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ISLANDS AS 'BAD GEOGRAPHY'. INSULARITY, CONNECTEDNESS, TRADE COSTS AND TRADE

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ISLANDS AS 'BAD GEOGRAPHY'.

INSULARITY, CONNECTEDNESS, TRADE COSTS AND TRADE

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Abstract

In this paper we explore the geographical dimension of insularity, measuring its effect on a comprehensive measure of trade costs (Novy 2012). Controlling for other geographical characteristics, connectedness (spatial proximity) and the role of historical events in shaping modern attitudes towards openness (measured through a quantification of routes descriptions in logbooks between 1750 and 1850), we give evidence that to be an island is not bad per se in terms of trade costs. Bad geography can be reversed by connectedness and open institutions.

Keywords: Islands, Geography, Connectedness, Trade, Gravity model.

JEL Classification: F10, F14.

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“*No man is an iland,*
intire of it selfe;
every man is a peece of the Continent,
a part of the maine; . . . .”
John Donne

1 Introduction

In this paper we take to the data the starting words of the 1624 *Meditation XVII* ode to humankind connectedness by the English poet John Donne. We focus on countries instead of individuals, and we study how much adverse geographical conditions, such as being an island, affect - literally - country's isolation. Our objective is to evaluate the geographical condition of insularity - measured through a novel index - distinguishing it from other geographical conditions, such as e.g. limited country's size in terms of territorial extension, that are as common for islands, and, especially, to explore the role of connectedness in influencing islands' trade costs. In a potentially increasingly integrated world, absolute and relative connectedness costs, the latter ones determined by the contextual position of the country in the network of international economic flows, or in terms of our incipit, by the easiness of being or not “. . . *a peece of the Continent, a part of the main* . . . ,” matter, in general, as an important determinant of the pattern of bilateral trade and investment Anderson and van Wincoop (2004). Their amounts shape the geographical distribution of production, income per capita and economic growth (Helpman, 2009). But space is not the only dimension of connectedness that matters.

Trade costs are influenced by the use of space that people master along history. The same use of space that shaped ancient and modern institutions and that encouraged the building of infrastructures, promotes, in general terms, a culture of openness that foster connections and modify the original structure of geographical linkages. Along the lines of Nunn (2009), we give account of this culture of openness through the quantification of informations contained in logbook records of vessels traveling between European ports and the rest of the world, between 1750 and 1850. The documentary sources, mostly kept in a number of European archives in Spain, Britain, Holland and France, allow to trace major navigation routes, the frequency of the different journeys, and, most of all, the anchorage and the in harbor stops of vessels in a selected number of islands. The strategic geographical position of some islands along sea lanes, with respect to other possible alternatives of harboring and obtaining sweet water and provisions, enhanced the probability of emergence of the culture of openness.

Our research hypothesis can be split in three subsequent parts: (1) trade costs are higher for islands, compared with countries of similar geographical characteristics; (2) connectedness reduces the cost of being an island, both within a country (country's partial insularity is less costly than full insularity, in terms of trade costs with other countries) and between countries (accounting for spacial proximity using different adjacency matrices measuring different levels of geographical distance); (3) the development of a culture of openness, that we call institutional connectedness, due to repeated historical interactions with merchants from mainland reduces even more the cost of being an island.

The estimation of the effect of these three dimension of insularity ('bad geography', spatial connectedness, and institutional connectedness) requires some preliminary data work and the planning of an empirical strategy that minimizes the limits due to time-invariant geographical data, in terms of controlling for omitted variables and unobserved heterogeneity. We built a comprehensive measure of bilateral trade cost, based on theory-founded gravity model of international and domestic trade, as in Chen and Novy (2011) and Novy (2013), in the first place. Subsequently, after some descriptive analysis, we structure a Hausman-Taylor empirical model, including both random and fixed effects to control for country-pair unobservables and country specific geographical characteristics. Finally, we include both dimension of connectedness, the spatial and the institutional one, in the analysis.

In the full structure of the paper, a short review of three streams of literature that are instrumental to the analysis is anticipating the bulk of the data description and the empirical setting, giving account of the role of geography in macro and international trade theory and empirics, of the specificity of islands as 'bad geography' entities, and on the recent literature that explore the role of historical events in shaping modern conditions in the economy of countries. Results come afterwards, following the tripartite structure previously mentioned. A final session on possible further explorations concludes the paper.

2 Building blocks: geography, islands and historical events

2.1 Geography and economic outcomes

The role of geography in economic development has recently filled the research agenda of development economists examining cross-country correlates of GDP per capita (Gallup *et al.*, 1999), since very recently (Spolaore and Wacziarg, 2013). While there is little doubt that geographic factors are highly correlated with economic development, there is however little consensus on how this correlation should be interpreted. Geography as a key determinant of climate and temperature, natural resources, disease, ease of transport, and diffusion of technology, can *directly* affect productivity, human capital accumulation and the use of other factors resources.[1] Hibbs and Olsson (2004), in search of an empirical validation of Diamond (1999),[2] control for biogeographic endowments (i.e. initial biological conditions: the number of animals and plants suitable to domestication and cultivation at each location 12,000 years ago) in a cross-country regression of contemporary levels of development on geographic variables. They find supporting evidence of Diamond's hypotheses, with geography being empirically more relevant than biology.

On the other hand, several authors claim that the influence of geography on economic development is merely *indirect*, through institutions and trade. The very influential evidence put forward by Acemoglu *et al.* (2001, 2002), showing that after controlling for the effects of institutions, geography did not matter for economic performance in their cross-sectional sample of countries, convincingly stress the primacy of institution over geography in causally determining the actual level of the wealth of nations. According to this view, geography plays an important secondary role, which in the specific

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[1] Spolaore and Wacziarg (2013), in their beautiful survey on the 'Deep determinants' of economic growth, show how " . . . a small set of geographic variables (absolute latitude, the percentage of a country's land area located in tropical climates, a landlocked country dummy, an island country dummy) can jointly account for 44% of contemporary variation in log per capita income, with quantitatively the largest effect coming from absolute latitude (excluding latitude causes the R^2 to fall to 0.29). This result [documents] the strong correlation between geography and income per capita."

[2] Diamond (1999) traces the contemporary level of economic development of countries to biological and geographical characteristics of territories that their inhabitants were able to exploit during the Neolithic transition. See also Ashraf and Galor (2013) for a recent discussion of the issue.

case of Acemoglu *et al.* (2001) determines the burden of deceases on settlers, which in turn shaped the type of institutional experience of colonies, and, through this channel, influenced the type of modern institutions and the present fortunes of economies. The indirect role of geography has further been clarified by Rodrik *et al.* (2004), focusing on trade. Geography in fact is an important determinant of the extent to which a country can become integrated in world markets, regardless country's own trade policies. A distant, remote, landlocked, isolated country faces greater costs of trade and therefore of integration.

The literature exploring the interplay between geography, institutions and trade is closer to the focus of our analysis, which is on islands. In this respect, the first geographical aspects that have to be considered are those ones related with higher distance from major international economic centers and corresponding higher transport costs.[3] The recent literature on the gravity equation (Eaton and Kortum, 2002, Anderson and van Wincoop, 2003) has theoretically shown that the position of a country with respect to his partner has to be considered relatively to its position with respect to all its feasible alternatives (see also Chaney (2008) and Helpman *et al.* (2008) on the issue of selection on foreign markets), i.e. its multilateral resistance (MR) terms. In an intuitive way, the structural gravity model (Anderson and Yotov, 2010) includes geography in its monadic dimension - introducing controls for landlocked countries and islands - and in its dyadic dimension - introducing controls for border sharing - as components of MR. When those terms are estimated using export and import countries fixed effects the empirical strategy does not allow to separate geography from all other factors which contribute to MR.

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[3] On the relation between geographic bilateral distance and trade costs, it is possible to propose two non mutually exclusive interpretations. Once distance is controlled for (i.e. in gravity equations), the incidence of geography on trade costs (and therefore trade volumes) is either saying something more about distance (e.g. its non linear effect across different geographical conditions, such as being a coastal country or a landlocked one, or an island) or saying that distance is not capturing all about the economic cost of geography. In a recent report, the World Bank (2010) emphasized that landlocked economies are affected more by the high degree of unpredictability in transportation than by the high cost of freight services. In other words, the role of geography *is primarily a question of the surrounding context.* The need to transit from another country's territory can become a condition of 'bad geography' because both exogenous and endogenous factors are likely to raise the total costs of logistics more than the isolated role of transport costs. In fact, some factors are out of a landlocked country's control.

In this paper we take a different direction from the one of structural gravity models, aiming to isolate the effect on trade costs of extreme geographical conditions, such as the one of islands, from the one of spatial and institutional connectedness. The issue is of relevance since, despite the importance of trade costs as drivers of the geographical pattern of economic activity around the globe, most contributions to their understanding remain piecemeal (Arvis *et al.*, 2013).

2.2 Islands as ‘Bad Geography’

The role of geographical restrictions as determinants of economic integration and income have received an increasing attention in the literature. Milner and Zgovu (2003) and Hoekman and Nicita (2008) find them the primary reason that developing countries are unable to benefit from trade preferences. Moreover, as Hummels (2007) pointed out, “ . . . as tariffs become a less important barrier to trade, the contribution of transportation to total trade costs . . . is rising.” The same evidence is confirmed in Bertho *et al.* (2014), that state: “maritime transport costs (MTCs) today matter more than tariffs. Ad valorem MTCs of exports to the United States are on average more than three times higher than the average US tariff, and in New Zealand are more than twice as high.” It is not a case that New Zealand is an island.

The interest on extreme geography conditions shown by policy frameworks such as the Almaty Program of Action (2003) or the EU Posei Program (2010), suggests that more evidence on how geography imposes costs to the economies of countries is needed.

Insularity is not in general considered the worst condition in terms of ’bad geography’. According to both empirical and theoretical literature, the most immediate case of extreme geographical condition is the lack of direct access to the sea. This is considered to be a fundamental cause of heterogeneity among countries. One out of four countries in the world is landlocked; in Africa, it is one out of three. On the contrary, having direct access to the sea is the geographical condition that has been found to be the most advantageous for the economy of a country: coastal countries are wealthier and experience 30% more trade than landlocked countries (see the references in Limao and Venables (2001). But the direct access to the see can generate extreme geographical conditions. Islands are completely surrounded by sea. This full land discontinuity raises costs by eliminating alternatives in the connection system of an island and by raising the level of uncertainty for the remaining alternatives. The small and remote nature of island countries (Briguglio and Kaminarides, 1993, Briguglio, 1995, Mimura *et al.*, 2007, Becker, 2012), should be considered in view of these characteristics, revealing the crucial physical difference between islands and coastal countries. But also not all islands are made the same.

In a recent work, Licio and Pinna (2012) constructing a new dataset, discuss about the dimensions which are better aimed at capturing the heterogeneity of the insular state. If the complete discontinuity of the land imposes a cost (i.e., limiting connectivity with other countries, as in the case of Madagascar), an increase in the number of islands to the level of an archipelagos (as in the case of Greece or Polinesia) can potentially raise that cost to the power. A second dimension that increases costs is distance from mainland. In fact, they find that the economic performance of island-states that are more isolated and remote is similar to that of landlocked countries. In a sense, if having direct access to the sea is a blessing, to be surrounded by too much is a curse. Furthermore, within the group of coastal countries, those whose territory is partially composed of islands perform better, in terms of income per capita or exports than countries with null or negligible degrees of insularity.[4] In this taxonomy, countries can be divided in Landlocked countries (LL), Coastal countries (C), Negligible number of island (N) and Partial islands (that we will group toughener in our subsequent analysis), and Islands (I). In a sense, this taxonomy allows to define a brand new *Index of Insularity* in which all countries are islands along a continuum that goes from Insularity=0 (LL) to Insularity=1 (I).

The boxplots in figure 1 show the non-monotonicity of the Index of Insularity with respect to GDP per capita and Exports. As far as (LL), the Index reveals the burden of being landlocked, as emphasized many times in the literature (Limao and Venables, 2001, Bosker and Garretsen, 2012). At higher levels of the Index both income and exports increase, to abruptly decreasing for Islands (I). The general impression received confirms what stated before: not all islands are equal, and intermediate levels of Insularity seem better than the extremes.

This preliminary evidence requires some confirmation and more specific analysis on what makes islands so different one from the other.

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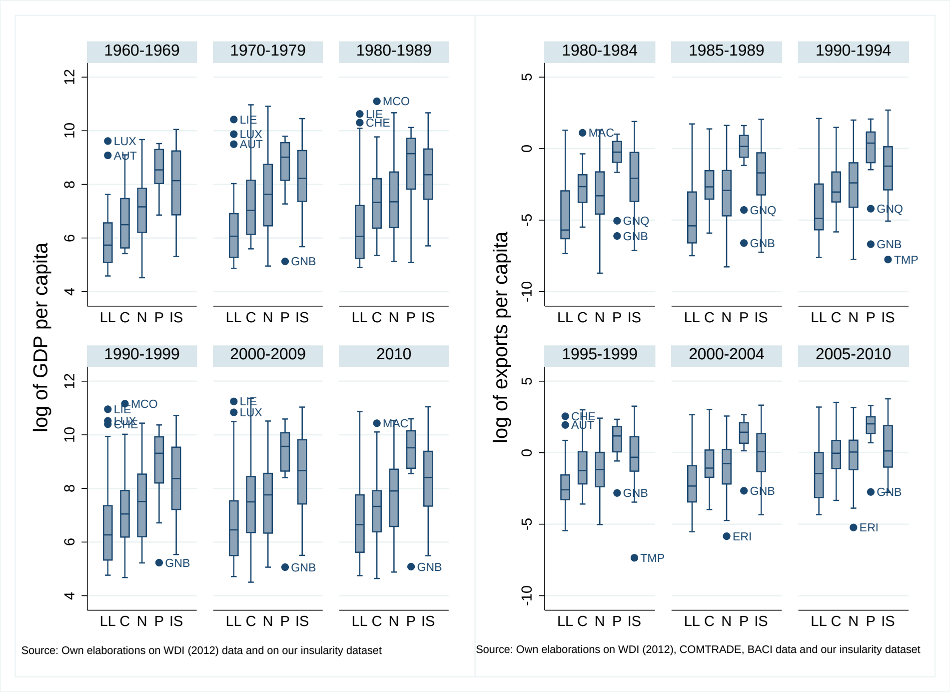
[4] This is an exiguous group of countries. Their limited number is outweighed by a larger share in terms of income in the wide group of coastal countries. Our initial results suggest that this smaller sample of economies bolsters the fortunes of coastal countries.

