross-commodity estimation exercise that does not condition on either the (endogenous) spatial pattern of product-level demands or an assumption that products share a common distance elasticity of trade costs.

most current empirical methods (i.e. PPML), Gyawali (2024) 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 estimates from a number of other papers that study landlocked countries' trade.[8] Several authors link the trade penalty associated with landlocked status to poor policy choices in the landlocked countries themselves, especially policies regarding transport.[9] 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.[10]

The effects of island status on trade are not as well studied as the effects of landlocked status, and are less clear-cut. The most useful paper regarding islands' trade is Langat et al. (2002), which conducts a meta-analysis over 95 papers that report a total of 2,044 estimates of the effects of island status on the level of trade. Estimates from the meta-analysis point to a positive and statistically significant effect of island status on the level of trade flows.[11] 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 islands' total imports and exports, rather than the bilateral trade flows usually studied in the gravity model of trade. We find an outsized role for commodities (and more specifically, fuels) in small islands' imports, a result that may be relevant to the literature on the level of islands' trade.

Our initial sets of results relate our product characteristics of interest to a small but

[8] See Faye et al. (2004), Arvis et al. (2010), and Paudel and Cooray (2018), among others.

[9] See Macchi and Raballand (2009), Arvis et al. (2010), and Borchert et al. (2012), among others.

[10] 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 and small island status relate to product characteristics.

[11] Papers used in this meta-analysis include Estevadeordal et al. (2003), Ghosh and Yamarik (2004), Rose (2004), Klein and Shambaugh (2006), and De Benedictis and Pinna (2015).

important set of country characteristics. As in Hillberry et al. (2025), the country characteristics we study are per capita GDP, population, geographic market access and WTO member status. Results for exports are similar to those reported in Hillberry, et al., while results for import composition follow intuitive patterns. Our main interest is in the differences observed between landlocked countries, small islands, and the rest of world.

Relative to the set of reference countries, we find the following results: 1) Products with low weight-to-value ratios are over-represented in landlocked countries' imports and exports and small islands' imports; 2) Landlocked countries conduct relatively more trade in products suited to containerized transport, though this effect is only statistically significant for imports and the effects are quite heterogeneous among landlocked countries; 3) Small islands' imports are biased towards products transported as non-containerized maritime freight, an outcome consistent with small islands having comparative advantage in processing raw materials (especially fuels); 4) Small islands' export bundles are biased towards products suited to sea shipment, and contain a disproportionate share of final products, but the significance of these effects depends on model specification; 5) The effects we observe for small 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 intuitive ways; and, finally 6) Heterogeneous effects among landlocked countries with respect to products' weight-to-value ratio are not statistically significant, suggesting that the bias against physically heavy products observed in (1) is a common feature of landlocked countries' exports and imports.

The remainder of the paper is organized as follows. Section 2 describes a mix of trade theories and other considerations, 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 affect 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.

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 landlocked countries and small islands), but the trade friction is generally treated as common across products. In this paper we focus on the implications of cross-product variation in trade costs, especially costs related to transportation. 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 physical weight, in suitability for different transport modes, and in products' production line position.

We take the view that most products are best suited to being transported by particular modes of transport, especially on overseas routes where mode-switching is difficult.[12] 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.

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. Heavier products likely face higher average freight costs, even after conditioning on likely transport modes. The incidence of higher product weights on trade may be larger or smaller among small islands or landlocked countries, relative to the reference group of countries.

2.2 Theories of industry location when trade costs are important

While a broad range of theories are potentially useful for interpreting our results, we view three groups of theories as helpful for interpreting the forces that drive most of our results. What these theories have in common is that they make predictions about how sectors with different kinds of trade frictions and/or positions in supply chains choose to locate in geographic space.

Theories following von Thünen (1826) explain that products facing higher transport costs will tend to locate nearest their destination markets. Products with lower trade costs

[12] Hummels and Schaur (2013) use the air-vs sea mode choice in U.S. imports to make inferences about the time-sensitivity of product-level imports. We extend this kind of analysis to separate products that move by container vessels from products that move by other kinds of waterborne transport in transoceanic trade.

can be produced further away. The von Thünen paper most similar to ours is Hillberry et al. (2025), who develop a monopolistic competition model of trade and location based on cross-product differences in transport intensity. In their empirical work, Hillberry et al. (2025) show that more geographically central countries are more likely to export products that are suited to transport by air or by container vessels. Countries in the periphery are much more likely to export products that cross oceans as non-containerized freight in maritime vessels. Since transport by bulk or other non-containerized maritime vessels costs less than other modes of transportation, these relationships are consistent with the model's prediction that industries producing transport-intensive products will tend to locate near the global center. Hillberry et al. (2025) show that the empirical relationships between product's transport intensity and countries geographic market access remain robust to controls for other sources of comparative advantage.

Krugman and Venables (1995) propose a model with similar geographical predictions, but different mechanisms. 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 intermediate trade costs lead manufacturing firms to agglomerate in the North. Krugman and Venables (1996) propose a 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. A key lesson of both models is that agglomeration of sequential stages of production allows firms to reduce the costs of trading intermediate goods by avoiding them.

Antràs and de Gortari (2020) propose a theory of spatial supply chain organization. There are costs of trading between stages and across countries. The 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.

2.3 Other considerations

Although not linked to particular theories of trade and location, we offer here a non-exhaustive list of some other considerations likely to affect our findings. First, the relative supply of different international transportation services varies over space. More expensive, network-oriented transport modes (air and container vessel) are likely to be more readily available in geographically central countries, lowering the price of these modes relative to others for regions in the geographic center.[13] Second, the suitability of trade in certain products may depend on infrastructure investments, which may be endogenous to country characteristics such as income and population size, among others. Third, countries' trade policy orientation may affect the composition of both their imports and exports.

[13] Brancaccio et al. (2020) explain that the international market for bulk shipping is similar to that of an urban taxi market, with shippers booking a bulk vessel to deliver to a specific destination. Upon delivery the vessel begins the process of searching for another cargo, typically in nearby waters. Ganapati et al. (2024) explain that container ships operate more like buses, stopping at several ports along a fixed route. Air transport is more readily available where passenger traffic markets are thick, because of common infrastructure needs and because air freight frequently travels on passenger planes. The different constraints and operating models across the three modes imply differences in the quality and quantity of different transport modes' supplies across the globe.

