ABSTRACT

A Social Networks Framework to Study the Influence of Language on International Trade in Services

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Social network theory has been overlooked as a tool to examine relationships in economics whereas all economic interactions create networks, some more complex than others. Specifically, attempts to estimate drivers of bilateral trade fall in this category. A significant number of studies explaining trade focus on the gravity model and estimate varieties of transformations. The literature widely measures the effect of language in gravity models using a dummy variable indicating the presence of common language between trading countries, and recently developed measures of linguistic distance. However, there has not been an attempt to estimate the effect of language as a factor that connects countries and allows one country to influence other countries in the network. This thesis constructs a network of countries whose interconnections are the similarities of the languages of the countries. I first estimate the linear effects of eigenvector centrality on per capita income, and then on exports. The results reveal that there is a positive relationship between linguistic influence and exports.

A Social Networks Framework to Study the Influence of Language on International Trade in Services

by

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A Thesis

Approved by the Department of Economics

Charles North, Ph.D., Chairperson

Submitted to the Graduate Faculty of
Baylor University in Partial Fulfillment of the
Requirements for the Degree
of

Master of Science in Economics

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Accepted by the Graduate School

May 2021

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Page bearing signatures is kept on file in the Graduate School.

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ACKNOWLEDGMENTS

I would like to thank Dr. Van Pham for his guidance throughout this thesis. I would also like to thank Dr. Jeanne Hill, and Dr. Lourenco Paz for being on my committee and for their feedback. I am very thankful to all my friends especially, Olaoluwa Ajimoko, Santiago Silva, Peter and Vanessa Doe, Trevor Hoogendoorn, and my family members, who supported me at Baylor and throughout the writing process. Finally, I thank Jesus Christ, my Lord and Savior, for guiding me to this point in my life and to complete this thesis.

CHAPTER ONE

Introduction

Consumption in services has increased in the last decades following technological growth and innovation. Consequently, services have become important for the global economy. Trade in services have increased, from constituting approximately 6% of world output in 1960 to 13.5% of it in 2019 (World Bank 2021). The increase in global service exports from 2005 to 2019 shown in Figure 1 below shows the trends in the exports of total services from 2000 to 2019. Except for 2008 and 2009 which shows the starkest decrease, there is an overall increase in exports over the last two decades. This indicates the need to understand factors that drive global services trade, not only for its own sake but also because exports can drive growth and development.

Deardoff (2010) defines a service as a "product that is not embodied in a physical good and that typically effects some change in another product, person, or institution". Services exports have expanded by 5.4 % annually on average since 2005 compared to the 4.6 % annual expansion of goods exports (WTO report 2019). These services span different categories from transportation to health services, and construction.

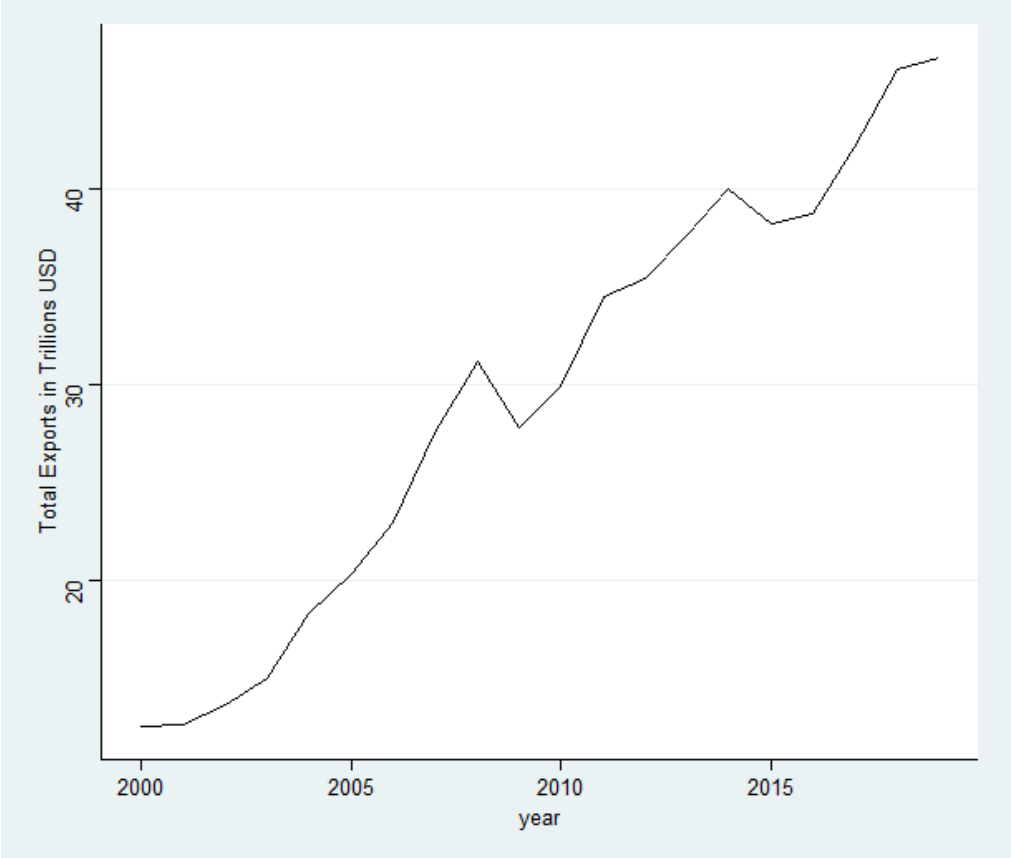

Figure 1. *The Growth of Global Service Exports, 2005 – 2019*. Source: WTO 2021

An analysis of world trade in 2017 by the WTO indicated that financial services were the most exported services between 2005 and 2017. This indicates that the technological trends and shifts in preferences favor certain categories of services more than others. More so, services that would have been considered untradeable are now mainstream (Amiti and Wei 2009, 203)- an unsurprising development, since more flexibility in delivery methods has removed the requirement that consumers and suppliers be in the same location (Francois and Hoekman 2010, 648) .

International trade in services has also increased in a more dynamic way and has been more resilient to economic shocks, when compared to the sluggish growth in goods trade (Eurostat, Statistics explained 2021). This resilience and the above trends is a basis

for maximizing trade in services in the nation's export-import portfolio since overall exposure of national output to risk is reduced.

Despite its importance to the global economy, it is usually difficult to study trade in services. This is due to the difficulty associated with collecting data on cross-border trade in service, caused by the intangible nature of services and the high capacity needed to record such data. In cases like financial and intellectual property-related services, collecting data is particularly challenging because the service is being consumed at the time of production.

Most studies attempting to explain trade in goods or services use the gravity equation developed by Tinbergen (1962) and Pöyhönen (1963). Language is a main variable of interest in this equation, and country-specific variables like GDP and distance from the equator are also part of the equation. The importance of language in international trade, specifically in services trade, cannot be overstated since ease of communication reduces costs for the exporter and importer. Till date, studies on the effects of language on trade have used a simplistic dummy-variable-oriented approach to measure the Language variable, while others have developed variations of Linguistic proximity and Linguistic distance to estimate the similarity between native languages.