Figure 1:

Insularity: GDP per capita and Exports



Source: Own elaborations on WDI (2012) data and on our insularity dataset

Source: Own elaborations on WDI (2012), COMTRADE, BACI data and our insularity dataset

Note: The figure presents the distribution of income per capita and exports by categories of the Insularity taxonomy. (LL) stands for landlocked countries, (C) for coastal countries, (N) for negligible number of island and (P) for partial islands; the final category is (I) Islands. Data comes from the World Bank WDI dataset and from COMTRADE and BACI-CEPII datasets. Further description of the data and of the data sources is included in the Appendix.

2.3 The long lasting effects of historical events

Before entering the bulk of the analysis, we need to give account of a new stream of literature that is strongly related to our own analysis. As summarized by Nunn (2009), the primary goal of this literature is to examine " . . . whether historic events are important determinants of economic development today." Acemoglu *et al.* (2001, 2002) and La Porta *et al.* (1997) paved the way to the analysis of the potential importance of an historic event, colonial rule in both cases, for long-term economic development. From the earliest subsequent studies, dealing essentially with the correlation of historically related variables with present-day economic outcome, the literature has developed in two directions. The firs one goes towards the exploration of new identification strategies of causal effects of history, the second one deals with the quantification of historical episodes, the digitalization of historical archives, the collection and compilation of new datasets based on historical data. The information content of such data has rapidly moved from sparse cross-sections to very detailed longitudinal structures.

Our contribution moves along this track, quantifying the information contained in a database drawing on British, Dutch, French and Spanish ships logbook records for the period 1750 to 1850. The data extracted from the original CLIWOC climatology database (a more detailed description of the database is included in section 3) allows to describe the main navigation routes in the XVIII and XIX Century, to keep records of the islands touched by that routes, and of the frequency of the different journeys, and, most of all, the anchorage and the in harbor stops of vessels in a selected number of islands. These two latter pieces of information are a true rarity in historical records of routes, roads and traveling. The possibility of weighting routes according to frequency of journeys, including the day of stopping, is per sè a great novelty in this field of research. Having this information at an international level is unique. We fully exploit the quality of the data in quantifying the emergence of a culture of openness in an international context, due to repeated institutional connectedness.

This is however not the first contribution on the role played by historical roads or communication routes in shaping the geographical distribution of contemporary economic outcomes. Dell (2010) in her seminal work on the persistent effect of Peru's mining Mita shows that the geographical propagation of the negative effect of the forced labor system instituted by the Spanish government in Peru and Bolivia in 1573 is related to the road system, and today Mita districts still remain less integrated into road networks. Martincus *et al.* (2012) use the (distance to the) Inca road network as instrument to the present road network to address the potential endogeneity of transportation infrastructure to domestic and international trade. Similar analysis on transport infrastructure has been done by Fajgelbaum and Redding (2014) for Argentina, by Banerjee *et al.* (2012) and Faber (2014) for China, Donaldson (2014) for India, Jedwab *et al.* (2014) for Kenya and Donaldson and Hornbeck (2013) for the US. To the best of our knowledge there are no papers that take a multi-country approach to the issue.

3 Navigation routes between 1750 and 1850: the vessels logbooks database.

In the empirical analysis that follows we make extensive use of the data included in the CLIWOC database. The Climatological Database for the World's Oceans 1750-1850 has been collected between 2000 and 2003 by several institutions, universities and research institutes, Europeans and non-Europeans under the EU funded EVK2-CT-2000-00090 project. The goal of the project was to collect and digitalize meteorological information reported in British, Dutch, French and Spanish ships logbook records contained in national archives.

The version of the database we re-elaborate in order to provide a new information source on world territories interested by historical trade routes is the 2.1 released in 2007. The first trip in the database is from a Dutch ship called Maarseveen which left Rotterdam directed to Batavia, on October 15, 1662, while the last one is again for a Dutch ship, called Koerier which left Curacao directed back to the Netherlands on June 21, 1855. The total number of logbooks included in the dataset is 1,758 giving rise to 287,114 daily observations. The database provides daily information on 5227 voyages (during some of them data have been recorded different times each day). The period goes from 1662 to 1855, but the database concentrates mainly on navigations after 1750. The number of trips from 1662 to 1749 are only 13. We listed them in 9 in the Appendix showing as information on locations is reported originally in the database. The identifier for each trip and calculations of the number of days of the journey is from our elaborations. The recorded navigations are based on 1922 historical ships.[5]

Table 2 shows trips from 1750 by nationality. It makes evident how there were different periods where several European countries were simultaneously involved in navigations to the opposite part of the world. English and Dutch routes show a higher density in the data but the richness of CLIWOC information stems from the fact that Spanish and French navigations are also present and spread in the years after 1750.[6]

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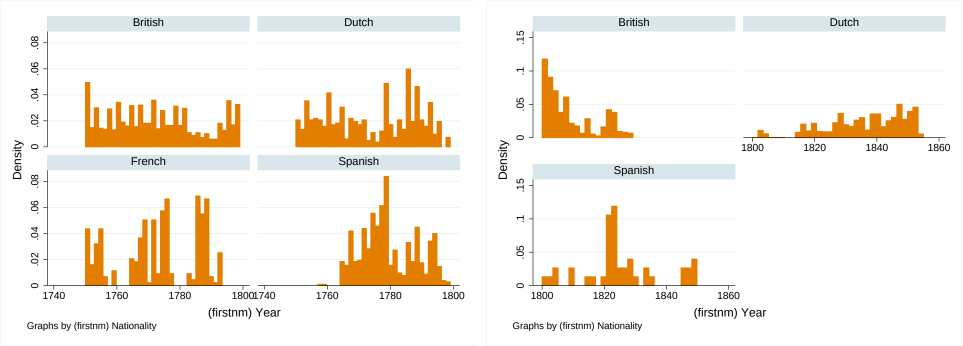
[5] The actual number of ships is 2010, some of them have the same navigation data recorded recorded in more than one archive with different logbooks numbers giving rise to duplicates in the trips' records and number of ships.

[6] The data include also a few Swedish trips and 1 trip with Danish, German and American vessels. They are not included in the graph. Also 12 French trips which concentrate on 2 years after 1800 are not shown. We include them in our further elaborations.

Figure 2:

Trips by Nationality: 1750-1852



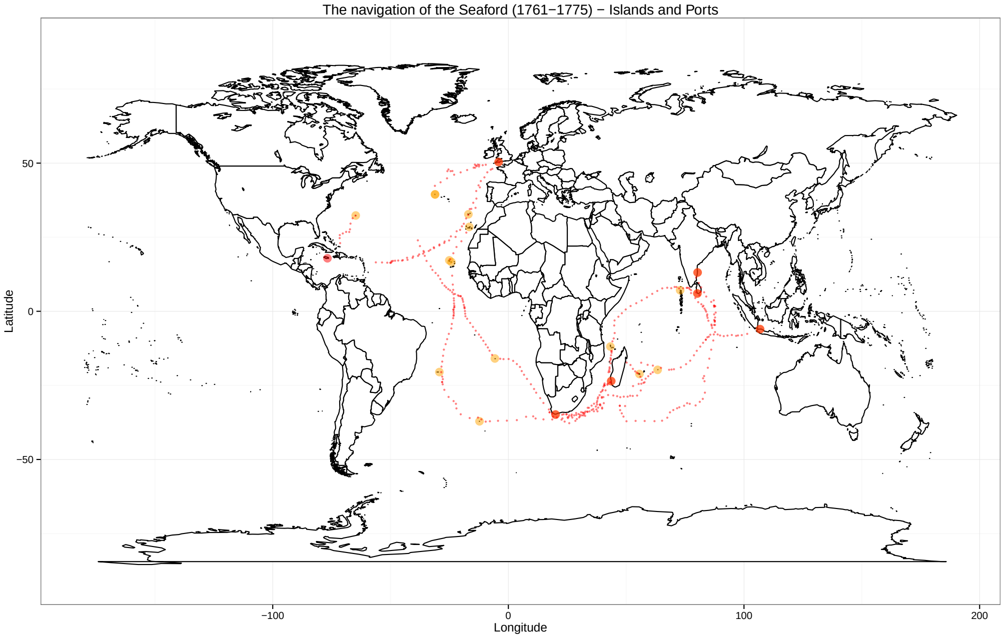
Note: The 1750-1800 period does not include 4 trips: 1 Danish, 1 German and 2 Swedish; trips after 1800 do not include 1 American trip

Logbooks included general information on the state of the vessel, the name of the captain, the port of origin and the destination of the journey; travel informations on the wind direction and wind force and vessel's speed: logbooks also registered other aspects of the weather and precipitation, the state of the sea and sky, thunder, lightning, and eventually the proximity of mainland. For our purpose, every record in the logbooks includes the location of the vessel, in terms of longitude and latitude.

In figure 3 we describe, as an example, the navigation of one single vessel included in the records of the CLIWOC database. The vessel Seaford, leaving Plymouth the firs day of February 1761 with destination Madras, in India. It anchored in Madras the 5th of July, 1761, after six month of travel. It then continued its journey until March 1775. The last record we have of the vessel corresponds to a logbook note written when leaving the Bermudas Islands. During fourteen years of traveling the Seaford touched the ports of Cape Town, St. Marys Road in Madagascar, Point Galle at Ceylon (Sri Lanka), Jakarta (Indonesia) and Jamaica; it also stopped for few hours or many days in Tenerife in the Canarias Islands, in Capo Verde, in the Island of Trindade (Brazil), in the Island of Tristian De Cunha (UK), in the Mauritius, and in the Comore Islands. In figure 3 we marked the islands touched by the Seaford with a yellow spot, and ports with a red spot, while the latitude and longitude of sailing days is depicted by the red dotted line. In the same way we are able to trace all routes travelled by all vessels in the database. As

Figure 3:

The navigation of the Seaford



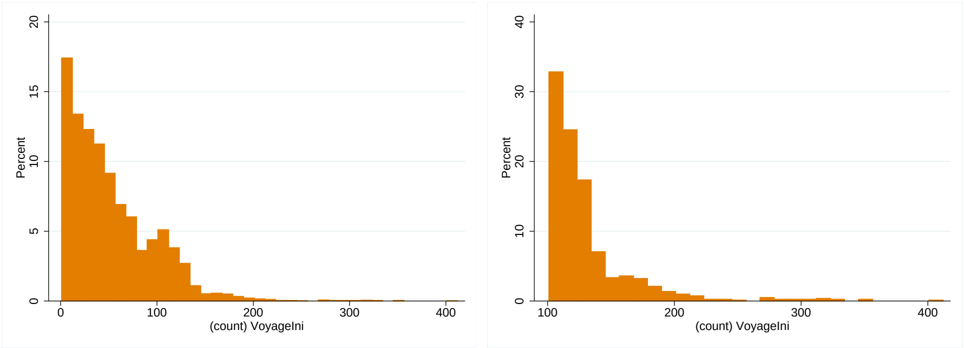
Note: The figure depicts the navigation of the vessel Seaford between 1761 and 1775. Jellow spots indicate the islands touched by the Seaford; red spots indicate ports. The latitude and longitude of sailing days is depicted by the red dotted line. Data comes from the CLIWOC database. Elaborations are our own. Further description of the data and of the data sources is included in the Appendix.

shown by the journeys of the Seaford, it is during navigations that islands could have had a special role, a possibility we will test in this paper. Islands are the first most likely territories to be encountered by ships navigating the sea.

Trips were quite long, depending on the distance which had to be covered and on special unpredictable events happening during the journey. Their length in number of days varies across our 5191 journeys from 1 to 412 days, the majority of trips are short ones but there is a long tail of long navigations (see 4) 64 of them last more than 180 days; 773 less than 180 but more than 100 days. During these journeys ships stopped for a variable time (usually not more than 1 week) in territories which have been blessed by their geography (in terms of natural harbours with respect to the currents and winds in the local sea space) for being approachable territories for those historical ships.

Figure 4:

Length of Journeys: number of days



In figure 5 we plot all available observations on the spatial position of vessels between 1750 and 1850. Major routes are immediately visible and it is also relatively simple to keep records of the islands touched by the different routes. We will take advantage of this information later on, as well as of the one on the frequency of the different journeys, and, most of all, the anchorage and the harbour stops of vessels in a selected number of islands.

4 Measuring trade costs

Its now time to focus on our dependent variable: trade costs.

To produce a comprehensive aggregate measure of bilateral trade costs[7], that takes into account all possible costs associated with international trade, we built upon some insights from the structural gravity equation literature (Anderson and van Wincoop, 2003, Anderson and Yotov, 2010, 2012, Fally, 2014).

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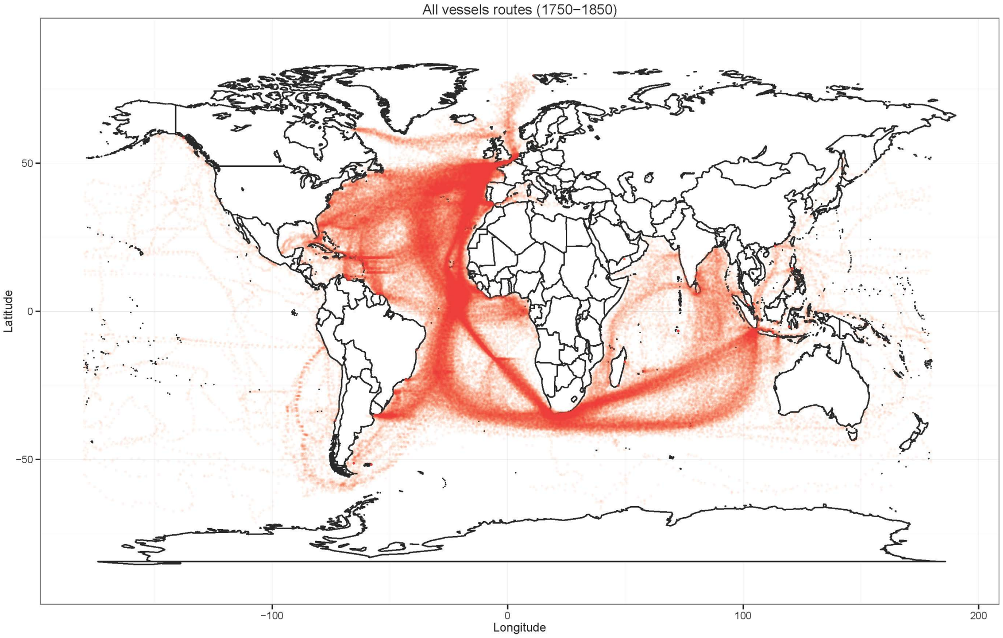
[7] The World Bank has recently produced a sectoral measure of the same class of indices used in this analysis, using the Inverse Gravity Framework methodology (Novy, 2013). The Trade Costs Dataset (ESCAP and World Bank, 2013), which is the result of this computational effort, provides estimates of bilateral trade costs in agriculture, manufactured goods and total trade for the 1995-2010 period. It includes symmetric bilateral trade costs for 178 countries, computed for each country-pair using bilateral trade and gross national output. There is not a full overlap between the Trade Costs Dataset and our own, both in the time series and in the cross-sectional dimension. We will come back to the existing differences in the two datasets later on.