3 Revealed comparative advantage and PPML

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 for imports, our interest in supply chains makes countries' differential purchases of imported products a relevant question. We propose a similar index for imports, replacing each X variable in (1) with its M counterpart.

It is apparent from (1) that, after controlling appropriately for variation in $\overline{X}_i$ and X_w^k, conditional variation in X_i^k is equivalent to conditional variation in RCA_i^k.[14] The literature on the determinants of comparative advantage from which we draw typically seeks to understand variation in (1) by estimating a log linear regression with $ln(X_i^k)$ on the left hand side and country- and industry-fixed effects included to control for variation $\overline{X}_i$ and X_w^k.[15] The variables of interest are interactions between industry- and country- characteristics. We apply the same strategy, except that a) we replace industry characteristics with the product characteristics, giving us more detail and a more finely grained look at trade flows, and b)

[14] $\overline{X}_w$ is the value of global trade and goes into the constant term.

[15] Nunn (2007) and Debaere (2014) use a log-linear specification. Romalis (2004) puts export shares on the left hand side and estimates in levels.

we use PPML regression instead of log-linear OLS. Our PPML estimator takes the form:

$$X_i^k = exp\left[\alpha_i + \alpha^k + \mathbf{C}_i\mathbf{Z}^k\mathbf{\Gamma}\right] + \epsilon_i^k \tag{2}$$

where α_i and α^k are country- and product- fixed effects, $\mathbf{C}_i$ a vector of country characteristics (including dummy variables indicating island and landlocked status), $\mathbf{Z}^k$ a vector of product characteristics, $\mathbf{\Gamma}$ a vector of coefficients on the country-product interactions, and ϵ_i^k is a mean zero error term.

Hillberry et al. (2025) explain that PPML offers three important advantages over log linear OLS in estimating conditional variation in RCA: 1) PPML allows the inclusion of zero flows, which are common in data on product-level trade at the country level; 2) the implicit weights in PPML estimation are dollar values, and consistent weighting is a valuable property when considering variation across both countries and products; and 3) PPML imposes adding up conditions such that $\widehat{\alpha}_i$ terms take values such that $\sum_k \widehat{X}_i^k = \overline{X}_i$, and the $\widehat{\alpha}^k$ terms take values such that $\sum_i \widehat{X}_i^k = X_w^k$. This property ensures that fixed effects in the PPML specification control exactly for the scale of products and countries in global trade flows. Variation in X_i^k, conditional on the fixed effects thus matches conditional variation in RCA.[16] These and other desirable properties of PPML have made it the preferred estimator for studies that estimate the gravity model of bilateral trade.[17] The particular properties of PPML highlighted above are at least as relevant to RCA estimation as they are to estimation of bilateral trade models.

[16] Fally (2015) discovers the latter two properties and discusses them in the context of the empirical gravity model. Hillberry et al. (2025) explain their advantages for exploring conditional variation in RCA.

[17] Yotov (2024) outlines the role of PPML in modern gravity model estimation. Francois and Manchin (2013) use a PPML gravity framework to estimate the role of institutions and transport infrastructure on the level of trade.

3.1 Country characteristics

The first set of country characteristics $\mathbf{C}_i$ that enter as controls include logged per capita gross domestic product (GDP) and logged population, as in Hummels and Klenow (2005).[18] The second set of control variables are measures of market access (an inverse measure of geographic remoteness) and a dummy variable indicating membership in the World Trade Organization (WTO). The primary country characteristics of interest are dummy variables indicating landlocked or small island status. We describe our approach to generating 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. Specifically, we use data on transport mode choices to calculate the propensity of each product to be transported by air and by container vessel in overseas trade, as well as the products' weight-to-value ratio. A fourth characteristic is an indicator variable that measures whether a product is purchased by final demand or is used in subsequent production. If the costs of trading with islands and landlocked countries exceeds those of other similar partners, we might expect them to import relatively more final products, rather than upstream products that require further processing. We take our product characteristic measures from U.S. data, and apply them to all trade flows. This ensures that our measures of product characteristics are fixed across geographic space.

We use U.S. data to construct product characteristics for several reasons. First, the

[18] 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.

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 of its trading partners, is useful for linking demands for timeliness to the air share of shipments.[19] Fourth, the rich input-output tables available for the U.S. allow it to serve as the best source of data on products' vertical position within supply chains.

3.3 Within-group heterogeneity

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. Landlocked countries in Europe likely have different trade bundles than landlocked countries in Africa or Latin America. The effects of small island status on trade composition may be very different in the South Pacific and in the Caribbean.

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 landlocked 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 landlocked countries' exports of products suited to air shipment depends on their geographic location.

[19] Hummels and Schaur (2013) use this measure to study the value of timeliness in international trade.

If landlocked countries in Europe are better able to export such products than landlocked countries in Africa or South America, this coefficient would be positive.[20] Our triple interaction specifications (for exports) appear as:

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

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.

4 Data

4.1 Trade Data

The data on export and import flows come from the BACI database - sourced from CEPII (2024). These data contain the value (in USD) and HS6 digit product code for exports and imports at the country level. Imports and exports for each product-country pair use the sample of data available for 2017.[21]

4.2 Country characteristics

4.2.1 Landlocked and island dummies

The primary variables of interest at the country level are two dummy variables that identify landlocked countries and small islands. The landlocked dummy is from CEPII (2024), which

[20] Note that the direct access of landlocked European countries to large markets in Europe may mean that they are able to export time-sensitive products to nearby markets without relying on air transport. The air share variable is an exogenous product characteristic in our regressions, not an indicator of the endogenous mode of travel on a particular route.

[21] 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 from our estimation island territories that report less than 5 percent of both their exports to and imports from their parent country, since it seems likely that their total trade flows are distorted by the omission of trade with the parent.

simply indicates whether or not a country has coastline on the sea.