In this study to examine how the influence of a language can affect exports of services, I use a social network-oriented approach instead of the traditional common language variables of the gravity equation to measure Language. I posit that countries with languages that are more central in a network will export more than those with less central languages. Centrality represents the level of influence that the language has in the network.

I also examine the effect of centrality on separate service categories to determine which services are more sensitive to language centrality.

Motivating Mechanism

The interest in understanding linguistic influence as a determinant of exports is based on the positive relationship between exports and GDP observed in Figure 2 below. Studies (Felipe et al., 2012) have attempted to explain why most countries in the world are not in "the club of rich nations", with income per capita above $12000 (IMF, 2021), by studying characteristics of countries' export baskets. Some argue that countries become rich because of the type of economic activities they engage in, and the type of goods and services they export.

Figure 2 below shows three clusters of countries based on their income levels; high, middle, or low. Countries are High income when gross national income per capita is greater than USD12000 as mentioned earlier, low if GNI is less than USD 1035, and middle if the GNI falls between the high and low thresholds (United Nations Development Country Classification, 2021). Countries doing well economically, in orange, mostly have high levels of service exports. Examples include Italy, Norway, Luxembourg, and others close to 12.5 on the y-axis. On the other hand, low-income countries such Central African Republic and Gabon have very low service exports. This indicates that high levels of national prosperity.

Figure 2. *GDP per Capita and Total Exports, 2000 - 2019*. Source: Comtrade 2021

However, not all countries in Figure 2 above with high service exports have high levels of per capita income. India for instance, has a significantly larger level of exports compared to countries with comparable per capita income levels, which corroborates Eichengreen et al. (2013) analysis of India's exports. This suggests that although exports generally move in the same direction as economic prosperity, there is more to the story. Specifically, that a country's ability to understand and deploy new technologies is also a key determinant for development.

Nonetheless, the positive relationship between service exports and per capita income in Figure 2 above warrants the need to focus on service exports as a major determinant of national prosperity and by so doing understanding factors that determine

the level of service exports. In fact, Gabriele (2006) found that in the long run services exports have a positive impact on GDP growth in developing countries.

Since the focus is on service exports and given the increasingly digital nature of the global economy, it is believed that ease of communication and the degree of information dispersion can be critical to influencing exports. The global economy is a large, closed and highly connected network, similar to a social structure. This implies that as human beings relate to each other and influence one another in social networks, so too do countries. Many types of networks can be formed to model the type of interactions between countries. For instance, CEPII, the French center for international studies has built a network modelling the nature of global bilateral exports and the strength of links between countries. A network can be built to represent diplomatic ties between countries, where not all countries will be connected in that network. In that same way, this study has constructed a linguistic network relating 195 countries in the world to each other.

The idea is to explore the level of similarity between native languages of the world, and in that sense to visualize the strength between countries. More importantly, I aim at establishing a chain of influence in this network and posit that influential countries would export more than their less influential counterparts. In keeping with the idea in network theory that influential countries are central to information dispersion, influential countries in the network will be able to spread their cultural cues and linguistic influence in the network, which in turn leads to ethnic trust, reduced cost of communications, increased access to international markets, and eventually growth in exports.

However, it is crucial to remain conscious of the endogenous nature of exports and alternative factors that influence it. Eichengreen et al. (2013) for instance found that factors

such as overall economic development, communications infrastructure, access to foreign technology, and spillovers between the merchandise and service exports can influence the level of exports.

Chapter two contains a literature review of the use of language variables and linguistic concepts to study bilateral trade – merchandise and service. It also includes an overview of studies on international service trade and domestic output, as well as the concept of centrality and its application to social networks. Chapters three and four detail the data and methodology used in the paper. Chapter five presents the results from the regressions and, finally, chapter six is a discussion of the results and conclusion.

CHAPTER TWO

Literature Review

Measurement of Language in Trade Models

Studies in international trade have established that language is a strong determinant of bilateral trade patterns. Specifically, countries sharing a common language trade significantly more with each other than countries using different languages, everything being equal. This follows from the increased globalization of the world and the associated wider market this has provided to companies who seek to maximize profits and minimize costs. These companies in turn make choices and decisions to achieve that end. Specifically, which countries to operate in, given the linguistic constraints. Language barriers can hinder international trade while language similarity can boost trade by decreasing communications costs (Ferro and Ribeiro, 2016). In the same light, Vlasenko et al., (2020) observe that language differences between economies can be used to assess the relative cheapness or costliness of business communications and the cost of localization of commodities in international trade which is not always in direct relation to the proximity of two languages in the linguistic family tree (Chiswick, B., & Miller, P., 2005). For instance, Polish and Ukrainian are linguistically close languages but use Latin and Cyrillic alphabet, respectively. Driven by the need to understand these language barriers, Ferro et al., (2016) estimate the relationship between language barriers and trade. They find that language plays an important role in the choice of foreign trading partners although sharing Portuguese, specifically, as the common language with a group of countries does not imply

exporting more to those countries as one would expect. Their policy recommendation is to increase multilingual policies in education and more investments in reaping the associated benefits.

Lami et al. (2015) conducted the first analysis of the effect of language on trade in an intra-national context. The authors analyzed unique data for a single-language country, Germany, and found that similarities in the local dialect have a significant positive impact on regional trade. This finding justifies the view that language similarities in regions enhances cultural identity which in turn leads to favorable trading conditions. They further attribute the increase regional trade flows to a cultural effect rather than decreased communications costs and similarity of institutions because linguistic similarities will likely reflect cultural ties across regions.

Language variables are usually included with a shared border dummy as a control variable in standard gravity models (Frankel 1997, 54) to estimate bilateral trade flow. The popular measure of common language CL in the gravity model is a binary one which takes a on values 0 or 1 to indicate the presence or absence respectively of a common language for given country pairs (Anderson and Wincoop 2004, 711). De Groot et al., (2004) use common language as a control when estimating institutional determinants of bilateral trade and arrive at findings which are consistent with the literature, that common language has a positive impact on trade flows. They nonetheless caution about the possible biasedness of their coefficient when country specific variables such as quality of regulations and governance effectiveness are excluded. To estimate the effect of experience in overcoming "dark" trade costs during bilateral trade, the same binary variable was used to model the presence of a common language and proved to be significant and reinforced the positive

relationship between common language and trade Dutt et al., (2020). Measuring experience as the cumulated sum of past exports and in years of positive trade, they find strong role by experience in reducing trading costs and increasing bilateral exports. Jan and Shah (2008) in a study that attempts to examine Pakistan's trade patterns with South Asian countries by using a gravity model of trade find consistent positive effects on trade of sharing a common language. Moreover, when using a gravity model to examine the impact of religion on international trade in goods and service, Lee (2013) found out that common language has a positive effect on trade in goods and services. The study showed that religion creates positive institutional and network effects, which increase international trade in goods.