Figure 5:
Trade routes: 1750-1850



Note: The figure depicts the navigation of the all vessels between 1750 and 1850. The latitude and longitude of sailing days is depicted by the red dotted line. Data comes from the CLIWOC database release 2.1. Elaborations are our own and will be described in a following section. A finer description of the data and of the data sources is included in the Appendix.

From Anderson and van Wincoop (2003) we know that the bilateral trade flow between country i and country j can be expressed[8] as:

$$X_{ij} = \frac{Y_i}{\Pi_i^{1-\sigma}} \cdot D_{ij}^{1-\sigma} \cdot \frac{E_j}{P_j^{1-\sigma}} \tag{1}$$

where Y_i is total output in country i, E_j is total expenditure in country j, D_{ij} is a measure of bilateral distance, and $\sigma > 1$ is the elasticity of substitution between varieties in a Dixit-Stiglitz utility function.[9] The terms $\Pi_i^{1-\sigma}$

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[8] Even if the obtained measure is time-variant, for the sake of simplicity, we disregard the time subscript, t, from the notation. Moreover, the index can be applied to sectoral data without any substantial change.

[9] As emphasized by Head and Mayer (2014), equation 1 can be derived from different trade models. In spite of being consistent with Armington (1969) preferences, the parameter σ would indicate the constant elasticity of substitution between varieties in

and $P_j^{1-\sigma}$ are the"inward" and "outward" multilateral resistance terms, capturing the interconnectedness among countries that is revealed through the price index in the importing market, $P_j^{1-\sigma}$, and through the price index $\Pi_i^{1-\sigma}$ capturing the degree of competition faced by the exporting country. Since Anderson and van Wincoop (2003), the multilateral resistance terms highlight the fundamental relevance of considering distance in relative terms, and not only in absolute terms, as expressed by D_{ij}.

Being σ the elasticity of substitution among product varieties, the varieties considered in the expenditure function of consumers must necessary include *both* domestic varieties and foreign varieties. Accordingly, the gravity equation (1) should consider not only foreign trade but also domestic trade, X_{ii} and X_{jj}.[10] On that we follow Jacks *et al.* (2008), Chen and Novy (2012) and Novy (2013).

Being N the total number of countries, for consistency we must have that:

$$Y_i \equiv \sum_{i \neq j}^{N-1} X_{ij} + X_{ii}; \tag{2}$$

$$E_j \equiv \sum_{i \neq j}^{N-1} X_{ij} + X_{jj}. \tag{3}$$

X_{ii} and X_{jj} are in general not observed and must be therefore estimated or - as in our case - can be calculated using equation (2) and (3).

Replacing the missing domestic trade with the calculated one, the trade matrix X_{ij} will now be a $N \times N$ matrix with domestic trade along the main diagonal, instead of the usual case of a $N \times (N-1)$ matrix, as it is commonly

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a monopolistic competition trade models á la Krugman. In Melitz (2003) and Chaney (2008) the same parameter refers to the exponent of the Pareto distribution of firms' productivity (the higher σ the less would be the productivity dispersion among firms). Finally, in Eaton and Kortum (2002) the parameter σ would indicate the exponent of the Fréchet distribution defining the countries' productivity across product varieties. See also De Benedictis and Taglioni (2011) on this point.

[10] The domestic trade component is usually disregarded in gravity models, making the model inconsistent with the data. Wei (1996) derives domestic trade in order to derive the notion of home bias from a microfounded gravity equation. According to his definition: " ...a country's home bias ...[is the] imports from itself in excess of what it would have imported from an otherwise identical foreign country (with same size, distance and remoteness measure)." See also Wolf (2000) on that.

used. When X_{ii} and X_{jj} are included in the trade matrix, Jacks *et al.* (2008) show that:

$$\tau_{ij} = \left(\frac{X_{ii}X_{jj}}{X_{ij}X_{ji}} \right)^{\frac{1}{2(\sigma-1)}} - 1 \tag{4}$$

Using this *indirect* approach of measuring trade costs, we obtain the comprehensive aggregate measure of bilateral trade costs τ_{ij}. As shown by Chen and Novy (2011), this trade cost index is the geometric average of international trade costs between countries i and j relative to domestic trade costs within each country.[11]

Intuitively, when countries trade more internationally than they do domestically that gets reflected in low trade costs, that will be high in the opposite case. The benchmark case, that is usually taken as a lower bound for τ_{ij}, is when in both countries total output is equally traded inside and outside the country. In that event $\tau_{ij} = 0$ for all level of σ.[12] As the ratio in equation 4 rises above one, with countries trading more domestically than internationally, international trade costs rise relative to domestic trade costs, and τ_{ij} takes positive values that reach the upper bound of the index, when countries do not trade internationally and $\tau_{ij} = +\infty$.

Since the index is a product of the two countries trade flows, the level of trade of one country influences the trade cost of the other country at the bilateral level. In this respect, τ_{ij} is a symmetric measure of bilateral trade costs.

4.1 Descriptives

Following the methodology proposed by Jacks *et al.* (2008), and further discussed in Chen and Novy (2011), Chen and Novy (2012) and Novy (2013), we calculate a comprehensive measure of bilateral trade cost, τ_{ij}, as in equa-

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[11] A similar measure of freeness of trade (or *phi*-ness) as been proposed by Head and Ries (2001) and Head and Mayer (2004), where ϕ_{ij} is an overall trade cost indirectly capturing the bundle of variables influencing trade cost, scaled by σ. See also Chen and Novy (2012) for some important details that make τ_{ij} different from ϕ_{ij}.

[12] When in the hypothetical case the domestic trade of one of the two countries is null, the ratio $\frac{X_{ii}X_{jj}}{X_{ij}X_{ji}} > 1$, and for a given σ, $\tau_{ij} = -1$. The events in which this happens in the data used are none. The Appendix 8.4 contains descriptive statistics on the the distribution of τ_{ij} and on some limited cases of unusual behavior of the index.

tion 4, for 191 countries and 18145 country pairs. We used bilateral trade data from the Cepii revision of the Comtrade UN database to derive the aggregate measure of bilateral trade x_{ij}, and we calculate internal trade x_{ii} using data on GDP reported in the World Bank WDI dataset. As far as σ we use estimates from the literature on trade elasticity (Eaton and Kortum, 2002, Anderson and Yotov, 2012), mainly working with a $\sigma = 11$, but also lowering the level of σ to 9 or 7 to check for the robustness of the results.

Even if it is possible to calculate such measure for every year between 1995 and 2010, we will exploit the time dimension of trade costs only in the descriptive analysis, while in the inferential part of the paper, since the geographic dimension of the data is time invariant, we will concentrate on the cross-country variability of τ_{ij}.

4.1.1 Trade and trade costs

In figure 6 we plot the chronological evolution of world exports between 1995 and 2010, measured in natural logarithms (left panel,) and the respective trade costs, measured by τ_{ij}. In the time span covered by the analysis, world exports evolve according to three phases: the first one of relatively moderate growth (1995-2002), the second one of acceleration (2003-2007), and the last phase of the Great Trade Collapse and its recovery (2008-2010).

During the first phase average international trade costs reduced sharply, moving from a proportion of 4.4:1 with domestic trade costs to a much moderate 3.75. In the subsequent phases the average τ_{ij} went up and down inside the band between 3.5 and 3.8. Even during the recent period of trade contraction, average trade cost increased, by no means, but not as dramatically as one could have imagined.

4.1.2 The distribution of trade costs

Figures 7 illustrates the frequency distributions of the log transformation of τ_{ij}. The kernel densities clearly show a trimodal empirical distribution with a different balance between the low, medium and high values of trade costs. Averages across the all periods reveal a neat heterogeneity in trade costs when looking at countries all together. Striking differences appear across level of insularity. Landlocked countries and Islands show higher level of trade costs, and a prevalent right mode; in Coastal and, especially, in Partial Island countries the right mode is less accentuated. This last group

Figure 6:

Trade and trade costs: 1995-2010

Note: The figure traces the time series of world exports (left panel, measured in natural logarithms) and trade costs (right panel,) as measured in equation 4 with $\sigma = 11$ and zero-trade flows replaced by $x_{ij} = 1$. Data comes from the BACI-CEPII database and the World Bank. Elaborations are our own. Further description of the data and of the data sources is included in the Appendix.

of countries is remarkably characterized by very low τ_{ij}. Country pairs with minimal trade costs are however present in all groups of countries, as shown by the left outliers in the levels of τ_{ij} visualized by the dots at the basis of the kernel densities.

4.1.3 Trade Costs and Insularity

To further explore the relationship between trade costs and insularity, we report in figure 8 a spatial scatter plot having longitude on the horizontal axis and latitude on the vertical axis, as in a cartogram, and where countries, identified by ISO3 codes, are located according to the latitude and longitude of countries capital cities. The countries dots are differentiated according to the color corresponding to the four level of the Insularity index previously described (black=landlocked; green=coastal; blue=partial island; red=island). The dimension of the dot is proportional to the level of the average country τ_{ij} in 2010, with $\sigma = 11$, in logs.[13]

Among the 191 countries included in the dataset, 32 are Landlocked, 88 are Costal, 17 are Partial Islands and 54 are Islands. In this latter group, as for the others, we have countries with very high average bilateral trade costs, such as Tonga (TON), and countries with low average bilateral trade costs,

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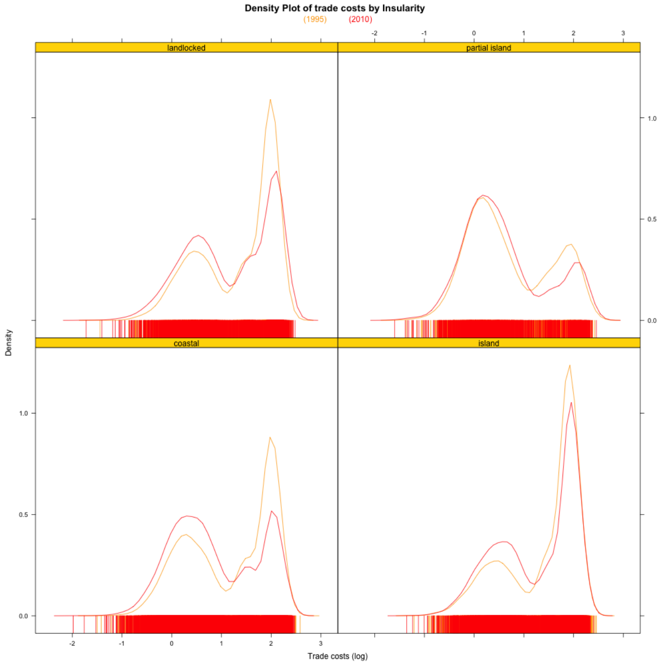
[13] See also the 3D version of this scatterplot (including a nonparametric surface visualizing estimated trade costs) and the related heatmap included in the Appendix.

Figure 7:

Kernel density of trade costs: Country pairs averages 1995-2010



Note: Our elaborations on BACI-CEPII data and the World Bank WDI data. τ_{ij} is computed according to equation 4 with $\sigma = 11$, and zero-trade flows replaced by $x_{ij} = 1$. The smoothing parameter of the kernel function is set optimally. The dots horizontally aligned below the kernel density depict the position of each observation.

such as the United Kingdom (GBR) or Singapore (SGP). In general, high or low trade costs do not seem to be a peculiar feature of any specific group of countries in the Insularity index.

Figure 9 uses the same data, measuring bilateral distance on the horizontal axis, and average bilateral trade costs on the vertical axis. Every country i is therefore identified by a couple of values, the first one is the average bilateral distance between country i and every trading partner j, the second one is the average bilateral trade cost (in logs) in 2010, between i and its trade partners. Countries are identified by Iso3 codes and dots are colored according to levels of the Insularity index, as in figure 8. In this case, to give evidence to the variability of bilateral trade cost for every country i, the size of the dots is made proportional to the standard deviation of the country τ_{ij} in 2010.

Figure 8:

Spatial scatter plot: trade costs (2010) and insularity

Note: Our elaborations on BACI-CEPII data and the World Bank WDI data. τ_{ij} is computed according to equation 4 with $\sigma = 11$, and zero-trade flows replaced by $x_{ij} = 1$. Dots are colored according to the different levels of the insularity index. The size of the dots is proportional to average country τ_{ij} in 2010.

Let's take Italy (ITA) as an example, the country has low average bilateral trade costs and also a low standard deviation of τ_{ij}, but it trades with countries located at a low average distance. Taking the United States (USA) as a comparison, the two moments of the distribution of bilateral trade costs are quite similar but the US trades on average with partners with are at a higher distance with respect to the ones of Italy.

The general tendency is of a positive correlation between distance and trade costs. This tendency is accentuated for landlocked countries and islands, less so for coastal countries. Variability of τ_{ij}, measured by its standard deviation is substantially unrelated with distance. Finally, islands can be roughly divided in two groups for each variable of interest: in terms of trade costs, figure 9 shows a prevalence of islands with high τ_{ij}, but also a substantial number of islands with low τ_{ij} (i.e. Singapore (SGP)); in terms of average bilateral distance, the islands in the Pacific Ocean are all characterized by trade with countries located at a very high distance, while island in the Atlantic Ocean are not. European islands form a third separate group.

Figure 9:

Distance and trade costs scatter plot (2010)

Note: Our elaborations on BACI-CEPII data and the World Bank WDI data. τ_{ij} is computed according to equation 4 with $\sigma = 11$, and zero-trade flows replaced by $x_{ij} = 1$. Countries are identified by Iso3 codes. Dots are colored according to the different levels of the insularity index. The size of the dots is proportional to the standard deviation of the country τ_{ij} in 2010.

As a side evidence, large islands (such as Australia (AUS), Indonesia (IDN), Japan (JAP), and the United Kingdom (GBR)) are associated with low trade costs. We will return to this issue later on.

4.1.4 Trade Costs and distance: Some European examples

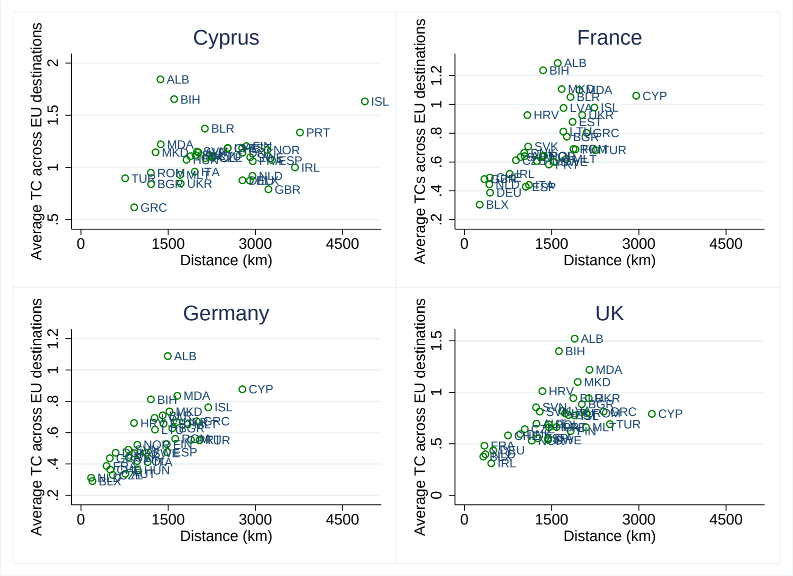
Let's now have a look at some specific country cases. We focus, as an example, on some European countries, with the twofold goal of illustrating how trade costs are related to distance to foreign markets but that they cannot be fully assimilated to distance, and that islands are different from other countries' geographical conditions in terms of how distance is related to trade costs.