Construction of the small island dummy involves some judgment calls. We view the small islands that interest us as facing different international transportation constraints than large island nations such as Japan or Australia. We exclude from our island indicator those islands with GDP of US$200 billion dollars or more. 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 Market Access Measures

Since von Thünen forces are likely to be important for the questions we ask, we construct measures of market access to serve as control variables. These measures are trade-weighted average distances to export and import markets, respectively. We follow Redding and Venables (2004) in generating regression-based measures of buyer market access (BMA) and seller market access (SMA), respectively. We differ from Redding and Venables (2004) in that we estimate with PPML, and that we include domestic trade flows and a home dummy in the specification. We are able to include home flows in these regressions because we use as inputs the aggregate trade flow data from the International Trade and Production Database for Estimation (ITPD-E) Release 3 (Borchert et al., 2021; Larch et al., 2025).[22] We use the

[22] The data used in our trade composition measures is from CEPII, which has product detail at the HS6-digit level. We use the ITPD-E data to calculate market access because it has domestic flows, and the inclusion of domestic flows is important for describing market access in large economies like the United States. The ITPD-E data use production data to infer domestic trade flows, and production data lacks the product detail that we wish to exploit in the trade composition measures.

available data from 2015, excluding services trade flows and only including the countries in the CEPII database. The specification we estimate in the market access exercise is

$$X_{ij} = \exp\left(\omega_i + \omega_j + \phi_1 \ln(Dist_{ij}) + \phi_2 ADJ_{ij} + \phi_3 HOME_{ij}\right) + \epsilon_{ij} \tag{4}$$

where X_{ij} is the (aggregate) value of bilateral goods trade 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, ADJ_{ij} a dummy variable that takes one when two countries share a land border, $HOME_{ij}$ a dummy that takes the value of 1 when $i = j$, the ϕ-terms are regression coefficients, and ϵ_{ij} is a mean zero error term. We estimate $\widehat{\phi_1} = -0.563$, $\widehat{\phi_2} = 0.680$ and $\widehat{\phi_3} = 2.453$. We calculate buyer's market access as $BMA_j = \sum_i e^{\widehat{\omega_i} + \widehat{\phi_1} \ln(Dist_{ij}) + \widehat{\phi_2} ADJ_{ij} + \widehat{\phi_3} HOME_{ij}}$. Seller's market access (SMA_i) sums over the j subscript and replaces $\widehat{\omega_i}$ as an input with $\widehat{\omega_j}$. We log BMA_j and SMA_i for use as an independent variable in our RCA analysis.[23]

4.2.3 Other country controls

In most cases the GDP per capita and population variables are from CEPII (2024); missing observations are replaced with data from the World Bank, International Monetary Fund, United Nations or selected national statistical agencies, as available. We use 2015 data for both measures, so that they may be taken as exogenous for our 2017 trade flows.

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

[23]The log BMA_j ranges between -2.68 (Bonaire) and 0.05 (China), and the log SMA_i between -2.77 (Bonaire) and 0.29 (Hong Kong).

fact, WTO members. Greenland, a territory of Denmark, is one example. We update the value of the WTO dummy to 1 in such cases.[24]

4.3 Product Characteristics

Products' transport characteristics are taken from U.S. import data for the year 2015, a choice we make so our measures can be taken as exogenous to the 2017 flows we study.[25] 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. In U.S. data, goods arriving by sea are either coded as arriving in container vessels 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 Hillberry and Jimenez (2024), 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 import value that arrives 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 Hillberry and Jimenez (2024), we convert this into a dummy variable that takes the value of 1 if products' have upstreamness scores less than or equal to 1.3.[26] All

[24] Online Appendix Table A1 lists territories we recoded in this way, along with their parent country.

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

[26] In a study of the costs U.S. cabotage laws impose on Puerto Rico, Hillberry and Jimenez (2024) choose boundary between upstream and final products using visual inspection of product descriptions. The composition of Puerto Rican bilateral import demands behave quite differently across the two product groups: in

products with upstreamness scores greater than 1.3 are coded as "upstream" products. We view this discrete indicator as preferable to a continuous measure of upstreamness because demand for final products is likely to be more spatially diffuse than demand for upstream products used as inputs for further processing. A continuous representation of upstreamness also mixes the overall length of supply chains with industries' position within each chain, a potential issue for exercises that explore variation across both products and countries.

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.[27] 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 0.21 and a median of 0.07. The container share variable is skewed in the other direction, with a mean of 0.69 and a median of 0.83. There is considerable variation across products in the weight-to-value ratio. Only 16 percent of the products are treated as final-stage production; the rest are upstream products.

Table 2 reports simple correlations among the product characteristics. Products' air share of shipment is negatively correlated with the container share of shipments ($\rho = -0.78$) and with products' logged weight-to-value ratio ($\rho = -0.71$).[28] There is a weaker but still

final demand there is substitution away from non-containerized and heavy products, while imported products that are upstream in production and typically shipped by sea are nearly absent from PR imports. Conceptually the boundary value of 1.3 means that products classified as final products have at 70 percent of their value consumed by final demand.

[27] As in Hillberry and Jimenez (2024), HS6 codes with missing data are assigned the values of their HS4 or HS2 codes. 516 products were assigned statistics from their HS4 and 71 products from their HS2.

[28] Our data only recognizes containerizable products by their presence on maritime container vessels, so the container share variable is zero when products solely move by air, thus producing the first large negative correlation coefficient. The second large negative correlation coefficient reported here reflects sorting of low weight-to-value products into air shipment. Estimated coefficients on weight-to-value ratios in the

sizable correlation between the share of a product's shipments that are containerized and the product's logged weight-to-value ratio ($\rho = 0.44$). The final-stage production dummy is negatively correlated with logged weight-to-value ratio ($\rho = -0.21$).

Our estimating sample also includes information from a total of 205 regions. Summary statistics are reported in Table 3. 38 of the sample regions (19 percent) are landlocked countries and 43 are coded as small islands (21 percent). 84 percent were WTO members in 2017.[29]

Table 5 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 lower 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.[30]

5 Results

Our exercises produce a large number of coefficient estimates, posing a challenge for reporting results. The country control variables are worthy of discussion, but our main interest are the conditional effects of landlocked and small island status. Our reporting strategy is

specifications that follow should be interpreted as an effect that is conditional on transport mode.

[29]Table 4 reports summary statistics for the sub-samples of small islands and landlocked countries.

[30]The inclusion of domestic trade flow data and a home dummy in the construction of our market access measures generates the positive correlation between market access and country sizes. In practice we observe that the market access variables better explain trade composition than country size when both measures appear on the right hand side.

to first provide a table with results from specifications that include only interactions with the country control variables, exclusive of the interactions with the landlocked and small island dummies.[31] We then report separate tables that summarize all results for landlocked, and then small island status, respectively. These latter estimates are taken from specifications that include all the control variables, as well as all the interactions involving both the landlocked and the island dummies. Results from specifications that include the triple interactions are reported in the same tables as the initial results for landlocked countries and small islands, respectively.