One problem with using a single dummy variable to measure the effect of language on trade is that the process of determining if a common language exists has varied across studies: they did not generally agree on a standard language for countries with multiple official and spoken languages. For instance, Frankel (1997) assumes that only a few languages have a significant impact on international trade and therefore used only English, Spanish, Chinese, Arabic, French, German, Japanese, Dutch, and Portuguese for evaluation of a shared language. On the other hand, Mayer and Zignago (2005) use a dummy variable that depends on whether a country pair share a language spoken by at least 9% of the population (17).

Melitz (2008) points out that including language minorities with other representative languages for a country could result in a very low probability that two random people from the nations' populations would speak the same language. He posits that majority languages influence trade through different mechanisms than minority

languages and so they need to be treated separately. He differentiates between communication and what he refers to as open circuit communication, which mirrors the presence of an established network of translation through major common languages. The dummy for direct communication was 1 if at last 4% of the population in the country pair spoke the language and the dummy for open circuit communication was 1 if two nations shared an official language or a language spoken by at least 20% of the population (670). He found that common languages promoted trade through both translation and communication, but direct communication had a larger effect on trade.

Studies have also differed in opinion on which component of common language is used for the dummy measurement.

This leads us to the second problem of using a single binary variable to capture bilateral linguistic ties is dimensional since it constrains language to one dimension. Using common official language for instance to model linguistic interaction fails to reflect the diverse sources of communication such as ethnic ties and trust and the ability to communicate directly and indirectly.

Melitz and Toubal (2014) proved that limiting the effects of language to common official language or to a single component of bilateral communication underestimates the contribution of language to international trade. Using aggregate measures of language influence, they found out that the impact of linguistic factors on international trade when included in the model together is at least twice as great as the usual dummy variable that relies on the presence of an official language. They proceed to suggest their own index to control for the aggregate impact of language in studies which do not want to dwell on the impact of language but still want to control for it with minimal error.

Dissatisfaction with the traditional language dummy variable has caused Fasih (2018) to propose its replacement with the linguistic proximity index defined as explained by y Adserà & Pytliková (2015). This index is the sum of the weights of four different levels of a family tree which may take on a discrete range from 0, 0.1, 0.2, …, 1, depending on their combination. This adds more variation to the hitherto binary language variable. But Vlasenko (2021) impugns this estimate based on its interpretability since it aggregates quantitative and qualitative variables.

But this dissatisfaction towards a binary measure of language stems from centuries. Among the studies that examined language as a non-binary variable, Boisso and Ferrantino (1997) used data from Katzner (1986) for native languages spoken by at least 1% of the population to develop a linguistic distance index based on the likelihood that two random people selected from both nations in a country pair would speak the same native language. Research on linguistic proximity or distance has flourished since then. Melitz and Toubal (2014), for instance, constructed two measures of linguistic proximity, LP1 and LP2. Inspired by an idea in Laitin (2000) and Fearon (2003) they based their calculations of linguistic proximities on Ethnologue classifications of language trees between trees, branches, and sub-branches. When constructing LP1, they allowed for 4 possibilities, 0 if 2 languages belong to separate family trees, 0.25 if 2 languages belong to different branches of the same family tree, 0.5 if 2 languages belong to the same branch (English and German) and 0.75 if 2 languages belong to the same subbranch (German and Dutch). They believed that this measure was problematic when comparing languages from different family trees because the method always gives a LP of 0 when the 2 languages are on

different family trees and it assumes that a 0.5 is the same in Indo-European group as in the Altaic, Turkic one.

They developed LP2 to overcome these problems. It relies on the Automated Similarity Judgement Program (ASJP) scoring of similarity of 200 words in a list that was first compiled by Swadesh (1952). After computing an 89 by 88 matrix of linguistic distances from Dik Bakker (in October 2010) they adjusted for instances where words with the same meaning can resemble each other by chance. To convert this distance matrix to a proximity matrix, they then took the reciprocal of each computed figure and multiplied it by the lowest number in the original series. This inverted the order of the numbers without changing the signs and converted the series from a 0-100 scale to a 0-1 scale. LP1 measures distance while LP2 measures proximity.

LP1 and LP2 have since been used in international trade. In a study examining the effect of language on foreign direct investment for instance, Feng et al., (2018) estimate a gravity model to examine a gravity model to examine how various aspects of language can influence bilateral foreign direct investment FDI. They find out that although common language tends to foster bilateral FDI, some components are more important than other. Specifically, bilateral FDI tends to be higher between countries that are linguistically proximate or share a common native language. They further observe that common native language, which indicates ethnic ties and trust, is the strongest predictor for FDI.

Vlasenko et al., (2020) estimates the impact of China's linguistic distance with its major trading partners on the exports. They propose the use of four indicators to determine if two countries are linguistically close or distant: 1) the estimated size of diaspora; 2) similarity of the writing systems; 3) level of institutional cooperation; 4) English language

proficiency. The binary outcome would take on a value of 0 for proximity or 1 for distance, depending on thresholds for either of the indicators mentioned above. Proximity for would be achieve by the presence of more than 100, 000 people in the Chinese diaspora of the trading partner, the presence of 5 or more Confucius institutes or classes officially opened in the country, or the use of Chinese characters as an official writing system or extensive experience of its use in the past. Based on the above estimates, they arrived at the conclusion that 24 countries were linguistically close to China, out of their 198 trading partners in the sample. Their estimation of the gravity equation yielded negative coefficients for linguistic distance, indicating its negative effect on bilateral trade and hence consistency with the literature.

As one of numerous studies that have attempted to estimate the effect of a language barrier on the level of trade, Lohman (2010) estimated a gravity model augmented by the Language Barrier Index. The findings indicate that a 0.10 increase in the Language Barrier Index (which corresponds to a 10% decrease in common linguistic features is associated with a 6.8% to 9.8% decrease in trade.

Service Trade

Though majority of studies have focused on commodity trade in the past, the growing share of service exports in the world output has increased the need to study international flows of services. Trade in services differ from commodity trade because the production of services is closely linked with the trade of services due to pre-production arrangements. Moreover, in some cases, the production and consumption of the service happen at the same time. Goods on the other hand can be produced without the knowledge of whether they will be sold in the domestic or foreign economy (IMF 1993, 51).
Despite this stark difference, studies conventionally use the gravity equation to estimate bilateral trade flows.

According to Hamanaka (2013), the gravity models used to examine services trade are almost like the gravity models used to study trade in goods. Classifies the independent variables in these models as relational factors and country-specific factors. The relational factors capture the relationship between country pairs and include common language, shared border, membership in the same RTA, and bilateral geographical distance. Unlike distance for which actual values exists, the first three are dummy variables for 1 if the condition exists and 0 otherwise. The country specific factors on the other hand pertain to each country and affects its trade with other countries. They include gross domestic product (GDP) per capita GDP, population, landlocked status, labor market and wages, contract enforcement, technology, and economic freedom.

In this light, though the focus would usually be to estimate the impact of some variable on service trade, the authors would include one of any numerous linguistics measures as control for language. For example, Lee (2013) uses gravity modelling to

examine the impact of religion on international trade in goods and services. The poisson pseudo-maximum likelihood estimator is used to correct for the presence of heteroscedasticity, and religion-related dummy variables are incorporated to investigate the relationship between religion and trade. The results show that religion creates positive institutional and network effects, increasing international trade in goods and services although these effects enhance trade in services more than trade in goods. Institutional effects exert a greater trade-creating effect than deliberately designed regimes, but a lesser effect than historically established cultural regimes like common language and colonial ties. They also find out that network effects on trade in services, although less significant than common language and colonial ties, promote trade to nearly the same degree as regional trade agreements and shared legal systems. The surmise institutional distance between countries is reduced by the co-religious networks created by religion, which enhance interpersonal trust.