Figure 10 gives evidence of the relation between distance to European markets and 1995-2010 average trade costs for four European countries: Cyprus, France, Germany, and the UK.

In general, at least for the three continental countries a some how positive correlation between distance and trade costs exists. However, in all cases the highest bilateral trade costs are with Albania (ALB), even if for none of the four countries Albania represents the European foreign market farther away. For France, Germany and the UK the trade partnership with Cyprus is the one that implies the longest distance, as far as intra-European trade.

Figure 10:

Trade Costs and distance: Some European cases



Note: The figure includes the scatterplots for Cyprus, France, Germany and the UK depicting the relation between distance to European markets (horizontal axis) and 1995-2010 average trade costs (vertical axis). Countries are identified by their ISO3 UN codes. Data comes from the CEPII database. Elaborations are our own. Further description of the data and of the data sources is included in the Appendix.

Two elements seems to characterize an island like Cyprus. First of all, trade costs reach higher levels with respect to the ones of the three continental countries. Secondly, the relationship between trade costs and distance doesn't seem to follow a linear path, but shows an inverted-U shape. Intermediate levels of distance show higher trade costs, and Italy (ITA), which is around 2000 Kms away from Cyprus, and the Netherlands (NLD,) which is 3000 Kms away from Cyprus, show the same level of bilateral trade costs.

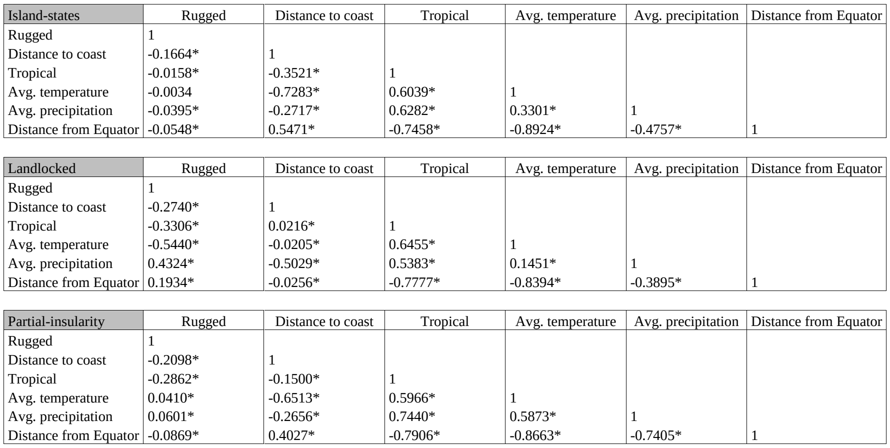
It is useful to summarize the evidence so far. Islands seem to be different from other countries in terms of trade costs. The spatial discontinuity with foreign countries add a further burden. On the other hand, islands are not all similar. What makes them different from each others?

4.1.5 Further geographical covariates

The first hypothesis is that islands are characterized by geographical specificities - apart being an island - that are different from the ones of other countries. The denomination of "island" could, therefore, hide some relevant geographical dimension that could explain why "islands" look so different in their trade costs.

The geographical dimensions that we consider and that we use as covariates in the empirical model described in section 5.

Figure 11: Simple correlation among covariates



Island-states	Rugged	Distance to coast	Tropical	Avg. temperature	Avg. precipitation	Distance from Equator
Rugged	1					
Distance to coast	-0.1664*	1				
Tropical	-0.0158*	-0.3521*	1			
Avg. temperature	-0.0034	-0.7283*	0.6039*	1		
Avg. precipitation	-0.0395*	-0.2717*	0.6282*	0.3301*	1	
Distance from Equator	-0.0548*	0.5471*	-0.7458*	-0.8924*	-0.4757*	1

Landlocked	Rugged	Distance to coast	Tropical	Avg. temperature	Avg. precipitation	Distance from Equator
Rugged	1					
Distance to coast	-0.2740*	1				
Tropical	-0.3306*	0.0216*	1			
Avg. temperature	-0.5440*	-0.0205*	0.6455*	1		
Avg. precipitation	0.4324*	-0.5029*	0.5383*	0.1451*	1	
Distance from Equator	0.1934*	-0.0256*	-0.7777*	-0.8394*	-0.3895*	1

Partial-insularity	Rugged	Distance to coast	Tropical	Avg. temperature	Avg. precipitation	Distance from Equator
Rugged	1					
Distance to coast	-0.2098*	1				
Tropical	-0.2862*	-0.1500*	1			
Avg. temperature	0.0410*	-0.6513*	0.5966*	1		
Avg. precipitation	0.0601*	-0.2656*	0.7440*	0.5873*	1	
Distance from Equator	-0.0869*	0.4027*	-0.7906*	-0.8663*	-0.7405*	1

Note: Further description of the data and of the data sources is included in the Appendix.

4.1.6 Connectedness

It's now time to go back to John Donne *Meditation*. Islands are not always severely isolated, some times for some of them is easier to be "… *a peece of the Continent, a part of the main* …". Geographical proximity with the mainland is probably the first candidate to explore in order to evaluate how connectedness with foreign countries can reduce the onus of islands bilateral trade costs.

A way to represent the relevance of spacial connectedness is the one that changes the visual perspective of the adjacency between countries taking space (latitude and longitude) in the background. This perspective is offered by a network visualization of countries proximity, as represented in figure 13.

The figure visualizes the spatial connectedness between countries, identified by their Iso3 codes. Countries that share a common land border are connected by a link;[14] light blue nodes are islands, yellow nodes are mainland countries. The nodes with a black thick circle around are landlocked counties, while nodes with a red circle are partial islands (PP), as defined in section 2.2. The position of each node depends on its relative spacial connectedness as obtained through the use of a "brute force algorithm" for network visualization.[15] Islands are located near the closer country according to the intervals $\leq$300 Kms, and $\leq$500 Kms.

The spatial network is characterized by a giant component of directly and indirectly connected nodes and by a second component made of countries of the Americas. The majority of islands are isolates, while some of them (e.g the United Kingdom and Ireland (IRL), or the Dominican Republic (DOM) and Haiti (HTI)) are locally connected.

Landlocked countries are located inside the network component. Some of them show a high level of centrality (e.g. Niger (NER) and Mali (MLI), or Hungary (HUN) and Austria (AUT)). Partial islands play the role of gatekeepers and are located at the boundaries of the network components. The position of islands in the topology of the spatial network depends on nearby countries. The United Kingdom has a central role in the networks, while Micronesia (FSM) is quite isolated. But the topology of the spatial network reveals an important element of the relative spatial position of countries: true isolation is rare and countries, even islands, should be considered as "parts of the main".

To capture spatial connectedness we define a nested index that progressively consider countries according to their level of spatial proximity. At the first level the index takes a value of one if the two countries i and j share a common land border; at the second level the index adds in the countries

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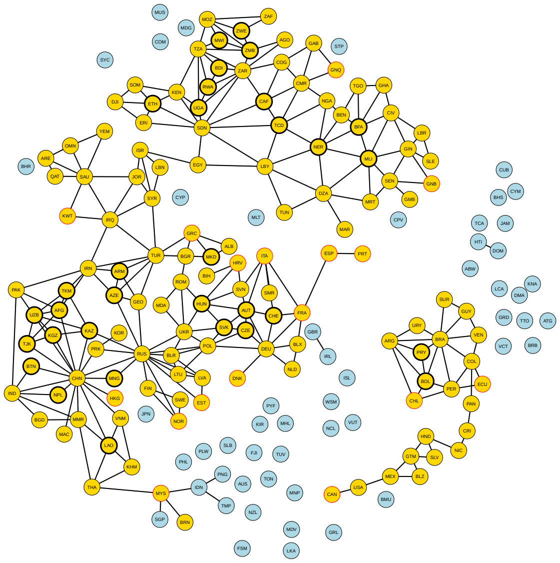
[14] The length of the link is endogenously determined by the visualization algorithm and has no specific meaning. The adjacency matrix that corresponds to the network in figure 13 is a binary matrix. Only two alternatives are considered: sharing or not sharing a land border. Pakistan (PAK) and India (IND) share a common land border, as India and Bangladesh (BGD). The difference in the length of the two different links is due to the general effect of global adjacency (e.g. Pakistan is linked also to Iran (IRN) that is not linked to India, and that drives India and Pakistan far apart.

[15] The algorithm used is the Kamada Kawai algorithm.

Figure 12:

A network visualization of countries' spatial connectedness



Note: The figure represents spatial connectedness between countries. Links connect countries that share a common border; light blue nodes are islands, yellow nodes are mainland countries. The nodes with a black thick circle around are landlocked counties, while nodes with a red circle are partial islands (PP) as defined in section 2.2. The position of each node depends on its relative connectedness as in the Kamada Kawai algorithm for network visualization. Islands are located near the closer country according to the intervals ≤300 Kms, and ≤500 Kms. Data comes from the CEPII database. Elaborations are our own. Further description of the data and of the data sources is included in the Appendix.

which bilateral distance is below the limit of 300 Kms; at the third level the index includes also the countries which bilateral distance is below the limit of 500 Kms. All remaining country pairs are given a value of zero.

The index will be used in subsequent regressions to control for the role of spatial connectedness in influencing trade costs.

5 The empirical model

While the recent literature on calculated trade costs measures (Chen and Novy (2011) and Novy (2013)) has been motivated to delve trade costs over time along with factors which have been driving their evolution, the starting model equation is the standard trade costs function as in Anderson and Yotov (2012):

$$\tau_{ijt} = exp(\alpha D_{ij} + X_{ijt}\gamma) + \epsilon_{ijt} \tag{5}$$

where the dependent variable is calculated as in 4; D_{ij} is the standard measure of distance and X_{ijt} is the matrix of geographical covariates, discussed in section 4.1.5.

In this paper we use the same methodology as in Novy (2013) to investigate the variance of trade costs in space, i.e. across countries, instead of its time variation. We modify the estimated equation accordingly, in order to adapt it to our variance analysis where correlates are time invariant. Therefore in our model the dependent variable is an average of τ_{ij} across the years (1995-2010) regressed against measures of the geography of a country either in its exporter of importer position (i or j). Controls for the heterogeneity of the pairs are captured by a random effect term, θ_{ij}, and the multilevel random effect modelling allows us to estimate coefficients for the time invariant terms we are interested in, including a control for the variance in trade costs across pairs. Our simple model looks like:

$$\begin{aligned} \ln\tau_{ij} = \beta_1 I_{ij} + \beta_2 Iboth_{ij} + \beta_3 LL_{ij} + \beta_4 LLboth_{ij} + \beta_5 PI_{ij} + \beta_6 PIboth_{ij} + \\ + \alpha \ln D_{ij} + \ln X_{ij}\gamma + \theta_{ij} + \epsilon_{ij} \end{aligned} \tag{6}$$

where θ_{ij} is the random component of the error term, with $E(\theta = 0)$ and variance constant for the pair; and ϵ_{ij} is a standard idiosyncratic error, clustered at the country-pair level. Using the same symbol as in the Insularity taxonomy, I is a dummy equal to 1 if one of the two countries in the pair is an island state; we also control for the case of both countries in the pair being islands, $Iboth_{ij}$. Similarly we include controls for landlocked countries, LL_{ij} and $LLboth_{ij}$, and for countries of partial insularity, P_{ij} and $Pboth_{ij}$.

In the following sub-section we illustrate results from running a maximum likelihood random effect model in logs as in equation 6 where the average $\ln\tau_{ij}$ is regressed on several geographic measures. Our main interest is on estimates of β_1, β_3 and β_5. In order to conduct a first robustness checks we also augment the model with other geographical characteristics at the country level and information on their main colonial experience, X_{ij}.[16]

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[16] Results do not change when the model is estimated allowing the time dimension of

5.1 Trade costs, geography measures and colonial links

Our first focus is aiming at understanding the position of islands with respect to countries with a different geography.[17] Columns (1) to (3) in table 1 include only controls for separating those country pairs where when one partner (and both) are islands (1); are islands or landlocked countries (2); are islands, landlocked or have only a portion of territory which is insular, what we call partial insularity (3). Estimates for the dummy coefficient associated to one of the country in the ij pair being an island reveal higher trade costs. The insularity effect is quite large: islands have costs which are higher between 49% and 20% with respect to the base group of coastal countries (countries which do not have islands except for a negligible part of their territory). The condition is shared by landlocked countries, where the smaller coefficient indicates that the differential in trade costs for countries without access to the sea is less severe. Column (3) offers a further element for interpreting results of higher trade costs for islands: the insular condition is mitigated when islands are administratively connected with the mainland (which in the majority of cases this implies a geographical proximity). Countries which have a portion of territory as islands seem to be characterized by lower trade costs with their partners, also with respect to the base group of coastline economies. All coefficients are significantly different from zero at 1%.

The term which captures those limited cases of both countries in the pair in the same geographical condition (both islands, both landlocked or both partial insular) suggest that having a two-sided (symmetric) geographical condition is more relevant for landlocked countries and also for those ones which are partially insular.

In columns (4) to (7) of table 1 we include further controls for testing the robustness of our significant and positive higher trade costs when an island or a landlocked country is in the pair. First of all the size of a country. The fact of being small is a geographic characteristics which repeatedly the literature has reported as a disadvantage condition (the main point being the limited possibility of exploiting diversification economies and to tap into

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the dependent variable and introducing a trend term along with the above covariates.