5.1 Product characteristics and country controls

Table 6 reports coefficient estimates associated with the interaction of the country control variables and product characteristics. We estimate the same specifications of (2) for exports and imports, respectively. For both exports and imports we estimate on two different sets of controls separately, and then on the complete set of controls. The results with the complete set of controls are similar to those with subsets of the controls, so we focus our discussion on those results. We report these results in Table 6, using column 3 for exports and column 6 for imports.

The first four rows of Table 6 consider interactions of the product characteristics with per capita income. Column 3 shows that products suited for shipment by air transport and by container vessel, as well as products near final demand are less heavily represented in export bundles of high income countries than in their low-income counterparts.[32] High

[31] Hillberry et al. (2025) offer a full examination of results involving the relationships between our main control variables and export composition.

[32] Since we also include country controls for market access, WTO member status and population, the

income countries' imports are conditionally less well-suited to air transport, are physically lighter and are more likely to be final goods than low-income countries' imports.

The next four rows of Table 6 consider interactions of product characteristics with countries' logged population size. On the export side, large population countries' RCAs are biased towards products that are physically heavy. Since we control for per capita income, we might expect countries with larger populations to be capable of making larger infrastructure investments, investments that may facilitate trade in heavy products. On the import side, large population countries' imports are more likely to be final goods.

We next turn to the market access variables, using seller market access in the export regressions and buyer market access in the import regressions.[33] Following the intuition of von Thünen (1826) and Hillberry et al. (2025), markets nearer the center of global trade flows might be expected to specialize in transport-intensive products, while the intuition of Antràs and de Gortari (2020) would suggest that such countries would specialize in final stage products. Consistent with these models' predictions, Column 3 results show that more geographically central regions are much more likely to export products that are transport-intensive (i.e. shipped by air or by container vessels), and are final products. The estimated effects of market access on mode choice-related characteristics and final product status are large. Moving from the 25^{th} to 75^{th} percentile of seller market access raises the contribution of fully air-shipped products to RCA by 99 percent, of products suited to container shipment

elements of GDP per capita not captured in the other controls may identify countries that are high income due to exports of petroleum or other fuels. The sign pattern observed here is consistent with that interpretation.

[33]These specifications are similar to those in Hillberry et al. (2025), except that a) those specifications estimate weight-to-value ratios separately from air and container shares, and b) those specifications include continuous measures of upstreamness rather than a 0-1 indicator of final products.

by 160.5 percent, and of final products by 20.6 percent. The negative coefficient on product's weight-to-value implies that product weight is lower in central than in remote regions, conditional on mode choice and location on production-chain positions.

The estimates for imports are reported in Column 6. These (buyer) market access interactions also indicate that products suited to air shipment are disproportionately represented in the trade of geographically central regions. The signs on the other interactions with market access produce opposite signs for import composition than are seen in the estimates for export composition, suggesting net trade in the product characteristics between remote and central regions. Geographically central regions import relatively fewer products suited to containerized transport than their more remote peers, though these estimates are only significant at the 10 percent level. The estimated positive sign on the interaction of buyer market access with the weight-to-value ratio and the negative coefficient on the interaction of buyer market access with the final dummy are both highly significant. The effects of market access on imports are quite large. Moving from the 25^{th} to 75^{th} percentile of buyer market access raises the contribution of products suited to air shipment by 109 percent. The same change in market access reduces the contribution of final products by 28.5 percent. These estimates offer further evidence supporting the geographic arrangement of supply chains in the manner predicted by Antràs and de Gortari (2020). The importing of relatively heavier products and exporting of lighter products by geographically central regions may also suggest that value is being added within production chains, with production stages organized to move goods from remote to more central regions as sequential production stages add more value than weight.

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 suitable for container shipment, to be physically light, and to be final products. These results are all intuitive, and the magnitudes are quite large. Conditional on the other country characteristics, the estimates imply that WTO members' exports of products suited to air transport are 419.7 percent higher than non-members' exports, containerizable products 429.1 percent higher, and final products 180.1 percent higher. The weight-to-value ratio of exports is 24.9 percent lower among WTO members than among non-members.

On the import side, we also find products suited to air transport to be much more common among WTO members; such products are approximately 161.2 percent more important in WTO members' imports than non-members'. Infrastructure investments and/or other aspects of trade policy (such as high-performing customs agencies) may support more trade in time-sensitive products among WTO members. WTO members' imports are less often final products than those of non-WTO members, with final products 24.3 percent less important in non-members imports. The opposing signs on the coefficient on the interaction between the final stage dummy and WTO membership in the export and import regressions, respectively, suggest net trade between members and non-members, with non-members selling upstream products to WTO members in exchange for final products.

5.2 Trade composition in landlocked countries and small islands

The Table 6 results are quite useful for motivating our research question. As in Hillberry et al. (2025), these results show that interactions of geographic market access variables with product characteristics related to transportation and supply chain position are quite important for understanding export composition. The estimated effects indicate high levels of statistical and economic significance for all interactions including sellers' market access terms. In results that are new to this paper, Table 6 also shows that interactions of the same product characteristics with buyers' market access are important for understanding *import* composition. Landlocked and/or small island status may intensify or change the effects of geography on trade. It is thus useful to investigate the additional effects of landlocked and small island status, conditional on other country controls like the market access variables.

Although the results in both tables are taken from the same specifications, we report them separately. We report results for landlocked countries' in Table 7 and small islands in Table 8. Results in columns 1-4 of both tables are from estimating (2), while columns 5-6 include the triple interactions described in (3). In columns 1 (for exports) and 3 (for imports) we report results for a specification of (2) that includes only transport characteristics in the interactions. In columns 2 and 4 we also include interactions with an indicator that the product is a final good.

Consider first the results for landlocked countries in Table 7. Columns 1-4 show that the sign pattern on interactions involving 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 are biased against products suited to air transport, in favor of products suited to container shipping, and in favor of lower weight-to-value products. On the import side, the coefficients on interactions involving the transportation characteristics all have the same sign, and are statistically significant.[34] The relative importance of containerizable products in landlocked country imports suggests container shipping may be relatively less-affected by landlocked status, although the heterogeneity analysis we do later in the paper shows that these effects are not common across landlocked countries, but vary strongly with countries' per capita income, market access and WTO-member status.