When comparing the level of services trade integration in Asia to Europe and North America Hamanka (2013) used the gravity equation for services and relies on relational factors to explain regional trade biases. He believes that the relational factors mentioned above explain regional bias. The findings showed that the regional bias of services trade in Asia is about the same level or higher in Europe, the regional bias of service trade is higher in Asia which is in sharp contrast to Europe and North America where the regional bias in goods is higher than the regional bias in services, and while Asia's regional bias in goods seems to be declining, the bias in services remains relatively high and constant. He attributes this bias to the high prevalence of Chinese as a shared language and the

archipelagic nature of Asian countries, in contrast to European countries that share common borders and speak many languages which enhances integration.

In another study of integration and trade biases, Nordas (2018) uses the gravity model to examine if the Nordics trade more with each other than what could be expected from their relative market size. He classifies the determinants of service trade as actionable and non-actionable determinants. The actionable determinants are policy based while the non-actionable include factors like sharing a land border, language, colonial past, and legal origin. He finds out that policy determined free trade agreements boost services trade by 75% and a single market by 45%, while the accumulated effect of all standard non-actionable shared geographical, institutional, and cultural features almost triples the services trade. He posits that the existing Nordic bias indicates that full integration of services markets may rely on deeper institutional and cultural factors.

International Trade and GDP per Capita

The theory of comparative advantage suggests that free trade increases global production of goods and services. Lambretch et al. (2012) measure trade freedom using the Trade Freedom Index published by the Heritage Foundation in 2011 as a component of EFI which considers direct trade barriers and non-tariff barriers. The second measure is Trade as a percentage of GDP and the last one is Weighted Average tariff rate across all Products which indicates the level of government hinderance to free trade. They observed nineteen countries from Asia, Europe, the Middle East, Northern Africa, Sub Saharan Africa, North and South America to identify the correlation and trends between free trade and GDP per capita. They found out that there is a strong link between free trade and GDP per capita. They nonetheless cautioned that free trade alone is not sufficient to achieve significant

increases in GDP per capita and it needs to be accompanied by other factors like political stability and resource endowments. Their recommendation could be considered a mere opinion, when compared to the robust study conducted by Robin et al., (200) ascertaining the primacy of institutions over geography and integration. They use European settler mortality rates and FR constructed trade shares as instruments for institutions and integration respectively to estimate the respective contributions of institutions, geography, and trade in determining income levels around the world. Their results indicate that quality of institutions is the most important factor for growth and once quality of institutions is controlled for, geography yields a weak positive effect. Trade becomes insignificant once quality of institutions is controlled for and has a negative sign which they consider "wrong".

Al-Shayeb and Hatemi-J (2016) used asymmetric generalized impulse response functions and the asymmetric causality tests developed by Hatemi-J to offer a review of the trade policy in the UAE and examine the dynamic interaction between trade openness and GDP per capita. They explain that asymmetry adds a more realistic assumption to the model since economic agents, according to them, economic agents usually react more to negative shocks than positive shocks. Their results from asymmetric generalized impulse response functions indicate that a positive permanent shock in the trade openness leads to a significant positive response in the cumulative sum of the positive component of the per capita GDP but they do not find the same response in the case of negative shocks.

Another country specific analysis to identify the relationship between trade and growth rate of GDP per capita was done by Hussain and Haque (2016) . They apply the Vector Error Correction Model (VECM) to an annual time series data for 1973 to2014 to examine the

relationship between foreign direct investment, trade, and economic growth in the case of Bangladesh. Their results show that the trade and foreign direct investment variables have a significant impact on the growth rate of GDP per capita. They check the validity of the VECM by doing post-estimation diagnostics tests which reveal normally distributed residuals of their regressions and absence of autocorrelation. Similar studies have been conducted for Greece over a period of 1960-2002 (Dritsaki et al., 2004), Nigeria between 1970 and 2008 (Umoh, Jacob, and Chuku, 2012), and Pakistan and India (Hossain and Hossain, 2012). The consensus has been that trade components and foreign direct investment has a positive relationship with per capita GDP.

Busse and Koniger (2012) estimate the effect of trade on growth since they believe that international trade in goods and service is a principal channel for the international exchange of ideas. They argue that the effect of trade on growth is ambiguous and that in dynamic panel estimates it will depend on the specification of trade. They specify trade as the volume of exports and imports as a share of lagged total GDP and use the System GMM estimator suggested by Arellano and Bover (1995) and Blundell and Bond (1998) to solve their suggested variation of an augmented Solow growth model. Their find that this measure has a positive and significant impact on growth.

Centrality and Influence from a Social Network Perspective

Based on Valente (1996) the term social network is a "pattern of friendship, advice, communication or support" (Valente, 1996) between individual members or groups of members within a social system (cf. also Burt and Minor 1983; Knoke and Kuklinski 1982; Scott 1991; Wellman 1988). Networks are applicable to many areas of life. In every instance where two or more entities interact a network can be formed. Identifying the most influential players in these social structures is key to efficiency and reduction in associated communications costs. The conventional world for influence in social networks and graph theory, is centrality. Freeman (1979) argues that individuals occupying a more central position in a social network have better access to valuable information and other resources than other individuals occupying fewer central positions. This is a reasonable assertion since the essence of a social network is the relationship between network members and hence the network structure induced by the mutual connections (Zinoviev and Duong 2009). The structural integration – interconnectedness- of actors into the network therefore significantly influences their communication and interaction (Landherr et al., 2010).

Landherr et al. (2010) model the relationships within a social network as a graph G with a set of VG nodes and a set of EG edges between these nodes. The set VG represents the members of the network while EG represents the relationships between them and thus describe the existence of relationships between the actors and in some instances the weight of the connection between members (Sabidussi 1966; Wassermann and Faust 1994) . The resulting network structure of a social network can also be represented by an adjacency matrix $Aij = (aij) \in \{0,1\}$ nxn. The entry aij where $i \neq j$ takes on a value of 1 for $aij \in EG$

and 0 otherwise, indicating the respective presence and absence of interactions between agents in the network.

Social networks classified into directed or undirected, and weighted or unweighted graphs (Wassermann and Faust, 1994, p.44). In directed graphs the nature of the relationship is one-sided while weighted graphs assign quantitative indexes to the edges of the networks. Though Milgram (1967) points out that everyone is connected to everyone else in the world in a short chain from an average of six contacts, there are cases where a network contains agents who are not connected to any other nodes.

Since the level of interconnectedness in a network will usually vary by node, several measures of interconnectedness have been developed in the literature and some refined over time. The most recurrent measures are Degree centrality, Closeness centrality, Betweenness centrality, and two measures of node influence namely Eigenvector centrality and Katz's centrality measure (Katz, 1953).