[17] Islands have been always separated from other countries with specific controls in the intuitive standard gravity exercise (Limao and Venables, 2001). Also in the structural gravity with fixed effects for the pair, controls for being an island or a landlocked economy are included for capturing their source of heterogeneity.

economies of scale). The fact of being a small island is the crucial condition reported in the literature of development (see references as Easterly and Kraay (2000)). Therefore it is our interest to dissect whether the effect we are capturing can be attributed to the fact of being small.[18] Results in column (4) suggest that size matters (smaller countries show higher trade costs) but also after controlling for it islands show higher trade costs than coastal countries. In column (5) we control for distance and results show that given for a distance islands and landlocked countries have higher trade costs than coastal countries while the result for countries which have islands is different. In columns (6) and (7) of table 1 measures of geography reported as robust correlates with income and trade are included: Nunn and Puga (2012) Puga's ruggedness index, standard variables reporting different climate zones in the planet (percentage of tropical territory, precipitation, distance from equator, as in La Porta *et al.* (1997)) and the standard distance from coast (see Data Info in 8). Results on our augmented models are consistent with expectation of bad geography conditions to be associated to higher trade costs. We do not report changes in the coefficients linked to the insular condition but, notably, we report on the information that the variable distance from coast add to our previous results: the measure shows a perfect capture of the nature of being landlocked. When we take it out (column 7) results come back to what previously stated.

In column (8) we also reported the effects of including colonial ties controls referred to several national-state empires.[19] Results on our variables of interest do not change: insularity is associated with higher trade costs; the case is replicated for landlocked countries, with a smaller size of the effect: landlocked countries have trade costs 16% higher than coastal countries; the effect increases to 22% when islands states are in the pair. Higher trade costs linked to the insular condition highlight a crucial element of the islands' geography: precluding the possibility of sharing the infrastructure of *contiguous* neighbours which are possibly better connected to the international markets.

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[18] We included a geographical measure of size, land extension in km squared so that to avoid elements of endogeneity with trade costs. Of course we do not control in this way for any density effect, size in land does not implies size in population or income thought this case is more evident for some countries with extensive land.

[19] Australian, Austrian, Belgian, German, Danish, Spanish, French, English, Italian, Japanese, Dutch, New Zealander, Portuguese, Russian, Turkish, American and Yugoslavian

Table 1: Trade costs correlates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	ln τ_{ij}	ln τ_{ij}	ln τ_{ij}	ln τ_{ij}	ln τ_{ij}	ln τ_{ij}	ln τ_{ij}	ln τ_{ij}
ISLAND	0.402***	0.481***	0.429***	0.385***	0.209***	0.254***	0.215***	0.200***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)
BOTH ISLANDS	0.0174	0.103***	0.0502*	0.00610	0.0421*	0.0658**	0.0302	0.0381
	(0.023)	(0.023)	(0.023)	(0.022)	(0.021)	(0.022)	(0.022)	(0.020)
LANDLOCKED		0.360***	0.308***	0.277***	0.267***	0.00772	0.266***	0.146***
		(0.013)	(0.013)	(0.013)	(0.012)	(0.015)	(0.012)	(0.016)
BOTH LANDLOCKED		0.245***	0.192***	0.160***	0.221***	-0.0646*	0.195***	0.0723*
		(0.036)	(0.035)	(0.034)	(0.032)	(0.031)	(0.030)	(0.033)
PARTIAL INSULAR			-0.321***	-0.337***	-0.334***	-0.154***	-0.192***	-0.0316*
			(0.016)	(0.015)	(0.014)	(0.014)	(0.014)	(0.015)
BOTH PARTIAL INSULAR			-0.244***	-0.261***	-0.250***	-0.0521	-0.0902	0.0219
			(0.065)	(0.064)	(0.059)	(0.053)	(0.055)	(0.071)
Land Area (1000 squared km)				-0.0602***	-0.0686***	-0.101***	-0.0653***	-0.130***
				(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Log of simple distance					0.358***	0.336***	0.344***	0.395***
					(0.007)	(0.007)	(0.007)	(0.007)
Terrain Ruggedness Index						0.0443***	0.0161***	0.00206
						(0.004)	(0.004)	(0.004)
Percentage Tropical Territory						0.241***	0.315***	0.221***
						(0.018)	(0.018)	(0.019)
Annual average temperature country						0.00500***	-0.00830***	0.0135***
						(0.001)	(0.001)	(0.001)
Precipitation (metres)						-0.155***	-0.240***	-0.109***
						(0.008)	(0.008)	(0.008)
Distance country from equator (La Porta 1999)						-0.562***	-1.048***	-0.149*
						(0.060)	(0.059)	(0.065)
Distance to nearest ice-free coast (1000 km.)						0.470***		0.286***
						(0.016)		(0.018)
Controls for colonial links	NO	NO	NO	NO	NO	NO	NO	YES
Constant	0.837***	0.672***	0.777***	0.899***	-2.150***	-2.016***	-0.916***	-3.015***
	(0.008)	(0.010)	(0.011)	(0.011)	(0.060)	(0.109)	(0.105)	(0.118)
Observations	34366	34366	34366	34366	34366	31132	31132	22642

Clustered ij standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Dependent variable is Trade Costs measured as in equation 4, with $\sigma = 11$ and replacement for zeros.

Reference category for Islands, Landlocked and Partially Insular countries are Coastal countries.

5.2 Trade Costs, bad geography and connectedness

What makes islands different from other territories? Islands are surrounded by sea, which is the opposite of the crucial characteristic which makes the geography of landlocked countries highly difficult. But sharing a border brings advantages. Adjacency favours exchanges through different channels most of time built thought historical passages (what results in what we call and measure as cultural openness). The way we address adjacency is directly linked to measures which capture the non-linear effect of distance on exchanges. In this part of the analysis we try to capture some of this reasoning by interacting our insularity measure with measures of contiguity which are adjusted for the spatial discontinuity generated by the sea.

$$\ln\tau_{ij} = (\beta_1 I_{ij} + \beta_2 Iboth_{ij} + \beta_3 LL_{ij} + \beta_4 LLboth_{ij} + \beta_5 PI_{ij} + \beta_6 PIboth_{ij}) \\ (\sigma SC_{ij} + \ln X_{ij}\gamma + \theta_{ij} + \epsilon_{ij}) \tag{7}$$

where SC_{ij} is an index that progressively consider countries according to their level of spatial proximity in a nested structure. SC_{ij} at the first level is equal to 1 if the two countries i and j share a common land border; at the second level the index adds in the countries which bilateral distance is below the limit of 300 Kms; at the third level the index includes also the countries which bilateral distance is below the limit of 500 Kms. All remaining country pairs are given a value of zero.

All equations in table 2 include controls for other geographical characteristics as in 1. We show therefore results when islands have been separated between those ones positioned near another economy within a distance of 300km (500km in equations 3 and 4) and those ones which can be called 'more isolated'. When islands trade with countries which are nearby they show much smaller trade costs, even smaller than the averages obtained for coastal countries. The result indicates how the crucial part of being an island is its position with respect its possible trade partners. A fact which pertains to countries in general but that for islands becomes crucial.[20]

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[20] What we are saying is directly related to what the taxonomy of the gravity model calls multilateral trade resistance. The point refers directly not only to having or not a proximate trade partner but also to the number of such alternatives. The more the better.

Table 2: Trade costs correlates

VARIABLES	(1) ln τ_{ij}	(2) lln τ_{ij}	(3) ln τ_{ij}	(4) ln τ_{ij}
ISLAND =0 × AND distance below 300 Kms=1	-0.279		-0.244	
ISLAND =1 × 1 AND distance below 300 Kms=0	0.302***		0.304***	
ISLAND =1 × AND distance below 300 Kms=1	-1.207***		-1.317**	
BOTH ISLAND =0 × AND distance below 300 Kms=1	-0.677*		-0.706*	
BOTH ISLAND =1 × AND distance below 300 Kms=0	-0.00922		-0.00774	
LANDLOCKED	0.293***	0.291***		
BOTH LANDLOCKED	0.181***	0.182***		
PARTIAL INSULARITY	-0.196***	-0.199***		
BOTH PARTIAL INSULAR	-0.0995	-0.0963		
ISLAND =0 × AND distance below 500 Kms=1		-1.068***		-0.939*
ISLAND =1 × AND distance below 500 Kms=0		0.301***		0.302***
ISLAND =1 × AND distance below 500 Kms=1		-1.192***		-1.195**
BOTH ISLAND =0 × AND distance below 500 Kms=1		0.127		0.0956
BOTH ISLAND =1 × AND distance below 500 Kms=0		0.000665		0.00214
LANDLOCKED =0 × AND distance below 300 Kms=1			-0.000721	
LANDLOCKED =1 × AND distance below 300 Kms=0			0.298***	
LANDLOCKED =0 × AND distance below 300 Kms=1			-0.290*	
LANDLOCKED =1 × AND distance below 300 Kms=0			0.182***	
PARTIAL INSULARITY =0 × AND distance below 300 Kms=1			0.149	
PARTIAL INSULARITY =1 × AND distance below 300 Kms=0			-0.197***	
PARTIAL INSULARITY =0 × AND distance below 300 Kms=1			0.255	
BOTH PARTIAL INSULARITY =1 × AND distance below 300 Kms=0			-0.0966	
LANDLOCKED =0 × AND distance below 500 Kms=1				-0.0135
LANDLOCKED =1 × AND distance below 500 Kms=0				0.296***
BOTH LANDLOCKED =0 × AND distance below 500 Kms=1				-0.281*
BOTH LANDLOCKED =1 × AND distance below 500 Kms=0				0.183***
PARTIAL INSULARITY =0 × AND distance below 500 Kms=1				0.106
PARTIAL INSULARITY =1 × AND distance below 500 Kms=0				-0.200***
BOTH PARTIAL INSULARITY =0 × AND distance below 500 Kms=1				0.194
BOTH PARTIAL INSULARITY =1 × 1 AND distance below 500 Kms=0				-0.0954
Geo Controls	YES	YES	YES	YES
Constant	2.014***	1.998***	2.013***	1.997***
	(0.091)	(0.091)	(0.091)	(0.091)
Observations	31132	31132	31132	31132

Clustered (ij) standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Dependent variable is Trade Costs measured as in equation 4, with $\sigma = 11$ and replacement for zeros.
Reference category for Island, Landlocked and Partially Insular countries are Coastal countries.

6 Historical routes and trade costs

How is connectedness build? In the previous section we show that an important part is played by the geographical position of a country with respect to all its potential partners. In this part of our paper we explore the possibility that connectedness builds on a process that has to be retrieved in history, in the way trade connections have been created in time.

Our elaborations on CLIWOC database allows us to identify territories which have been touched by historical trade routes. We provide two types of information from historical routes: places where ships had long stops, which were normally located in the colonial regions, linked to the mother country by special economical ties; locations where ships had short stops during the journey, i.e stopovers normally motivated by conditions and technicalities related to navigating a specific route. The former identifies places which had already an economic meaning for the traders: they already at the time were labelled as trade posts; therefore their quality in terms of guaranteeing a good market access for the goods to be exchanged could have contributed to reduce already their trade costs. The latter instead would help to identify territories with a different quality: they had a peculiar geography to make them accessible to ship during long trips, which had the need to stop for whatever reason the navigation asked for: resting the crew, loading any necessity for continuing the journey; waiting for an adverse meteo condition to cease and so on.

6.1 Long Stops

The first data we treated in order to arrive to a new informative base is the naming of routes origins and destinations. We selected 5191 trips (out of the 5227) for which we have complete information on the location of origin and destination. Locations in CLIWOC are recorded as found in logbooks (see 9 in the Appendix for an example). Since the same location has been written in several different ways, origin and destination information has been harmonized, collecting the several names which were given to the same place, arriving to identify current locations and countries of pertinence.

The more the higher the level of connectedness. This is the case for countries which have access to the sea but also share several borders with other countries which in turn share multiple borders.

Results from this work has identified 383 locations of travel origin and 632 destinations. To each one we associated the current country name, the country ISO code and the frequency of recurrence in all 5191 trips. Table 3 lists locations with have been found at least 50 times in our data.

Table 3: Most frequent departure and arrival locations of Historical Routes

Origin	Freq. in Routes	Country ISO code	Destination	Freq. in Routes	Country ISO code
La Corua	738	724	Batavia	344	360
Coastal East India	489	699	La Corua	230	724
Batavia	447	360	Spithead	202	826
LA HABANA	254	192	LA HABANA	162	192
Cadix	213	724	Montevideo	128	858
Hellevoetsluis	207	528	CDIZ	120	724
Falkland Islands	201	238	Curacao	119	530
Texel	190	528	Suriname	102	740
Nederland	187	528	St Helena	97	711
Barcelona	169	724	Nederland	93	528
Curacao	158	530	Barbados	88	28
Rochefort	100	251	Madras	87	699
Montevideo	98	858	Nieuwediep	83	528
Rotterdam	97	528	Hellevoetsluis	72	528
Galle	92	144	Downs	71	826
Nieuwediep	87	528	Rotterdam	69	528
Amsterdam	83	528	Plymouth	68	826
Iceland	80	352	UK	68	826
Suriname	77	740	Paramaribo	64	740
St Eustacius	72	530	Table Bay	64	711
Acapulco	71	484	Bombay	64	699
Middelburg	70	528	St Eustacius	61	530
Vlissingen	61	528	Halifax	61	124
Brest	57	251	Texel	59	528
Paramaribo	52	740	Madeira	58	620
			Kaap de Goede Hoop	56	711

[*] Our Elaborations from CLIWOC 2.1, De Benedictis and Pinna (2015)

Frequency numbers disclose a robust concentration both in terms of cities of departures and arrival and origin and destination countries. We found 134 (314) localities which appear as routes' origin (destination) only once, also after the work of naming harmonization has been completed. Only 83 (88) localities appear more than 10 times as origins (destinations) of navigations.

Islander localities are well represented in the list of localities. In the main position we find a remarkable presence of Indonesia, Cuba, Barbados, St Eustacius, Barbados and the Falklands. At the country level frequency number gets higher since several countries have more than one cities or towns as origin or destination of historical routes. 101 current nations host origin harbours while the number reduces to 81 when hosting terminal docks. Table 4 lists countries which have at least 100 recurrences in the database of single trips derived from CLIWOC 2.1.

Table 4: Most frequent departures and arrivals of historical routes, at the country level

Country Origin	Frequency in Routes	Country Destination	Frequency in Routes
Spain	1162	Great Britain	640
Netherlands	1087	Netherlands	505
India	689	Indonesia	485
Indonesia	645	Spain	724
Antigua	262	India	294
Cuba	259	South Africa	266
France	228	Antigua	201
Cape Verde	206	USA	179
South Africa	201	Suriname	171
Sri Lanka	186	Cuba	170
Great Britain	183	Canada	167
Suriname	165	Porto Rico	143
USA	105	Uruguay	130

* Our Elaborations from CLIWOC 2.1, De Benedictis and Pinna (2015)

The correlation at the country level for being an origin or a destination has been found to be equal to 0.94. This implies that controls for long stops have to be included separately. Islands which appear at the country level reveal the preponderance of the Atlantic and Indian oceans navigations in the origin database.

6.2 Short Stops

In order to identify short stops different variables referring to the duration of the journey have been used. In fact trips were quite long, depending on the distance which was covered and of events happening during the journey. The number of days varies from 1 to 412 days.