Coefficients on the weight-to-value ratio are negative and statistically significant for both exports and imports. Since product weight is a characteristic we take from U.S. import data (and is thus fixed across countries) these results show that the mix of products traded by landlocked countries is substantially different than in reference countries, with a strong bias towards trade in products with lower weight-to-value ratios. While perhaps unsurprising, the fact that both exports and imports 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 most likely explanation would be that the set of products that landlocked countries can easily trade is limited by absence of direct access to the sea, and trade in products with high weight-to-value ratios are disproportionately burdened by lack of sea access.

[34] Landlocked countries' imports of products that are fully containerized in U.S. imports are 56.2 percent higher than their never containerized counterparts. Imports of products that travel exclusively by air in U.S. import data are 39 percent less common than imports that travel by exclusively by sea.

Inclusion of the final-stage product dummy does not change the sign or significance of the transport-related product characteristic variables, except that the interaction with air share in exports becomes statistically significant and that the same interaction in imports becomes less significant (now at the 10 percent level). We find no statistically significant effect of the final stage indicator on the composition of landlocked countries' trade.

Turning to the results for small islands in Table 8, we find that their export bundles are substantially biased towards sea-shipped products. In column 1, the coefficient on the interaction of the air share with island status (-1.546) indicates that products suited to sea shipment are approximately 4.7 times as important in small islands' exports as in the exports of reference countries. This large effect remains when the final-stage product dummy is added to the specification, but becomes statistically insignificant in that case.

On the import side, the coefficients on products' air share and container share in columns 3 and 4 are large, negative and statistically significant. These results show that islands' purchase a disproportionate amount of products suited to sea shipment, but not suited to travel in container vessels. Most of the trade that fits this pattern consists of primary commodities that travel in bulk vessels and tankers, and suggests that small islands may have comparative advantage in processing primary products that travel in such vessels. In order to understand the result we investigate further, and find that a disproportionate share of small islands' imports are fuels. Pooling all fuel and related products with HS-4 digit codes equal to 2709, 2710 or 2711, our data show that the share of fuel in small islands' imports is 0.189. In contrast, the share of fuel in global imports is just 0.104. One explanation for the disproportionate share of fuels in small islands' imports would be that they are relatively good locations for refineries.[35]

The weight-to-value coefficient in small islands' imports is negative and statistically significant in column 3, indicating a further bias in favor of physically lighter products. This coefficient grows in magnitude (but weakens in statistical significance) when the final product dummy is added in column 4. The coefficient on the final product dummy is not statistically significant. Taken together, the estimates for small island imports suggest that these countries/territories have import bundles that are quite different than those of reference countries, with biases towards products that are shipped in non-containerized sea vessels, but also towards physically light products.

5.3 Heterogeneity within each region type

In order to consider heterogeneity within each region type we interact the landlocked and small island dummies, respectively, with interactions between the product characteristics that we consider and the other country characteristics. Of particular importance are the interactions with the market access variables, for these describe how geographic position can exacerbate or mitigate the effects of landlocked or small island status on trade composition.

The results associated with triple interactions involving the landlocked dummy appear in columns 5 and 6 of Table 7. 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 less oriented towards containerizable products and less

[35] We thank Anna Maria Pinna for suggesting the possibility that refineries may be conditionally more likely to locate on islands.

towards final goods. Low-population landlocked countries are more heavily specialized in containerizable and final products. On the import side, high-income landlocked countries have relatively smaller imports of containerizable products. Higher-population landlocked countries also import more products suited to air shipment. The sign on the same interaction is positive for exports (though not statistically significant). These effects might arise because larger countries are able to invest more heavily in infrastructure that supports air freight.[36]

Turning to interactions of the landlocked dummy with the market access variable, we find that the trade composition of landlocked countries is much more responsive to market access than is trade in the reference countries. The large, positive and statistically significant coefficient (4.458) on the interaction of landlocked status, container share and market access implies that a given improvement in market access generates an 86 times larger shift of the export bundle towards easily containerized products in the export bundles of landlocked countries than in the bundles of reference countries. The same interaction has a large positive and significant coefficient for imports as well. Our inference is that geographically remote landlocked countries are at an even more severe disadvantage than remote countries with access to the sea when it comes to trading products that are easily containerized.

On the export side, the coefficients imply a similarly large effect on the contribution of final products to the export bundle. Consistent with the intuition of Antràs and de Gortari (2020), Table 6 results reveal a positive relationship between market access and the importance of final goods in a country's export bundle. This effect is much stronger among

[36]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.

landlocked countries than in reference countries. The coefficient of 4.528 on the relevant triple interaction in Table 7 implies that a given improvement in market access is associated with a 93 times larger increase in the importance of final products in landlocked countries' export RCA than in reference countries'.

Turning to interactions with WTO status, we find that landlocked status reduces the effect of WTO member status on exports of products suited to air transport or container shipping, and to final products. Table 6 results show that these three characteristics are strongly associated with WTO member status among countries' exports generally. The results in Table 7 indicate that these relationships are much weaker among landlocked countries. On the import side, landlocked countries that are WTO members are more likely to import products suited to container shipping and final-stage products than their non-member (or not landlocked) counterparts. The latter finding may arise because landlocked non-WTO members are relatively less likely to participate in global supply chains (as evidenced by relatively fewer upstream products in the import bundle).

Perhaps most interesting of the triple interaction results for landlocked countries is the lack of statistical significance for all coefficients related to interactions involving products' weight-to-value ratio. Columns 1-4 revealed a robust negative relationship between products' weight-to-value ratios and their relative importance in landlocked countries' trade; this is true of both exports and imports. The lack of statistically significant evidence of cross-country heterogeneity with respect to products' weight-to-value ratio in columns 5 and 6 suggests a lesson that can be taken to be common in landlocked countries' trade: Landlocked countries do less trade in products with high weight-to-value ratios. Paired with evidence from the literature that landlocked countries do less trade and trade fewer products than their peers, this result offers fairly persuasive evidence that landlocked countries' reduced trade flows are associated with limited transport options that restrict trade possibilities in physically heavy products.

Columns 5 and 6 of Table 8 report results from triple interactions involving the small island dummy. There are few statistically significant interactions on the export side. The only coefficients that are statistically significant at the 5 percent level are the interactions between products' container share and small islands' population, and the interaction of small islands' WTO status with the final-stage product dummy. The positive coefficient on the former interaction may arise because larger population islands are likely better integrated into the container shipping network, an interpretation that is strengthened by a large and statistically significant coefficient on the same interaction on the import side. The negative coefficient on the latter interaction indicates that small islands that are WTO members also appear to be conditionally more likely to export upstream products (this is the same sign pattern we observe among the landlocked countries).