The DC σD represents the simplest measure of centrality and determines the number of direct contacts as an indicator of the quality of a network member's interconnectedness (Nieminen 1974, p. 333). It increases with the number of direct contacts of a node.

The closeness centrality σc is predicated on the notion that nodes with a short distance to other nodes can spread information very productively through the network (Beauchamp 1965). The CC σc(i) of a node i, is calculated by summing up the distances between the node and all other nodes of the network (Sabidussi 1966, p. 583). Taking the reciprocal of the distance creates an index which increases in value when the distance to another node reduces (Landherr et al., 2010)

In the case of Betweenness centrality σB, a node is highly connected if it is located on as many shortest paths between other node pairs.

Freeman (1979, p.223) models this centrality for node (x) as

$$\sigma B = \sum_{i=1, i \neq x}^{n} \sum_{j<1, j \neq x}^{n} \frac{g_{ij}(x)}{g_{ij}} \quad (3)$$

with gij representing the number of shortest paths from node i to node j, and gij(x) denoting the number of these paths which passes through the node x.

The Eigenvector centrality σE is based on the idea that a relationship to a more interconnected node increases one's own centrality than a relationship to a lesser interconnected node (Landherr et al., 2010). According to (Bonacich and Lloyd 2001), the Eigenvector centrality for node (i) is measured as

$$\sigma E(i) = vi = \frac{1}{\lambda_{max}(A)} \sum_{j=1}^{n} a_{ji} \cdot v_j \quad (4)$$

where v = (v1,…, vn)T refers to the eigenvector of the maximum eigenvalue of the adjacency matrix, λmax(A).

Katz (1953) posits that not only the number of direct connections but also the further interconnectedness of actors plays an important role for the overall interconnectedness of agents in the social network. He therefore includes all paths of arbitrary lengths from node (i) to all other nodes in the network in the following estimator.

$$\sum K(i) = 1T \left(\sum_{i=1}^{\infty} k^i A^i \right) e_x \quad (5)$$

where 1 = (1, …, 1, 1)T represents the nx1vector consisting of ones only, ex = (0, …, 0, 1, 0, …,0)T is a unit vector, and k is a weighting constant which is usually positive.

Since the corresponding adjacency matrix, A=(aij) only contains the values 0 and 1, the entry ãxy of the matrix Ã=Ai represents the number of paths of length i from one node to the other (Katz 1953, p. 40). For the convergence of the series, k must be smaller than the

reciprocal value of the maximum eigenvalue λmax(A) of the adjacency matrix A (Katz 1953, p. 42). This simplifies the Katz coefficient to

$$\sigma k(x) = \quad 1T((I_n - kA)^{-1} - I_n)ex \qquad (6)$$

with In referring to the identity matrix of the dimension n=|VG|. The weighting factor k can then be sometimes interpreted as the probability that a single relationship is useful for node x. Assuming independence of probabilities this results in a probability of k2 for a relation of second degree, and so forth (Katz 1953, p. 41).

Studies across various fields have used the above-mentioned centrality measures in different capacities.

For instance, Shijaku et al. (2020) analyze how firm's structural positioning, captured through network centrality, affects organizational aspirations to engage in international strategic alliance. They are specifically interested on the effects of centrality on internationalization behavior in response to the performance aspiration gaps. Using a sample of 7760 alliance collaborations from the top 81 global pharmaceutical firms from 1991 to 2012 they find that ISA formation is increased as firms are positioned more centrally in their network.

In a study on the social network centrality of Chief Executive Officers (CEO), Lopez et al. (2018) examine how CEO network centrality relate to corporate cash holdings. They find a significant negative relation between CEO network centrality and the level of corporate cash holdings, suggesting that firms with higher-centrality CEOs hold less cash.

Agus and Yan (2020) draw from social capital, social network theory of stakeholder influence and stakeholder management to examine the relationship between board network

centrality and a firm's environmental, social and governance performance. They construct degree, closeness, eigenvector, betweenness and information centralities as measures of access to social capital and timely information. Using a sample of non-financial firms listed in the UK FTSE 350 index from 2007 to 2018, they find that board networks have a positive influence on firm's ESG performance.

CHAPTER THREE

Data

The data used in this study comes from multiple sources. First, the exports data comes from the UN Comtrade Database and contains total global annual exports and imports for 154 countries from 2000 to 2019, in an unbalanced panel. The panel is unbalanced because data for certain export categories is unavailable for some countries during certain time periods. Since many services, especially in categories such as communications, and computer and information are dependent on the level of technology, countries which lacked such support systems could not produce or trade in such services. This creates zeros in the data. I nonetheless include the years when these countries record no trade in such categories to avoid survival bias. This leaves the possibility to investigate the level of influence that technological progress has on total service imports and exports, and if it is significant in the presence of language centrality. The total exports are measured in millions 2020 US dollars and are broken down into five main classes on the website based on 2002 EBOPS classifications: travel, transportation, telecommunication, financial, and construction services.

The total exports for a given country in this study are a sum across all classes of exports from 2000 to 2019, that is,

$$\sum_{c=1}^{5} \sum_{t=2000}^{2019} Exports_{tc}$$

where c is the class and t represent the year.

The Language data comes from CEPII the French center for research in international economics. This data shows linguistic proximity LP for 196 countries. Each country is connected to the other 195, creating a highly connected linguistic network with 196 nodes and 38220 edges. The edges are then weighted by the LP, a time invariant index calculated by Melitz and Toubal (2014) .

LP is based on native language and measures the linguistic closeness between two native languages. They developed this index to correct for the ease of communication between nations that did not had no common language. The rational was that although some countries do not share common languages there is still a possibility for communication, hence there is a need to account for such communication. They consider 89 languages and used a maximum of 2 majority native languages per country to compute the LP. In the case of 2 languages, they adjusted the relative percentages in the country to sum to 1, the same score that they ascribed to a single native language. Therefore, Switzerland showed 0.74 for German and 0.26 for French, Bolivia 0.54 for Spanish and 0.46 for Quechua. The minimum percentage recorded for a native language was 0.13 for Russian in Israel. Languages with an insufficient percentage of native speakers or countries with high linguistic index LI or both were excluded from the LP calculation. India for instance with a LI of 0.94 out of 1 was assigned a 0 in the process of determining native languages. South Africa was also assigned a 0. The idea is that countries with a high linguistic index have so many native languages that no specific one pertains to most of the population. Therefore, for each country pair in the data there is 1,2, or 4 linguistic proximities to consider. When there were 2 or 4, they constructed an appropriate weighted average, which is based on the products of the population ratios in both countries. A LP of

0 between 2 countries can mean either that the 2 countries speak the same language – and therefore LP is irrelevant – or that their languages are so different that there is no proximity between them (Melitz and Toubal, 2014). When the network is weighted, 30 countries, mostly from Sub Saharan Africa are not connected to any other node since the weight is 0 as explained above. This reduces the number of edges to 13695. I consider some limitations to this technique which I will explore in the results section.