It is during navigations that islands could have had a special role, a possibility we will test further along. Islands are among the most likely territories to be encountered by ships navigating the sea. CLIWOC presents the daily position of the vessel in terms of latitude and longitude.[21] Information is also given on the modality the measure was taken: dead reckoning, from true navigation, interpolated manually or, what we will focus on, inserted as an '*actual position of ports or islands*' (quoting CLIWOC variable definition) which were found during the navigation.

We concentrated on this last category and we joined this data with another pregnant piece of information from CLIWOC. Detail is given on whether ships were at anchor or moored. Filtering daily position measures for all trips we arrive to identify a list of islands, what we will call the 'treated' group. Here treatment has been the involvement of a territory in historical navigations because ships used to *stop* and *anchor*.[22]

There are further piece of information that we can use as a robust check for our identification of islands involved in historical routes:

1 there are territories where the vessel position has been inserted as an '*actual position of ports or islands*' but in these locations the ship was not at anchor or moored (PI in Table 5). This is a minor group of not treated countries;

2 anchor could happen also in places which were not identified as ports or islands. We do not have more information on what this stops were meant for, but using a GIS programme we know that the ship was anchored near some territories. We call countries hosting locations in this group 'weakly treated' (WT in Table 5) because thought the vessel position was not precisely referred to a port or an island we can trace the country hosting the anchoring location. It is not clear whether these stops implied interactions, therefore according to our definition of 'treatment', the treatment is 'weak', less certain.

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[21] Report on the strong reliability of this measure.

[22] Detail is also given on encounters between vessels (it happened 8633 times in the original database). In 220 cases the encounter happened when the ship was at anchor in a specific location. We are now collecting also the information on which ports (georeferenced point) ships of different nationalities used to *meet*, sharing the docking place.

3 during all days of navigation the position(s) of the vessel is recorded to be or not coastal, meaning 'to be in port or near coastal disturbances' (quoting CLIWOC variable definition). It is always coastal for records that identify our treated group. Some days the position is coastal without the ship being anchored.

Among the large group of countries (99) which have never being involved in navigations, their presence has never been tagged in daily navigations, not even when the vessel position has been recorded as 'coastal' are included countries which cannot be involved in historical sea routes by geography, landlocked. We already control for them. Also, there are some countries which are the origin or destination of routes. And then there are islands, located in all seas, from Caribbean, Atlantic and Pacific Ocean islands. Table 5 lists all the 54 islands in BACI trade costs dataset according to the different groupings.

We reckon the joint information on how the geo reference position of a ship has been taken (ports or island) and the fact the ship to be anchored to be able identify locations blessed by the crucial geographic condition of being accessible territories for ships running trade at the time. Consequences of that accessibility on the local economy of such stopovers is a further point we do not develop in this paper. Here the aim is to provide a simple test on whether the geographic advantage of 'being an easy access point' for ships navigating the sea at that time is related to the relative 'easiness' of trade (trade costs) at our times.

The estimated equation is augmented for an interaction term between the type of involvement in the historical routes and the islandic condition.

$$\begin{aligned} \ln\tau_{ij} = (\beta_1 I_{ij} + \beta_2 I_{ij} \times \mathrm{HR}_{ij} + \\ \beta_2 Iboth_{ij} + \beta_3 LL_{ij} + \beta_4 LLboth_{ij} + \beta_5 PI_{ij} + \beta_6 PIboth_{ij}) \\ exp((GEO_i GEO_j)\beta_4) + \gamma_{ij} + \epsilon_{ij} \end{aligned} \tag{8}$$

where 'HR' identifies different condition of 'treatment': countries origin or destination of historical routes; countries with locations deriving from the position of the vessel inserted as actual position of a 'port or island' AND where historical ships were anchored (strong treatment); those countries which had locations where ship were anchored (though not reported as 'actual places as ports or islands') (weak treatment). The base group is will continue being

Table 5: Islands: Stop-overs and control groups

Islands ships anchored	Islands not involved
Antigua and Barbuda	Aruba
Australia	Bahrain
Bahamas	Bermuda (PI)
Barbados	Brunei (PI)
Comoros	Cayman Islands
Cape Verde	Cyprus
Cuba	Dominica (WT)
Great Britain	Dominican Republic
Haiti	Fuji (PI)
Indonesia	Micronesia (WT)
Irland	Grenada (PI)
Japan	Greenland
Sri Lanka	Island (PI)
Madagascar	Jamaica (PI)
Mauritious	Kiributi
Philippines	St Kitts and Navis (WT)
Sao Tome and Prince	St Lucia
Trinidad and Tobago	Maldives
	Marshall Islands
	Malta (PI)
	Northen Mariana Islands
	New Caledonia (WT)
	New Zeland
	Palau
	Papua New Guinea (WT)
	French Polinesia (WT)
	Singapore (PI)
	Solomon Islands (PI)
	Seychelles
	Turks and Caicos Islands (PI)
	Tonga (WT)
	Tuvalu
	St Vincent and the Granadines
	Vanuatu
	Samoa

[*] Our Elaborations from CLIWOC 2.1, De Benedictis and Pinna (2015); WT=weakly treated; PI=Ports or Islands position

the coastal countries and controls for other geographic characteristics will be included.

6.3 An augmented model

In table 6 we report on results for our interaction between the condition of being an island and being interested by routes. All the possible combinations are included, and therefore we will be able to measure different correlation effects:

- the effect on trade costs from being an origin /destination /a stop-over where ships anchored, for all countries in the sample, regardless their geographic condition; it comes from the coefficient on the 0 1 combination of the interaction term;
- the effect on trade costs from being an island; it comes from the 1 0 combination of the same interaction term;
- the *differential* effect that being an origin/destination/a stop-over where ships anchored has on islands, with respect to the other countries which are treated. It is the last combination of the interaction term;

All specifications of the augmented model in 8 confirm that islands have higher trade costs (coefficient in the second row of interaction terms). Being a route origin (but also a route destination) is strongly associated to lower trade costs (40% less). The differential effect for islands is always significant and implies a further reduction in trade costs of 15%.

As noted above being an origin or a destination is a process endogenous to the same route existence. Trade routes started in order to reach a peculiar destination that had some characteristics 'good' for trade. And being the origin mainly in the nations of the ship, the association with lower trade costs is easily understood. The result that more highlights the role of history in combination with a 'good' geography (from the point of view that being approachable by ships during navigations creates a change in the environment) can be read in the third specification of the table: this involvement has the same effect of being associated to lower trade costs now. For islands this specific involvement in historical trade is associated to a further reduction in trade costs equal to 8%. Including a control also for those territories where anchoring took place (weak treatment) the differential result for islands goes away, but still the strong association from historical routes to present trade costs distribution is confirmed.

In table 7 we test whether the fact of being accessible by historical routes was just due to a favourable geographic position: i.e. exactly the fact of being 'relatively' near to the mainland. This case is more likely in those routes which connected Europe to Asia, since the long navigation along the African coasts. Therefore we include a more complex interaction term, where we control for spacial connectedness as in 7 and the involvement in trade routes during the journey of historical ships. Results disclose how both connectedness and the involvement in historical routes is associated to lower trade costs (85%); there is the usual increase in trade costs associated to islands 38%. Being territories where ships used to stop is associated with lower trade costs in general, with a stronger effect 7% for islands, but the strong results is that such differential effect is even stronger (65%) when looking at trade of those islands with their most proximate trade partners, with respect the case of similar (proxime) trade of the islands which were not a stop over.

7 Concluding Remarks

We investigated on the role of the role of geography in determining differences across space in trade costs. We used a measure derived from the structural gravity model of trade as in Novy (2013), in order to consider costs of moving goods behind borders with respect to moving them domestically. Our multilevel empirical model, includes random effects controls for country-pair unobservables and in the meanwhile it treats country specific geographical characteristics as fixed effects. In this set up we register a systematic difference in a 'indirect' measure of trade across associated to geographical characteristics. The point we raised in the paper relates to a simple but fundamental question: how should we interpret this result? Our try to answering this question gains insight from the analysis of a particular geographical status: insularity, the condition of having 100% spacial discontinuity with other countries. Our scrutiny on islands has been run side by side with the opposite status of being completed surrounded by other countries. Islands have been always separated from other countries with specific controls in the intuitive standard gravity exercise (Limao and Venables, 2001). Landlocked countries are another geographical condition which received even more attention in the literature. What's the major point of being landlocked? A recent report by

Table 6: Trade costs correlates

VARIABLES	(1) ln Tij	(2) ln Tij	(3) ln Tij	(4) ln Tij
ISLANDS and ORIGIN OF ROUTES				
0 1	-0.363***			
	(0.015)			
1 0	0.315***			
	(0.020)			
1 1	-0.148***			
	(0.016)			
ISLANDS and DESTINATION OF ROUTES				
0 1		-0.313***		
		(0.016)		
1 0		0.326***		
		(0.024)		
1 1		-0.0867***		
		(0.017)		
ISLANDS and COUNTRIES with P or I where ship anchored				
0 1			-0.335***	-0.320***
			(0.015)	(0.016)
1 0			0.338***	0.383***
			(0.015)	(0.021)
1 1			-0.0677***	0.00664
			(0.015)	(0.023)
ISLANDS and COUNTRIES where ship anchored, no in P or I				0
0 1				-0.0388*
				(0.016)
1 0				-0.110***
				(0.018)
1 1				0
BOTH ISLANDS	0.0611**	0.0508*	0.118***	0.102***
	(0.021)	(0.022)	(0.021)	(0.022)
LL	0.190***	0.208***	0.241***	0.227***
	(0.012)	(0.012)	(0.012)	(0.012)
BOTH LL	0.0415	0.0364	0.155***	0.122***
	(0.030)	(0.031)	(0.029)	(0.029)
PARTIAL INSULAR	-0.160***	-0.155***		-0.120***
	(0.013)	(0.014)		(0.014)
BOTH PINSULAR	-0.0652	-0.0631	-0.101	-0.0323
	(0.053)	(0.054)	(0.053)	(0.053)
LDIST	0.361***	0.359***	0.348***	0.350***
	(0.007)	(0.007)	(0.007)	(0.007)
GEO CONTROLS	YES	YES	YES	YES
Constant	-0.838***	-0.901***	-0.761***	-0.726***
	(0.101)	(0.103)	(0.102)	(0.101)
Observations	31132	31132	31132	31132

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Dependent variable is Trade Costs measured as in equation 4, with $\sigma = 11$ and replacement for zeros.

Reference category is the group of Coastal countries.

Table 7: Trade costs correlates

VARIABLES	(1) ln Tij	(2) ln Tij
ISLANDS and P or I where ship anchored and DISTANCE within 300km		
0 0 1	-0.314^{***}	
	(0.047)	
0 1 0	-0.310^{***}	
	(0.015)	
0 1 1	-0.625^{***}	
	(0.073)	
1 0 0	0.325^{***}	
	(0.015)	
1 0 1	-0.0783	
	(0.214)	
1 1 0	-0.0736^{***}	
	(0.014)	
1 1 1	-0.730^{***}	
	(0.169)	
ISLANDS and P or I where ship anchored and DISTANCE within 500km		
0 0 1		-0.283^{***}
		(0.045)
0 1 0		-0.309^{***}
		(0.015)
0 1 1		-0.617^{***}
		(0.072)
1 0 0		0.327^{***}
		(0.015)
1 0 1		-0.105
		(0.144)
1 1 0		-0.0723^{***}
		(0.015)
1 1 1		-0.503^{***}
		(0.123)
BOTH ISLANDS	0.101^{***}	0.101^{***}
	(0.022)	(0.022)
LANDLOCKED	0.228^{***}	0.228^{***}
	(0.012)	(0.012)
Both LANDLOCKED	0.146^{***}	0.145^{***}
	(0.029)	(0.029)
PARTIAL INSULAR	-0.123^{***}	-0.123^{***}
	(0.014)	(0.014)
BOTH PARTIAL INSULAR	-0.0342	-0.0332
	(0.053)	(0.053)
Log of simple distance	0.322^{***}	0.319^{***}
	(0.007)	(0.008)
Constant	-0.515^{***}	-0.491^{***}
	(0.105)	(0.106)
Observations	31132	31132

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Dependent variable is Trade Costs measured as in equation 4, with $\sigma = 11$ and replacement for zeros.
Reference category is the group of Coastal countries.

the World Bank (2010) advance a clear evidence that landlocked economies are affected more by the high degree of unpredictability in transportation than by the high cost of freight services *per se*. Once distance is controlled for, as in the gravity equation, the incidence of geography on trade costs (and therefore trade volumes) is either saying something more about distance (e.g. its non linear effect across different geographical conditions, such as being a coastal country or a landlocked one, or an island) or saying that distance is not capturing all about the economic cost of geography. In our work we provide some evidence that geography plays a role when looking at trade facts (such as trade costs) when it constraints the capability that a country has to relate, to properly *connect* to other economies. More on this, connectivity is not a dimension that can be reduced neither to a bilateral dimension (instead it refers to the position of a country with respect to all possible alternatives, i.e. it is multilateral) nor to a simple distance measure (it has to be referred to the repetition of facts in time which in first place may have given different weights to similar geographical distances, i.e. the process of building trading relations).

The starting point of our empirical exercise moves from the recent literature motivated to delve trade costs over time along with factors which have been driving their evolution. A simple analysis on the variance of 'indirect' measure of trade costs, as in Chen and Novy (2012) across subgroups such as islands, landlocked countries and countries which have a portion of territory in islands, indicates that costs are higher firstly for islands-states. They display costs which are 140% higher with respect to the reference group, coastal countries. Also landlocked economies show higher costs but the coefficient's magnitude for this group is smaller. Islands are surrounded by sea, which is the opposite of the crucial characteristic which makes the geography of landlocked countries highly difficult. But sharing a border brings advantages such as sharing the infrastructure of *contiguous* neighbours which are possibly better connected to the international markets. Also, if this element introduces elements of unpredictability, since a landlocked country has to bargain conditions for passing another country's land, relying therefore on factors which are out of their direct control, islands are excluded from such a possibility. Another element adds some understanding on the insular condition. Insularity is mitigated when islands are administratively connected with the mainland (which in the majority of cases this implies a geographical proximity). Countries which have a portion of territory as islands seem to

be characterized by lower trade costs in their trade relationships, also with respect to the base group of coastline economies.
We dig up on this first evidence by interacting our insularity measure with measures of contiguity which are adjusted for the spatial discontinuity generated by the sea. When islands trade with countries which are nearby they show much smaller trade costs, even smaller than the averages obtained for coastal countries. The result indicates how the crucial part of being an island is its position with respect its possible trade partners. A fact which pertains to countries in general but that for islands becomes even more crucial. Here is what we call connectedness, spacial connectedness.