We see substantial variation within the small island group with respect to the composition of imports. Variation in per capita income is not particularly important, but there is some evidence that higher income islands are more likely to import physically heavy products. The coefficient on the export side has the same sign, suggesting that higher incomes facilitate small islands' trade in heavy products. Small islands' population is quite important for the composition of the import bundle, with large population islands' imports containing substantially more products suited to transport by air and by container vessel, and more products that are physically heavier. Large population islands may be better integrated into transport networks and/or have better infrastructure, facilitating the importing of a wider set of products than similar islands with smaller populations.

Small islands' market access also seems to be an important determinant of their import composition. The coefficients on the interactions of market access and island status with the air share of shipments, the container share, and the weight-to-value ratios are all negative, large and statistically significant. This pattern of coefficients would be consistent with better situated islands being even more responsible for islands' relatively larger imports of fuels than islands with lower market access scores. If refineries are more likely to locate on islands, more centrally located islands would seem to be better candidates, and this sign pattern would be consistent with that explanation.

All four of the interactions with WTO status are positive, large, and statistically significant. Small islands that are WTO members appear to be better integrated into global transport networks (with relatively larger shares of products suited to shipment by air or in containers, and high weight-to-value products). Final products are a larger share of WTO-member small islands' imports than they are among non-members. The general pattern would suggest greater integration into global trade networks among WTO member islands, though the coefficient on the final dummy does not directly support that intuition. The small islands we study are less likely to import upstream products generally (perhaps because they are a poor location for processing trade). The islands that are WTO members import relatively more final products, but export relatively more upstream products, indicating stronger comparative advantage in upstream production, relative to their non-member peers.

6 Conclusion

Empirical studies of the *level* of goods trade have shown that landlocked countries trade considerably less than comparison countries, while islands trade relatively more. We ask whether the composition of these country types' trade is different than the composition of reference countries. Our hypothesis is that the trade of landlocked countries and small islands are burdened by particular transport frictions, which may affect their participation in global supply chains. We ask if the composition of landlocked countries' and small islands' exports and imports depend upon cross-product variation in transport-related characteristics and an indicator of whether or not the product is consumed by final demand.

After considering other country characteristics that affect trade composition, we find that both the exports and imports of landlocked countries and the imports of small islands are biased against products with high weight-to-value ratios. Products normally shipped in containers are over-represented in landlocked countries' imports, but this is primarily true in imports by geographically central landlocked countries like those in Europe. Small islands' imports are biased against air-shipped and containerized freight, an outcome suggesting that these regions have comparative advantage in processing raw materials; refineries processing imported liquid fuels appear most likely given these particular commodities disproportionately large share in small islands' imports. Small island's exports are biased towards sea-shipped and final-stage products, but the significance of these estimates depend on the specification. The prevalence of the product characteristics we consider in the composition of imports and exports are heterogeneous within the groups of landlocked countries and small islands, respectively. Variation in trade composition within each country group is largely intuitive with respect to countries' per capita income, population, geographic location, and WTO member status. One result that appears to be common across the members of a country group is that products with low weight-to-value ratios are overrepresented in both the exports and imports of landlocked countries.

7 Data availability statement

The data used in this study are taken from publicly available sources. A full replication package is available in Jimenez and Hillberry (2026).

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Table 1: Summary Statistics - Product Transportation Characteristics

	# Obs.	Mean	Std. Dev	Min	Perc. 25	Median	Perc. 75	Max
Air share^k	5,044	0.21	0.29	0.00	0.01	0.07	0.30	1.00
Ctnr share^k	5,044	0.69	0.32	0.00	0.48	0.83	0.96	1.00
$\ln(WV^k)$	5,044	-2.04	1.73	-13.28	-2.92	-1.98	-0.97	4.11
Final^k	5,044	0.16	0.37	0.00	0.00	0.00	0.00	1.00

Note: Air share^k is the product k share that is shipped by air in U.S. import data. *Ctnr share*^{k} is the product k share shipped in container vessels. $\ln(WV^k)$ is the natural log of the weight-to-value ratio of every product k. Final^k is a dummy variable equal to 1 if the product's upstreamness score is less than 1.3 and 0 otherwise.

Table 2: Correlation - Product Transportation Characteristics

	Air share^k	*Ctnr share*^{k}	$\ln(WV^k)$	Final^k
Air share^k	1.00			
Ctnr share^k	-0.78	1.00		
$\ln(WV^k)$	-0.71	0.44	1.00	
Final^k	0.07	-0.02	-0.21	1.00

Table 3: Summary Statistics - Country Control Variables

	# Obs.	Mean	Std. Dev	Min	Perc. 25	Median	Perc. 75	Max
LL_i	205	0.19	0.39	0.00	0.00	0.00	0.00	1.00
ISL_i	205	0.21	0.41	0.00	0.00	0.00	0.00	1.00
$\ln(\text{GDP pc})_i$	205	8.65	1.44	5.75	7.55	8.69	9.77	11.57
$\ln(\text{Pop})_i$	205	15.39	2.36	9.21	14.09	15.79	17.00	21.04
$\ln(\text{SMA})_i$	205	-1.63	0.44	-2.77	-1.95	-1.73	-1.41	0.29
$\ln(\text{BMA})_j$	205	-1.73	0.44	-2.68	-2.05	-1.85	-1.46	0.05
WTO_i	205	0.84	0.37	0.00	1.00	1.00	1.00	1.00

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

Table 4: Country Controls for Small Island and Landlocked Countries

Panel A. Small Islands								
	# Obs.	Mean	Std. Dev	Min	Perc. 25	Median	Perc. 75	Max
$\ln(\text{GDP pc})_i$	43	9.03	1.08	6.03	8.29	9.16	9.79	10.87
$\ln(\text{Pop})_i$	43	12.28	1.89	9.21	11.20	12.17	13.28	17.00
$\ln(\text{SMA})_i$	43	-1.98	0.26	-2.77	-2.16	-1.98	-1.86	-1.40
$\ln(\text{BMA})_j$	43	-2.11	0.21	-2.68	-2.24	-2.11	-2.03	-1.57
WTO_i	43	0.79	0.41	0.00	1.00	1.00	1.00	1.00