Data on the geography variables like distance from the equator (DISTEQ), continent code, and landlocked status comes from CEPII. The continent code classifies the countries in the sample into Africa, Europe, Oceania, North America, and South America. The distance from the equator is measured in North or South, where values in the north are positive and those in the south are negative. The landlocked status is a binary variable which takes a value of 1 if the country shares boundaries with the ocean or 0 otherwise.

The indicators of economics prosperity come from different sources. Data on real GDP, real per capita income and total annual population comes from the World Bank section for World Development Indicators. All except population are measured in 2020 US dollars. The data for the human development index HDI comes from the United Nations Human Development Reports. The HDI is a composite index measuring average achievement in three dimensions of human development – a long and healthy life, knowledge and a decent standard of living (UNDP).

The human capital index HCI comes from the World Bank Human Capital Index 2020 Update. This index is country specific and calculates the contributions of health and education to worker productivity. The final index score ranges from zero to one and measures the productivity as a future worker of a child born today relative to the benchmark

of full health and complete education. This index is composed of five elements; probability of survival to age 5, expected years of school, harmonized test scores, adult survival rate, and learning-adjusted years of school.

Indicators of government quality come from the World Bank's Worldwide Governance Indicators (WGI) and include rule of law, control of corruption, government effectiveness, voice and accountability, political stability, and quality of regulations. Rule of law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Government effectiveness captures the perception of the quality of public services, the quality of the civil service and the degree of its independence form political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Voice and accountability measure the perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and free media. Finally, regulatory quality measures the perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. Each of these measures range from -2.5 to +2.5 where opposite ends of the spectrum indicate bad governance and good governance, respectively, in the given dimension. The initial data is for 2000 to 2019 but I obtained a country specific average over the period.

Measures

I compute three measures from the data; Eigenvector centrality, strength, and a simplified integration index.

Eigenvector centrality EVC is used in this study to capture language centrality. It was first developed by Bonacich (1972) as an improvement for degree centrality. Unlike Degree Centrality DC which considers the contribution of every neighbor to equally influence each node's centrality, EVC is based on the idea that an actor is more central if it is related with actors that are themselves central (Runhau, 2000), thereby extending the concept of DC to consider the level of influence of the neighboring nodes. This makes a connection to influential nodes important, as it would imply increase access to information flow. Our network, G(E = 38220, V = 196) generates an adjacency matrix A, where aij = wij = LPij , where LPij $\in$ 0<R <1 for countries with weights and 0 for countries such as India, Nigeria, and South Korea with a high linguistics diversity index. Because A is symmetric (195x195) all its eigenvalues are real, its eigenvectors are orthogonal, and it is diagonalizable (Golub and Van Loon, 1983). Bonacich (1972b) defined the centrality c(vi) of a node vi as a positive multiple of the sum of adjacent centralities. Meaning that the centrality of a node is proportional to the sum of the centralities of the nodes to which it is connected, making that node influential only if its neighborhood contains central nodes. The eigenvector centrality is simply the solution to v the eigenvalue-eigenvector equation.

$$Av = \lambda v \tag{8}$$

where λ is the maximum eigenvalue of A. Choosing the eigenvector of the maximum eigenvalue is based on Frobenius theorem that a real square matrix with positive entries

has a unique largest real eigenvalue and that the corresponding eigenvector can be chosen to have strictly positive components. This yields a vector of 195 entries.

The strength is a weighted measure of degree centrality described in chapter 2. This index was developed by Barrat et al (2008) when studying the architecture of complex networks. Studying the scientific collaboration network and the world-wide air transportation network, two networks which are representative examples of social and large infrastructure systems respectively, they developed Strength as an index that assigns to each node, a weight that is proportional to the intensity of the connections among the various elements of the graph.

$$S_i = \sum_{\forall j \in N(i)} a_{ij} Lp_{ij} \quad (9)$$

Where aij is the connections between two nodes and =1 where there exists a connection or 0 otherwise, LP is the linguistic proximity between countries country (i) and (j) and N(i) is the neighborhood of node (i) defining the nodes that are connected to it. In other words, it measures the strength of vertices in terms of the total weight of their connections.

The Integration coefficient ranges between 0 and 1 and measures the openness of a country. This coefficient has been used as an instrumental variable for trade in past studies (Rodrik et al., 2002); Acemoglu et al (2. Unlike the literature which uses the sum of imports and exports over all categories, I chose to include only export and interpret the ratio as a propensity to export.

$$I_i = \frac{\sum_{c=1}^{5} \sum_{t=2000}^{2019} Exports_{tc}}{\sum_{t=2000}^{2019} GDP_t} \quad (10)$$

Where *Ii* is a given country's propensity to export, c is the type of service, and GDP is the annual GDP of country (i).

Descriptive Statistics

Table 1 below shows the summary statistics of the key variables. The maximum EVC value is 0.219, indicating that the overall values are very small. Compared to that the maximum strength is 64.911 and the log of exports is 22.934. The values for HDI, HCI and RULE are also very small relative to strength and exports.

Table 1. Descriptive Statistics of Key Variables

Variable	*M*	*SD*
1. EVC	0.07	0.04
2. Strength	20.34	11.20
3. Log Exports	17.54	2.47
4. Log PCGDP2019	8.77	1.49
5. Log PCGDP2000	7.75	1.61
6. Log Population	18.84	2.03
7. Education	11.40	2.31
8. Law	-0.01	0.91

Note. *M* and *SD* are used to represent mean and standard deviation, respectively. EVC is the eigenvector centrality and Strength is the node strength representing the sum of linguistic proximities with adjacent countries. Education is the average years of education by country. Log PCGDP2019 and Log PCGDP2000 are the natural logs of GDP per Capita in 2019 and 2000 respectively. Law is a measure of government quality which captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood for crime and violence.

Figure 3 below is a sub-section of the network, to provide context. The network contains nine nodes, each representing a country. The edges show the linguistic proximity between these nine countries, and their respective sizes indicate which countries have stronger linguistic ties. The scale shows the level of influence of each country.