The question which follows is straightforward. Once physical distance is taken as given, what other factors help to build connectedness? In the second part of our paper we explore the possibility that connectedness builds on a process that has to be retrieved in history, in the way trade connections have been created in time. In order to test for this hypothesis, we rely on the Climatological Database for the World's Oceans 1750-1850 (CLIWOC) which reports on British, Dutch, French and Spanish ships logbook records for the period 1750 to 1850. Logbooks included general information on the state of the vessel, first of all the port of origin and the destination of the journey and along with other climatological information eventually the proximity of mainland. For our purpose, every record in the logbooks includes the location of the vessel, in terms of longitude and latitude. CLIWOC database allows us to identify territories which have been touched by historical trade routes. A first direct way is to use the information from one specific variable which informs on whether during the route the ship stopped in a specific port or island. At this stage of the work we also use the information of weather the island has been the starting point of a route. In this way we can add some complexity to the information given by the database on trade routes as the one we are using: counting the number of times an island is the starting port of a route we trace the possibility and capability of constructing a position favourable to trade by a country in time. First results from this analysis show that for islands trade costs are still higher, but the differential attached to this geographical position is strongly reduced when countries are shown to be involved in a route. The reduction is clear already when a simple measure of being a stop over of the ship voyage to the final destination is used. The evidence is confirmed when a count variable is included: islands which have been more times the origin of routes are more likely to have lower trade costs.

This first evidence from the use of historical data would suggest that along geographical distance, history has helped to shape the geography of the actual world. The process of building trade relations had a role in creating something which is likely to work also after centuries: a culture to openness, an aspect which is fundamental if a country aims to better position its economy in the international market. The mechanics underlying this process may work through a country's institutions' and/or infrastructure building process. Our results would suggest that these dimension are worth further research.

Our work in progress: use the information of the database in a way which is likely to provide information on how the involvement in the historical trade route is likely to provide information on the present quality of trade infrastructure of a territory. Within the same route we are able to identify stops during the journey. Short stops are likely to be due to the quick provision of goods necessary for the continuation of the journey. Longer stops, which can be attributed to several reasons (weather conditions, damages of the vessel, other technical problems during the voyage, or merely the fact of having reached an important trading post) are likely to be the ones which helped a country to create that culture of connectedness still important when dealing with trade today.

8 Appendix

8.1 Data Info

The data matrix dimensions are $191 \times 190 \times 11$, including 191 countries, listed bellow, from 1995 to 2010.

1. Bilateral trade data are sourced from the CEPII-BACI version of the COMTRADE UN Database.
2. **Trade Costs:** 1995-2010, calculated using the CEPII-BACI database from COMTRADE UN Database and for GDP data the WDI database of the World Bank;

3. **Insularity measure**: dummies for full *Insularity* (1 if the country is an island-state); *Landlocked*: 1 if the country is landlocked; *Partial insularity*: 1 if the country has at least 2% of its all territory on islands; *Coastal*: 1 if the country has access to the sea and the percentage of insular territory is below 2%. The source for this measures is Licio and Pinna (2013) insularity dataset;

4. **Ruggedness** (Terrain Ruggedness Index, 100 m). Originally devised by Riley, DeGloria and Elliot (1999) to quantify topographic heterogeneity in wildlife habitats providing concealment for preys and lookout posts. Source: (Nunn and Puga, 2012).

5. **Distance from equator**. Source: La Porta *et al.* (1997).

6. **Tropical climate** (%); percentage of the land surface area of each country that has any of the four Kappen-Geiger tropical climates. Source: (Nunn and Puga, 2012).

7. **Other geographical characteristics**: Distance from coast; Average temperature; Precipitation (SEDAC, 2009).

8.2 Islands data

Data for trade costs analysis (Islands as Bad Geography)
46 Variables 580640 Observations

---

iso

```
         n    missing    unique
    580640          0       191

lowest : ABW AFG AGO ALB ARE, highest: YEM ZAF ZAR ZMB ZWE
```

---

year

```
         n    missing    unique    Info    Mean     .05     .10     .25     .50     .75     .90     .95
    580640          0        16       1    2002    1995    1996    1999    2002    2006    2009    2010

           1995  1996  1997  1998  1999  2000  2001  2002  2003  2004  2005  2006
Frequency 36290 36290 36290 36290 36290 36290 36290 36290 36290 36290 36290 36290
%             6     6     6     6     6     6     6     6     6     6     6     6
           2007  2008  2009  2010
Frequency 36290 36290 36290 36290
%             6     6     6     6
```

---

latitude

```
         n    missing    unique    Info    Mean       .05       .10      .25      .50      .75      .90
    580640          0       187       1   18.81   -21.150   -13.967    4.383   16.783   38.733   50.100   5

lowest : -44.28 -35.30 -34.92 -34.67 -33.50
highest:  59.42  59.92  60.13  64.15  64.18
```

---

longitude

```
         n    missing    unique    Info    Mean     .05      .10      .25     .50     .75      .90
    580640          0       190       1   22.14  -82.42   -72.33   -15.72   21.00   55.47   116.43   1

lowest : -175.23 -149.57  -99.17  -90.52  -89.17
highest:  171.75  173.15  174.78  178.42  179.20
```

---

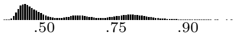
continent

```
         n    missing    unique
    580640          0         5

          Africa America   Asia Europe Pacific
Frequency 148960  121600 145920 115520   48640
%             26      21     25     20       8
```

---

trade cost 11



```
         n    missing    unique    Info    Mean      .05      .10      .25      .50      .75      .90
    503576      77064    250623       1   3.819   0.7453   0.9131   1.3211   2.5246   6.6626   8.0265   8

lowest : -0.12054 -0.07886 -0.04511 -0.04417 -0.03232
highest: 13.23861 13.30980 13.47653 13.49345 13.60827
```

---

log trade cost 11

```
       n  missing   unique      Info     Mean       .05      .10       .25       .50
  503566    77074   249846         1    1.012 -0.29381 -0.09087  0.27852  0.92613
     .75      .90      .95
 1.89652  2.08275  2.15021
lowest : -5.060 -3.835 -3.703 -3.463 -3.339
highest:  2.583  2.589  2.601  2.602  2.611
```

8.3 CLIWOC data

log trade cost 8

n	missing	unique	Info	Mean	.05	.10	.25	.50	.75	.90	
503566	77074	249764	1	1.76	0.1956	0.4229	0.8459	1.6190	2.8530	3.0990	3

```
lowest : -4.702 -3.474 -3.341 -3.100 -2.975
highest:  3.771  3.779  3.796  3.797  3.809
```

---

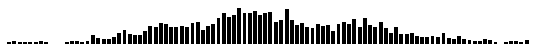
log trade cost 7

n	missing	unique	Info	Mean	.05	.10	.25	.50	.75	.90	
503566	77074	249964	1	2.142	0.4254	0.6670	1.1214	1.9690	3.3598	3.6411	3

```
lowest : -4.547 -3.317 -3.184 -2.942 -2.817
highest:  4.415  4.423  4.443  4.444  4.458
```

---

log gdp



n	missing	unique	Info	Mean	.05	.10	.25	.50	.75	.90	.9
551190	29450	2901	1	23.38	19.44	20.21	21.70	23.20	25.25	26.65	27.5

```
lowest : 16.22 16.33 16.36 16.36 16.43
highest: 30.22 30.26 30.27 30.29 30.30
```

---

log bilateral trade

n	missing	unique	Info	Mean	.05	.10	.25	.50	.75	.90	.95
580640	0	322882	0.93	8.598	0.00	0.00	0.00	10.43	15.52	18.40	19.83

```
lowest :  0.000  6.908  6.909  6.909  6.909
highest: 26.416 26.457 26.468 26.524 26.529
```

---

log domestic trade

n	missing	unique	Info	Mean	.05	.10	.25	.50	.75	.90	.9
540740	39900	2846	1	23.02	19.14	19.96	21.32	22.83	24.76	26.26	27.3

```
lowest : 14.78 16.11 16.19 16.30 16.31
highest: 30.14 30.19 30.19 30.20 30.22
```

---

log land area

n	missing	unique	Info	Mean	.05	.10	.25	.50	.75	.90	
580640	0	187	1	11.18	5.768	6.551	9.982	11.625	13.120	14.052	1

```
lowest :  3.332  3.401  3.912  4.094  5.193
highest: 15.951 16.023 16.029 16.048 16.611
```

---

log population

n	missing	unique	Info	Mean	.05	.10	.25	.50	.75	.90	.9
580640	0	3050	1	15.35	11.10	11.78	14.05	15.66	16.89	17.94	18.6

```
lowest :  9.130  9.134  9.138  9.141  9.146
highest: 20.994 20.999 21.004 21.009 21.014
```

---

i island state

n	missing	unique
580640	0	2

```
0 (416480, 72%), 1 (164160, 28%)
```

---

i or j island state

n	missing	unique
580640	0	2

```
0 (298112, 51%), 1 (282528, 49%)
```

i and j island state

n	missing	unique
580640	0	2

```
0 (534848, 92%), 1 (45792, 8%)
```

island state 3

n	missing	unique
580640	0	3

```
0 (298112, 51%), 1 (236736, 41%), 2 (45792, 8%)
```

i partial insularity

n	missing	unique
580640	0	2

```
0 (528960, 91%), 1 (51680, 9%)
```

i or j partial insularity

n	missing	unique
580640	0	2

```
0 (481632, 83%), 1 (99008, 17%)
```

i and j partial insularity

n	missing	unique
580640	0	2

```
0 (576288, 99%), 1 (4352, 1%)
```

partial insularity 3

n	missing	unique
580640	0	3

```
0 (481632, 83%), 1 (94656, 16%), 2 (4352, 1%)
```

i landlocked

n	missing	unique
580640	0	2

```
0 (483360, 83%), 1 (97280, 17%)
```

i or j landlocked

n	missing	unique
580640	0	2

```
0 (401952, 69%), 1 (178688, 31%)
```

i and j landlocked

```
      n  missing  unique
 580640        0       2

0 (564768, 97%), 1 (15872, 3%)
```

---

landlocked 3

```
      n  missing  unique
 580640        0       3

0 (401952, 69%), 1 (162816, 28%), 2 (15872, 3%)
```

---

contiguity

```
      n  missing  unique
 580640        0       2

0 (571744, 98%), 1 (8896, 2%)
```

---

contiguity 300

```
      n  missing  unique
 580640        0       2

0 (571008, 98%), 1 (9632, 2%)
```

---

contiguity 500

```
      n  missing  unique
 580640        0       2

0 (569120, 98%), 1 (11520, 2%)
```

---

contiguity 3

```
      n  missing  unique
 580640        0       4

0 (569120, 98%), 1 (1888, 0%), 2 (736, 0%), 3 (8896, 2%)
```

---

distance

```
      n  missing  unique  Info  Mean   .05   .10   .25   .50    .75    .90    .95
 580640        0   18137     1  8195  1403  2214  4572  7747  11642  14811  16404

lowest :    10.48    59.62    60.77    80.98    85.94
highest: 19719.86 19747.40 19772.34 19812.04 19904.45
```

---

log distance

```
      n  missing  unique  Info   Mean    .05    .10    .25    .50    .75    .90    .9
 580640        0   18077     1  8.786  7.246  7.703  8.428  8.955  9.362  9.603  9.70

lowest : 2.349 4.088 4.107 4.394 4.454
highest: 9.889 9.891 9.892 9.894 9.899
```

---

distance percentual

```
      n   missing    unique     Info     Mean     .05     .10     .25     .50     .75     .90     .95
 580640         0       101        1   0.5883    0.18    0.26    0.42    0.61    0.77    0.89    0.93

lowest : 0.00 0.01 0.02 0.03 0.04, highest: 0.96 0.97 0.98 0.99 1.00
```

ruggedness

```
      n   missing    unique     Info     Mean       .05       .10       .25       .50       .75      .
 580640         0       191        1    1.266   0.02471   0.15447   0.38780   0.91395   1.87804   2.520

lowest : 0.002898 0.006226 0.006456 0.006769 0.009513
highest: 4.761175 4.885416 5.042515 5.300787 6.740056
```

distance from coast

```
       n   missing    unique      Info      Mean       .05       .10       .25
  580640         0       191         1    0.2952 9.516e-05 1.559e-03 2.461e-02
     .50       .75       .90       .95
1.348e-01 3.893e-01 8.995e-01 1.186e+00
lowest : 0.000e+00 1.781e-07 8.952e-06 9.849e-06 1.085e-05
highest: 1.645e+00 1.694e+00 1.841e+00 1.918e+00 2.206e+00
```

avg temperature

```
      n   missing    unique     Info     Mean     .05     .10      .25      .50      .75      .90      .95
 565440     15200       148        1    18.89    2.10    6.40    11.15    22.57    25.55    27.15    27.60

lowest : -16.05  -5.35  -5.10  -0.70   1.50
highest:  27.65  27.85  28.00  28.20  28.25
```

distance equator

```
      n missing  unique    Info    Mean     .05     .10     .25     .50     .75
 565440   15200     111       1  0.2774 0.02222 0.05556 0.13411 0.22222 0.43333
    .90     .95
0.54944 0.62222
lowest : 0.00000 0.01111 0.01356 0.01389 0.02222
highest: 0.66667 0.68889 0.71111 0.72222 0.80000
```

tropical

```
      n   missing    unique     Info     Mean       .05       .10       .25       .50       .75       .90
 580640         0        53     0.89   0.4419    0.0000    0.0000    0.0000    0.1713    1.0000    1.0000   1

lowest : 0.000e+00 6.131e-05 3.213e-04 1.792e-03 3.007e-03
highest: 9.778e-01 9.897e-01 9.955e-01 9.983e-01 1.000e+00
```

precipitation

```
      n   missing    unique     Info     Mean      .05      .10      .25      .50      .75      .90      .9
 562400     18240       181        1    1.281    0.125    0.250    0.591    1.113    1.834    2.593    2.87

lowest : 0.051 0.057 0.074 0.078 0.083
highest: 3.035 3.142 3.259 3.436 7.369
```

legal origin gbr

```
      n   missing    unique
 568480     12160         2

0 (383040, 67%), 1 (185440, 33%)
```

legal origin fra

n	missing	unique
568480	12160	2

`0 (319200, 56%), 1 (249280, 44%)`

legal origin soc

n	missing	unique
568480	12160	2

`0 (465120, 82%), 1 (103360, 18%)`

legal origin deu

n	missing	unique
568480	12160	2

`0 (553280, 97%), 1 (15200, 3%)`

legal origin sca

n	missing	unique
568480	12160	2

`0 (553280, 97%), 1 (15200, 3%)`

gatt

n	missing	unique
580640	0	2

`0 (174800, 30%), 1 (405840, 70%)`

rta

n	missing	unique
580640	0	2

`0 (549660, 95%), 1 (30980, 5%)`

Table 8: Number of CLIWOC data per ocean, country and period.