Panel B: Landlocked Countries								
	# Obs.	Mean	Std. Dev	Min	Perc. 25	Median	Perc. 75	Max
$\ln(\text{GDP pc})_i$	38	7.83	1.51	5.75	6.63	7.71	8.65	11.57
$\ln(\text{Pop})_i$	38	15.94	1.08	13.25	15.51	16.09	16.68	18.42
$\ln(\text{SMA})_i$	38	-1.66	0.34	-2.07	-1.94	-1.69	-1.52	-0.85
$\ln(\text{BMA})_j$	38	-1.72	0.36	-2.16	-2.03	-1.75	-1.51	-0.83
WTO_i	38	0.82	0.39	0.00	1.00	1.00	1.00	1.00

Table 5: 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	-0.68	-0.23	1.00			
ln(SMA)$_i$	-0.03	-0.41	0.46	0.50	1.00		
ln(BMA)$_j$	0.01	-0.45	0.44	0.54	0.94	1.00	
WTO_i	-0.03	-0.07	0.15	0.17	0.10	0.10	1.00

Table 6: Composition of Export Supply and Import Demand

		X_i^k			M_i^k	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
ln(GDPpc)$_i\times$ Air share^k	0.00834		-0.401**	-0.0703		-0.324**
	(0.128)		(0.202)	(0.107)		(0.134)
ln(GDPpc)$_i\times$ *Ctnr share*^{k}	-0.0417		-0.648***	-0.0297		0.0395
	(0.0778)		(0.115)	(0.0559)		(0.0747)
ln(GDPpc)$_i\times$ ln(WV^k)	-0.0650***		0.0164	-0.0486***		-0.0743***
	(0.0209)		(0.0290)	(0.0168)		(0.0204)
ln(GDPpc)$_i\times$ Final^k	-0.114***		-0.235***	0.213***		0.324***
	(0.0437)		(0.0685)	(0.0310)		(0.0424)
ln(Pop)$_i\times$ Air share^k	0.245***		-0.0754	0.107		-0.147*
	(0.0824)		(0.120)	(0.0720)		(0.0887)
ln(Pop)$_i\times$ *Ctnr share*^{k}	0.254***		-0.175*	-0.0323		0.0386
	(0.0495)		(0.0949)	(0.0425)		(0.0541)
ln(Pop)$_i\times$ ln(WV^k)	-0.0118		0.0457***	0.0163		-0.00928
	(0.0108)		(0.0151)	(0.0110)		(0.0118)
ln(Pop)$_i\times$ Final^k	0.104***		0.00668	-0.0142		0.0859***
	(0.0362)		(0.0397)	(0.0263)		(0.0284)
ln(MA)$_i\times$ Air share^k		0.852***	1.297***		0.727***	1.248***
		(0.279)	(0.471)		(0.189)	(0.294)
ln(MA)$_i\times$ *Ctnr share*^{k}		1.018***	1.804***		-0.243*	-0.338*
		(0.178)	(0.346)		(0.131)	(0.190)
ln(MA)$_i\times$ ln(WV^k)		-0.142***	-0.257***		0.0658**	0.124***
		(0.0413)	(0.0654)		(0.0329)	(0.0450)
ln(MA)$_i\times$ Final^k		0.273**	0.353**		-0.165**	-0.567***
		(0.116)	(0.157)		(0.0726)	(0.110)
WTO$_i\times$ Air share^k		1.277*	1.648**		0.603	0.960**
		(0.689)	(0.650)		(0.421)	(0.432)
WTO$_i\times$ *Ctnr share*^{k}		1.050**	1.666***		0.0347	-0.00303
		(0.431)	(0.422)		(0.202)	(0.199)
WTO$_i\times$ ln(WV^k)		-0.285***	-0.287***		-0.0251	0.0641
		(0.0888)	(0.0783)		(0.0524)	(0.0548)
WTO$_i\times$ Final^k		0.764**	1.030***		0.0995	-0.278**
		(0.321)	(0.318)		(0.117)	(0.114)
Constant	14.60***	19.30***	28.44***	19.24***	19.60***	17.58***
	(1.022)	(0.353)	(2.332)	(0.605)	(0.189)	(1.090)
Observations	1,034,020	1,034,020	1,034,020	1,034,020	1,034,020	1,034,020
Pseudo R2	0.775	0.782	0.786	0.869	0.867	0.872

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 share of product k's U.S. imports that arrived in container vessels. (WV^k) is Weight/Value of product k in U.S. imports. ln(GDPpc)$_i$ is the natural log of country i's GDP per capita. ln(Pop)$_i$ is the natural log of country i's population. $(MA)_i$ is the Market Access measure of country i. All models are estimated with country- and product-fixed effects using the PPML estimator over a database of export and import flows, respectively, for 2017 at the country-product level.

Table 7: 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)
$LL_i\times$ Air share^k	-0.585	-0.716**	-0.494**	-0.368*	-10.41	-9.000
	(0.357)	(0.349)	(0.237)	(0.219)	(13.27)	(5.759)
$LL_i \times Ctnr\ share^k$	0.216	0.170	0.446***	0.479***	24.00**	4.792
	(0.272)	(0.285)	(0.124)	(0.126)	(10.61)	(3.283)
$LL_i \times \ln(WV^k)$	-0.159***	-0.175***	-0.0973***	-0.0796**	1.391	0.155
	(0.0477)	(0.0480)	(0.0318)	(0.0329)	(2.100)	(0.801)
$LL_i\times$ Final^k		-0.123		0.128	28.46***	0.749
		(0.155)		(0.0927)	(6.140)	(2.324)
ln(GDPpc)$_i\times$ $LL_i\times$ Air share^k					0.680	0.0512
					(0.558)	(0.259)
ln(GDPpc)$_i \times LL_i \times Ctnr\ share^k$					-0.723*	-0.297**
					(0.381)	(0.136)
ln(GDPpc)$_i \times LL_i \times \ln(WV^k)$					-0.101	-0.0382
					(0.0890)	(0.0379)
ln(GDPpc)$_i \times LL_i\times$ Final^k					-0.948***	-0.134
					(0.266)	(0.0995)
ln(Pop)$_i \times LL_i\times$ Air share^k					0.654	0.544***
					(0.410)	(0.211)
ln(Pop)$_i \times LL_i \times Ctnr\ share^k$					-0.608*	-0.0321
					(0.358)	(0.119)
ln(Pop)$_i \times LL_i \times \ln(WV^k)$					0.0262	0.0130
					(0.0697)	(0.0299)
ln(Pop)$_i \times LL_i\times$ Final^k					-0.778***	-0.00122
					(0.184)	(0.0842)
ln(MA)$_i \times LL_i\times$ Air share^k					3.190	0.250
					(2.233)	(0.849)
ln(MA)$_i \times LL_i \times Ctnr\ share^k$					4.458***	1.169***
					(1.459)	(0.447)
ln(MA)$_i \times LL_i \times \ln(WV^k)$					0.648	0.0622
					(0.452)	(0.156)
ln(MA)$_i \times LL_i\times$ Final^k					4.528***	-0.144
					(0.948)	(0.247)
WTO$_i \times LL_i\times$ Air share^k					-4.544***	-0.365
					(1.185)	(0.434)
WTO$_i \times LL_i \times Ctnr\ share^k$					-2.017***	0.527**
					(0.757)	(0.267)
WTO$_i \times LL_i \times \ln(WV^k)$					-0.280	0.00252
					(0.174)	(0.0625)
WTO$_i \times LL_i\times$ Final^k					-1.825***	0.612***
					(0.512)	(0.146)
Constant	27.28***	27.73***	18.73***	17.45***	27.72***	17.72***
	(2.493)	(2.594)	(1.217)	(1.168)	(2.681)	(1.194)
Observations	1,034,020	1,034,020	1,034,020	1,034,020	1,034,020	1,034,020
Pseudo R2	0.785	0.787	0.871	0.873	0.788	0.873