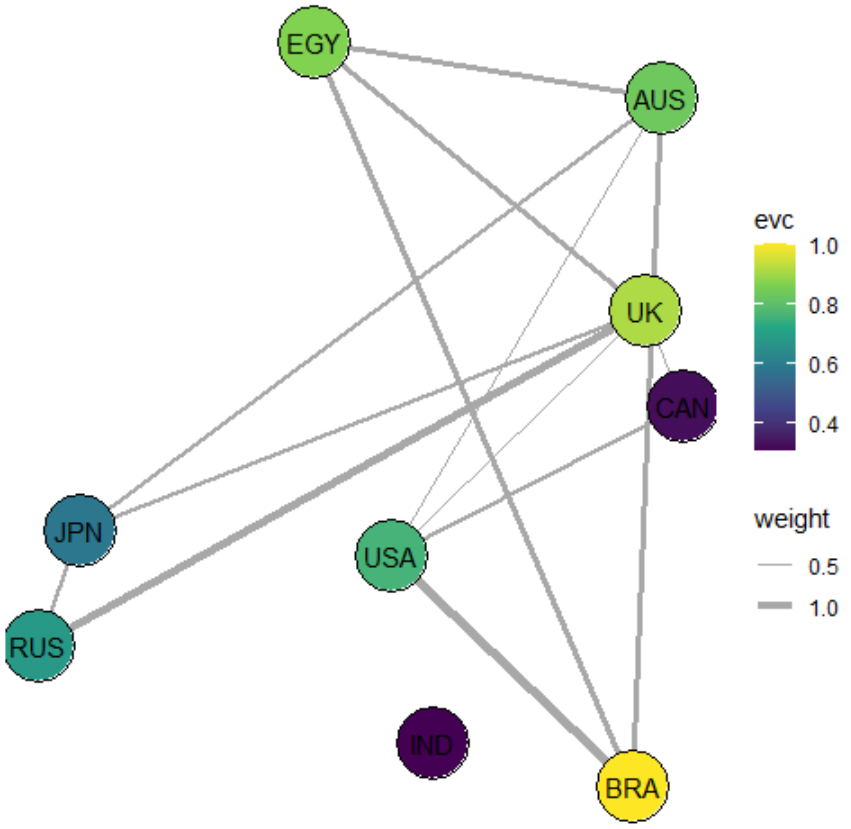

Figure 3. *Subsection of Language Network*. Source: CEPII Language Variables

As indicated by the legend, the influence increases with level of brightness, and Brazil has the highest eigenvector centrality hence is the most influential in this subsection. Of course, adding other nodes and actors in the network will change this result as we will see in the future. India and Canada have almost no influence in the network. India's case is obvious since it is disconnected from everyone in the network. However, Canada's is due to its connection with poorly connected nodes, the USA, and the UK. We describe the above graph as G (E = 9, V = 13).

Figure 4 below shows the relative influence of countries in the network. Influence rises on the scale with maximum at yellow, and the greener or less blue a country is the

more influential it is. The grey countries are those that are not present in the sample. These include Namibia, Botswana, Kazakhstan, and others. This shows that yellow Netherlands has the most influential native language in the network that includes our 196-country sample. The countries that were assigned 0 LP by construct and are disconnected from the network are at the bottom of the influence chain, as expected, since they have no neighborhood. The centrality seems to be distributed in classes; Brazil, Denmark and Angola seem to have the same level of influence slightly above the US, Canada, and Australia. Countries in Europe, particularly around the Schengen zone seem to lean more towards the influential side while majority of non-zero countries is Africa are weak, slightly below China.

Some of these observations seem counterintuitive, but if we consider the nature of EVC we realize that linguistic influence in this case depends on the centrality of the languages in a country's neighborhood. So, connection to a country with a high index of strength will drive the EVC. The similarity in centrality between Angola and Brazil, and the European country raises the question of transmissions across romance languages and whether their initial similarity creates a medium for similarity in neighborhoods, in which case they would likely have similar levels of influence.

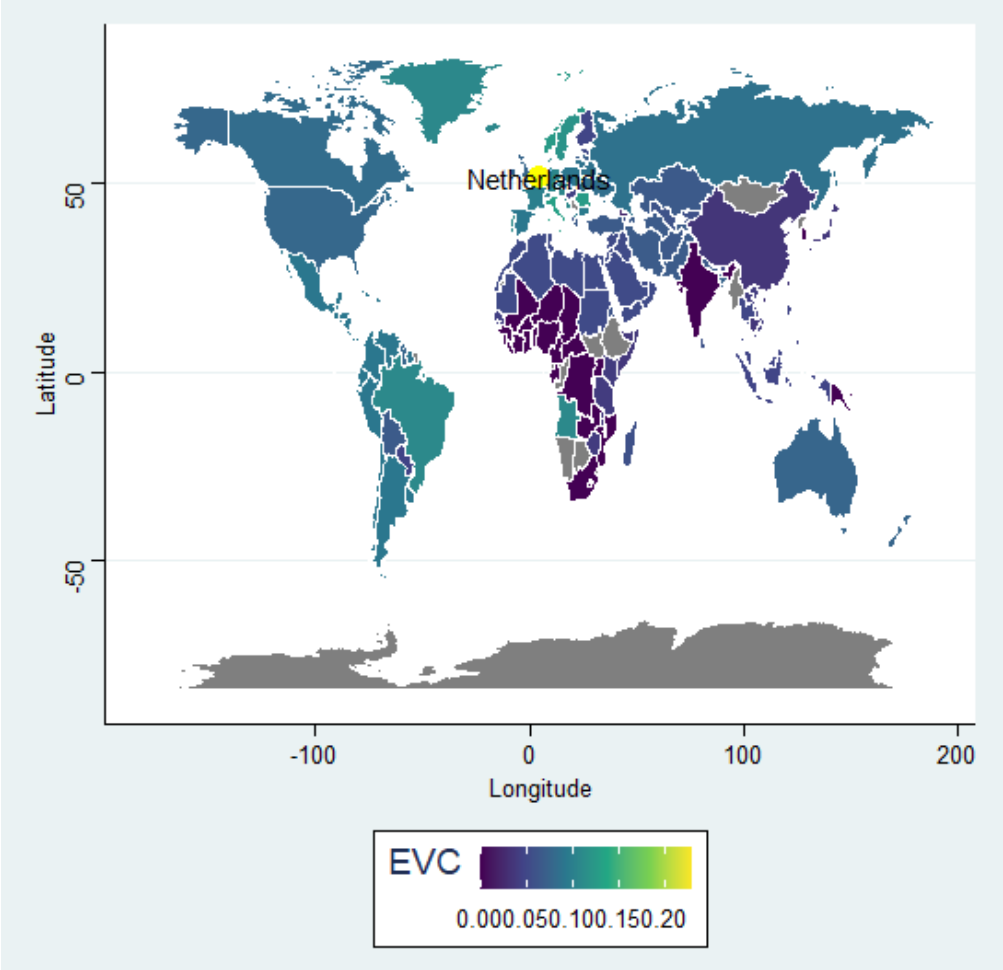

Figure 4. *Language Influence Across Countries*. Source: CEPII Language Section

CHAPTER FOUR

Methods and Design

The OLS is the main model used throughout this study. I use OLS to estimate the relationship between EVC and per capita income, strength, and per capita income, EVC and total exports, strength, and total exports, and EVC and strength on five categories of service exports.

Figure 5 below shows the distribution of total service exports. The exports are in trillions of 2020 USD and the figure indicates that most countries exported less than 2 trillion USD worth of services between 2000 and 2019. The outlier is the USA, with approximately USD 9 trillion followed by the UK, Germany, France, China, and Japan.