		North Atlantic	South Atlantic	Indian	Pacific	All
Spain	$\leq$1800	28236	11622	319	1614	41791
	$>$1800	399	190	301	89	979
UK	$\leq$1800	31603	12530	16104	1281	61518
	$>$1800	9270	5202	7002	200	21674
Netherlands	$\leq$1800	20045	5109	5142	0	30296
	$>$1800	31932	18348	26617	1481	78378
France	$\leq$1800	3898	158	159	896	5111
	$>$1800	32	28	46	0	106
Total		125415	53187	55690	5561	239853

Table 9: Trips in CLIWOC between 1662 and 1749

VoyageID	ShipName	VoyageFrom	VoyageTo	Nationality	Number of Days
16630214Maarseveen	Maarseveen	Rotterdam	Batavia	Dutch	113
16621015Maarseveen	Maarseveen	Rotterdam	Batavia	Dutch	74
16750921NaSa DEL ROSARIO	NaSa DEL ROSARIO	EL CALLAO	EL CALLAO	Spanish	39
16770412Africa	Africa	Texel	Batavia	Dutch	141
16990331Wesel	Wesel	Kaap de Goede Hoop	De eilanden Dina en Maarseveen	Dutch	44
17420222DESCONOCIDO-01	DESCONOCIDO-01	LA HABANA	SAN AGUSTIN DE LA FLORIDA	Spanish	12
17451206SAN ANTONIO	SAN ANTONIO	BUENOS AIRES	BUENOS AIRES	Spanish	120
17460620La Gironde	La Gironde	Rochefort	Baie de Chibouctou-Rochefort	French	93
17461024La Gironde	La Gironde	Rochefort	Baie de Chibouctou-Rochefort	French	53
17480219Freden	Freden	Gothenburg	Canton	Swedish	158
17491128Polanen	Polanen	Batavia	Kaap de Goede Hoop	Dutch	164
17490129Freden	Freden	Canton	Gothenburg	Swedish	8

* Our Elaborations from CLIWOC 2.1, De Benedictis and Pinna (2015)

8.4 τ_{ij} characteristics

In some cases the index τ_{ij} takes a negative value. This happens when $\frac{X_{ii}X_{jj}}{X_{ij}X_{ji}} > 1$ but the square root of the term is less than 1. These cases pertain always to the same county pair: Malaysia and Singapore for the period 1997, 1999, 2000, 2002 and 2007.

Particular cases are those ones where the value of internal trade is negative because of the high value of re-exports. Observations which satisfy this condition are pertinent for some years to Antigua and Barbuda; Belize; Guyana; Liberia; Malaysia; Marshall Islands and Singapore. In this case the value of the index is undefined, except for those cases where both countries in the pair report a negative value of the internal trade term.

After the change in trade values from 0 to 1 (144934 cases of pair's trade in both or either direction equal to zero), the value of the ratio is undefined when either:

1. trade in either or both directions between the *ij* couple is missing; this happens in the matrix without repetition 8147 times (5217 joint missing; 1517 and 1413 asymmetric missing values in trade). All these observations pertain to 2011, but this year is excluded from the analysis.

2. GDP is missing for either or both countries (in 847 cases the value of GDP is missing for both countries in the pair; and 15056 and 16118 asymmetric cases);

3. when the values for internal trade are negative (4652 and 6216 cases where one of the countries has exports greater than GDP; in 75 cases the value in the square root term of τ_{ij} is still positive: both countries have a negative internal trade therefore the index can be computed; in 1 case, where internal trade is negative for both countries, the index is missing since also case 1 is satisfied.)

8.5 Imputing and trimming data

We imputed data on trade costs when the income data was not available. We substitute, for each unit of τ_{ij} with a missing value (not the ones with zero bilateral trade), the predicted mean of a linear regression having as covariates time and country pair dummies, the log of bilateral trade (adjusted for zero trade flows, as described in the text), the log of countries land area, the log of countries population, the log of bilateral distance, and a dummy indicating the presence or absence of a regional trade agreement. The regression explains the 83.7 % of the variability of the data.

We also (minimally) trimmed the data for outliers. We excluded all observations that had a level of bilateral distance (in logs) below 3 (16 observations), and all observation with a trade cost (in logs) below -2.5 (5 observations).

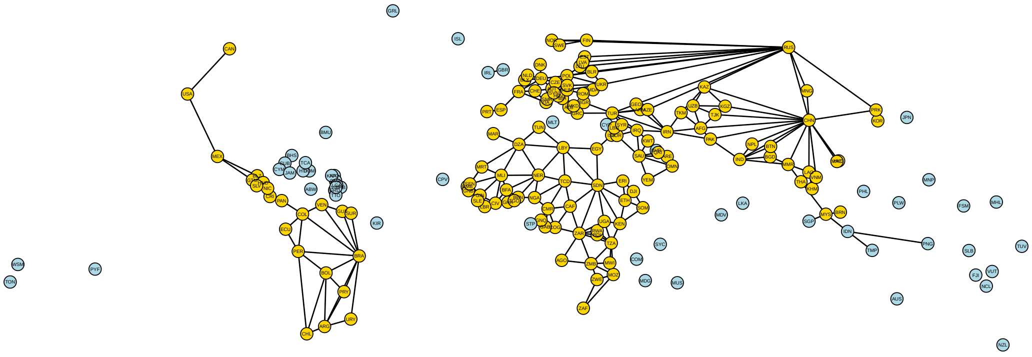
The imputation and trimming procedures are fully described in the supplementary material to the paper.

8.6 Georeferenced connectedness

To measure and visualize countries connectedness we use a proximity index that takes a value of 1 if countries share a common border, and zero otherwise. Nodes are positioned according to the latitude and longitude of capital cities.

Figure 13:

A network visualization of countries' connectedness



Note: Nodes are positioned according to the latitude and longitude of capital cities. Links are present when countries share a common border. Data comes from the CEPII database.

8.7 3D scatterplot and spatial heatmap of trade costs

It is very helpful to have a first glance to the main variable of interest through a visualization of the relationship between space (latitude and longitude) and trade costs. We do it sequentially using a 3D scatterplot and a heat map.

In figure 14 we plot the level of countries' trade costs in 2000 (the vertical axis) having the position of each country fixed (on the two horizontal axes) by the country's latitude and longitude. The fluctuation of the nonparametric interpolation of trade costs, that visualizes a spline regression of trade costs on the the spatial coordinates, with an optimal choice of knots of 25, makes evident that trade costs are higher at the edges of the surface and at center of it, with a trimodal local distribution. The local modes of this three dimensional distribution are in the Caribbeans, Africa and the North-East of Asia, but the global mode is in the Pacific.

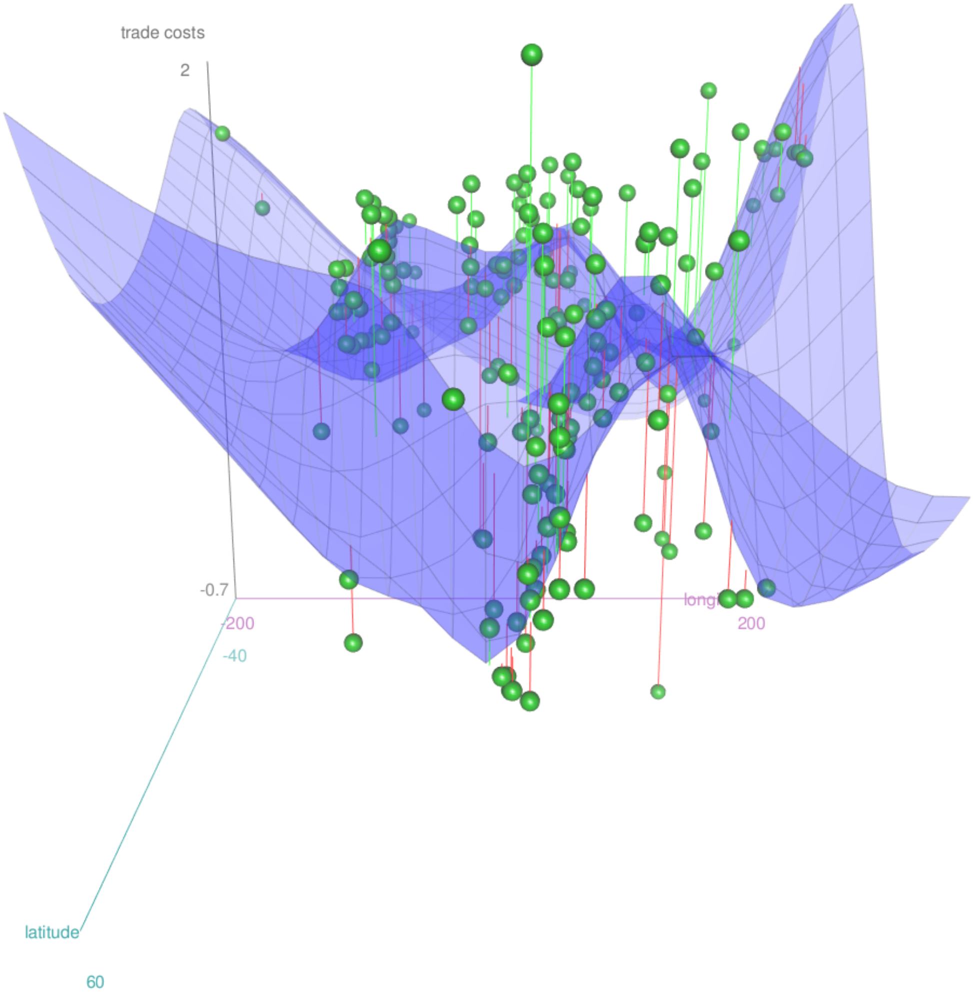
The heatmap in figure 15 projects on the longitude-latitude space the estimated level of trade costs from the above spline regression. The scale of trade costs, that goes from 0 to the maximum level of τ_{ij}, moves progressively from a light blue (low trade costs) to a dark red (high trade costs).

Countries are identified by ISO3 code, and red and black dots indicate Islands and other countries. The dark red areas correspond to the high trade costs modes in figure 14. They identify countries in the Pacific, the Caribbeans, in East Africa and the Indian Ocean, and in the North-East of Asia.

Islands are present in both "light blue" and "dark red" zones.

Figure 14:

A 3D visualization of trade costs in space (2000)

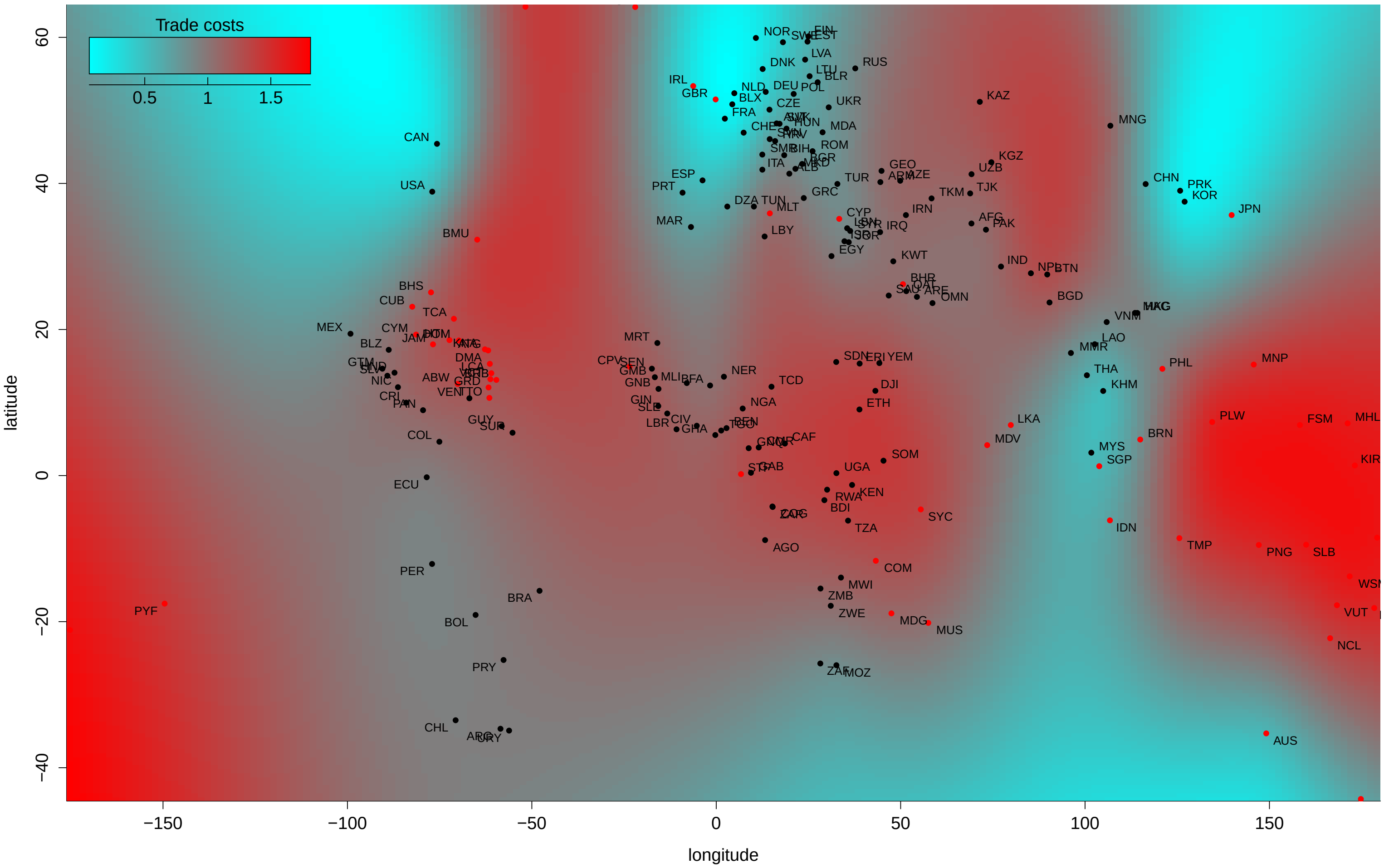


scatterplot.png

Note: Nodes are positioned according to the latitude and longitude of countries' capital cities. The third dimension (the vertical axis) measure the trade costs (with $\sigma = 11$) in year 2000. The smooth surface visualizes a nonparametric interpolation of trade costs on latitude and longitude. We use a 3D spline with 25 knot points. Data on latitude and longitude comes from the CEPII database.

Figure 15:

A heatmap visualization of trade costs in space (2000)



ts.pdf

Note: Nodes are positioned according to the latitude and longitude of countries' capital cities. Countries are identified by ISO3 code, and red and black dots indicates Islands and other countries. Trade costs ($\sigma = 11$) are on a continuous scale, from the minimum level of τ_{ij} to the maximum level of τ_{ij} in 2000, that goes from a light blue (low trade costs) to a dark red (high trade costs). Data on latitude and longitude comes from the CEPII database.

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