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 share of product k's U.S. imports that arrived in container vessels. (WV^k) is Weight/Value of product k. ln(GDPpc)$_i$ is the natural log of country i's GDP per capita. ln(Pop)$_i$ is the natural log of country i's 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 0 otherwise. All models are estimated with country- and HS6 product- fixed effects using the PPML estimator over a database of export and import flows, respectively, for 2017 at the country-product level. All variables from Table 6 are also included, as well as the same double and triple interaction terms shown above but for small islands.

Table 8: 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)
$ISL_i\times$ Air share^k	-1.546**	-1.193	-2.700***	-2.827***	-22.39	-56.33***
	(0.740)	(0.730)	(0.638)	(0.805)	(16.91)	(18.42)
$ISL_i \times Ctnr\ share^k$	0.122	0.218	-1.151***	-1.187***	-12.35	-18.90***
	(0.359)	(0.363)	(0.254)	(0.297)	(7.977)	(7.196)
$ISL_i \times \ln(WV^k)$	-0.120	-0.0689	-0.161**	-0.179*	-3.757*	-6.769***
	(0.103)	(0.101)	(0.0811)	(0.104)	(1.994)	(2.046)
$ISL_i\times$ Final^k		0.350*		-0.122	-1.325	1.901
		(0.203)		(0.280)	(4.796)	(7.908)
ln(GDPpc)$_i \times ISL_i\times$ Air share^k					0.902	1.498*
					(0.941)	(0.821)
ln(GDPpc)$_i \times ISL_i \times Ctnr\ share^k$					0.254	0.264
					(0.356)	(0.310)
ln(GDPpc)$_i \times ISL_i \times \ln(WV^k)$					0.197*	0.208**
					(0.117)	(0.0920)
ln(GDPpc)$_i \times ISL_i\times$ Final^k					0.0239	-0.307
					(0.265)	(0.346)
ln(Pop)$_i \times ISL_i\times$ Air share^k					1.045	1.558***
					(0.714)	(0.505)
ln(Pop)$_i \times ISL_i \times Ctnr\ share^k$					0.566**	0.534***
					(0.272)	(0.194)
ln(Pop)$_i \times ISL_i \times \ln(WV^k)$					0.136	0.177***
					(0.0826)	(0.0576)
ln(Pop)$_i \times ISL_i\times$ Final^k					0.231	-0.106
					(0.152)	(0.201)
ln(MA)$_i \times ISL_i\times$ Air share^k					1.113	-6.818**
					(2.330)	(2.713)
ln(MA)$_i \times ISL_i \times Ctnr\ share^k$					-2.260*	-2.873***
					(1.352)	(1.081)
ln(MA)$_i \times ISL_i \times \ln(WV^k)$					0.171	-0.876***
					(0.282)	(0.332)
ln(MA)$_i \times ISL_i\times$ Final^k					-0.0509	-0.0954
					(0.814)	(1.061)
WTO$_i \times ISL_i\times$ Air share^k					-0.376	6.018***
					(3.447)	(2.274)
WTO$_i \times ISL_i \times Ctnr\ share^k$					-1.792*	2.814***
					(0.973)	(0.869)
WTO$_i \times ISL_i \times \ln(WV^k)$					0.199	0.667***
					(0.347)	(0.246)
WTO$_i \times ISL_i\times$ Final^k					-2.056***	2.402**
					(0.714)	(0.964)
Constant	27.28***	27.73***	18.73***	17.45***	27.72***	17.72***
	(2.493)	(2.594)	(1.217)	(1.168)	(2.681)	(1.194)
Observations	1,034,020	1,034,020	1,034,020	1,034,020	1,034,020	1,034,020
Pseudo R2	0.785	0.787	0.871	0.873	0.788	0.873

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Models (1),(2) and (5) have as the LHS variable the exports X_i^k of country i and HS6 digit product k. Models (3), (4) and (6) have as the LHS variable the imports M_i^k of country i and HS6 digit product k. $Ctnr\ share^k$ is the share of product k's U.S. imports that arrived in container vessels. (WV^k) is Weight/Value of product k. ln(GDPpc)$_i$ is the natural log of country i's GDP per capita. ln(Pop)$_i$ is the natural log of country i's 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 with GDP less than New Zealand's GDP and 0 otherwise. All models are estimated with country- and product-fixed effects using the PPML estimator over a database of export and import flows, respectively, for 2017 at the country-product level. All variables from Table 6 are also included, as well as the same double and triple interaction terms shown above but for landlocked countries.

Online Appendixes

A Islands in the CEPII database with updated WTO membership

Table A1: Islands with updated WTO membership and related WTO member country

Updated WTO membership	Related WTO country
ABW	NLD
BES	NLD
COK	NZL
CUW	NLD
GRL	DNK
MSR	GBR
NCL	FRA
PYF	FRA
SHN	GBR
SXM	NLD

Note: All codes correspond to the ISO country codes. The left column lists islands that are not independent from a WTO member and are classified in the CEPII database as a non-WTO member. The right column reports the WTO member to which each island is related. We recoded islands in the left hand side column as WTO members.