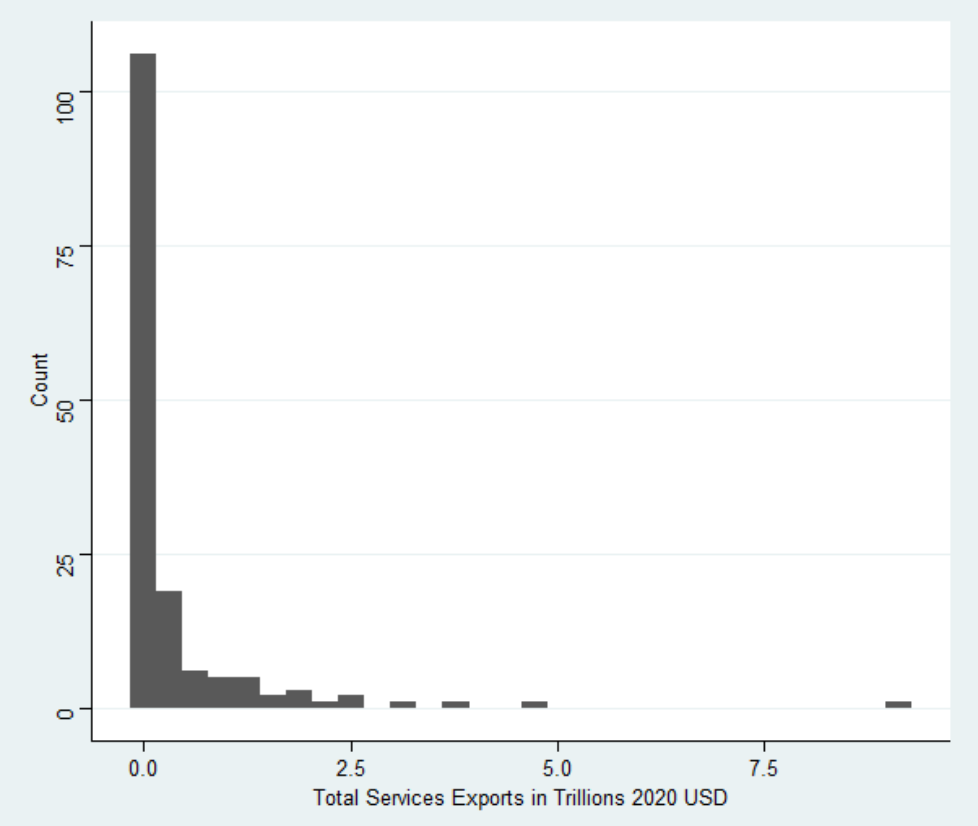

Figure 5. *Distribution of Total Exports, 2000 - 2019*. Source: UN Comtrade Database, 2021

Although the zeros disappear when we sum exports over all categories over time, their effect stays in the data since countries usually export in billions and if we assume that national exports are usually steady around a given amount during years when the country trades, then, there would be no overcompensation during years of positive trade enough to offset the zero in a different year. That explains the skewness of the data.

The regression model is stated as follows:

$$\text{LCGDP}_\text{i} = \beta_0 + \beta_1 \text{Centrality}_\text{i} + \phi \text{X}_i + \varepsilon_\text{i}$$

$$\text{Exports}_\text{i} = \beta_0 + \beta_1 \text{Centrality}_\text{i} + \phi \text{X}_i + \varepsilon_\text{i}$$

Where LCGDP_i is the natural log of per capita GDP in 2019, Centrality is the eigenvector centrality and then strength in subsequent regressions, ε_i is the associated error

term, ϕ is a row vector of coefficients, and X is a column vector of control variables including per capita GDP in 2000 to control for the base income, Geography variables such as distance from the equator, dummy variables for Africa, Europe, and North America, integration, population, average years of schooling, human development index, human capital index, and measures of government quality.

Population is used to measure the size of an economy (Frankel, 2007). There is a relationship between population, GDP per capita, and economic integration since the GDP per capita is the GDP divided by population, and integration is the total exports as a share of GDP. This is relevant because Frankel suggests, in the case of gravity models, that when including GDP per capita and GDP in the model and the coefficient of GDP is less than one it indicates that the trade of a country rises less than proportionate with its size. More so the GDP per capita could have a possible effect on the level of trade. Increased income per capita reflects technological growth, associated with innovations in production which could be demanded by other countries, thereby opening doors for exports. Although the continent variable was included, omission of a variable indicating membership to regional trading agreements would likely be insignificant since regional trade agreements have been found by some (Francois and Hoekman 2010, 674); Moxnes (2003) to not be statistically significant in gravity models and to fail at liberalizing service trade.

The control variables are added progressively to the base models for robustness and export-specific regressions also follow.

CHAPTER FIVE

Results and Discussion

Table 2 below reveals an almost perfect correlation between EVC and strength. From this I expect the effects of EVC on any independent variable to move in the same direction as the effects of strength. Although they have different interpretations. The measures of government quality are also highly correlated and all the correlations are significant at a 5% and 1 % level.

Table 2. Pairwise Correlations of Key Variables

Variable	EVC	Strength	Log Exports	Log PCGDP 2019	Log PCGDP 2000	Log Pop	Edu
EVC							
Strength	.99**						
Log Exports	.42**	.42**					
Log PCGDP2019	.57**	.55**	.74**				
Log PCGDP2000	.52**	.51**	.66**	.96**			
Log Pop	-.09	-.08	.53**	-.15	-.18*		
Edu	.61**	.61**	.64**	.79**	.71**	-.15	
Law	.42**	.41**	.60**	.83**	.83**	-.11	.63**

Note. * indicates $p < .05$. ** indicates $p < .01$. EVC is the eigenvector centrality and Strength is the node strength representing the sum of linguistic proximities with adjacent countries. Edu is the average years of education by country. Log PCGDP2019 and Log PCGDP2000 are the natural logs of GDP per Capita in 2019 and 2000 respectively. Law is a measure of government quality which captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood for crime and violence. Lop Pop is the natural log of total population from 2000-2019.

The measures of government are also negatively correlated with population suggesting that large countries have a propensity to be governed poorly- an arguably reasonable point of view if one considers the African countries. But the sign is also not strong

Eigenvector Centrality and Per Capita GDP

Table 3 below shows the country level OLS regressions of log GDP per capita on Eigenvector centrality. The base model shows that there is a significant positive correlation between language influence and income per capita. Influential countries are those connected to countries that have strong linguistic proximities with their neighborhood.

This observation is supported by the consistently positive sign of the EVC across the regressions except in (10) where the control variable is human development Index. The R^2 of the regressions in columns 2 and 10 is 0.92 and 0.91 respectively, indicating that over 90 percent of the variation in income per capita in 2019 for the countries sampled is explained by the EVC and income per capita in 2000, and variation in EVC and human development index, respectively. The lowest R^2, 0.32, comes from Model 1.

To contextualize the magnitude of the effect of EVC on the income per capita let us consider Norway with an EVC of 0.134 which is well above the 75th percentile of 0.097, and Kenya, with and EVC of 0.05. Countries similar to Norway will have a per capita GDP of approximately $USD 24,000 on average while countries similar to Kenya in EVC like the Laos People Republic and Tanzania will have a per capita income, on average, of about

$USD 4200, a difference of about $ USD19700 [$e^{7.33+20.57(0.1340)} - e^{7.33+20.57(0.05)}$]. And this is assuming that only language influence affects the per capita income.

Hence if the coefficient estimated in Table 3 were causal, it would imply a fairly large effect of EVC on per capita income. But due to the obvious omitted variable bias it is not, which leads to the next set of robustness checks. These checks could most likely be limited themselves since the models are only estimated with EVC and not in a multiple linear regression, leading to OVB. It nonetheless lets us observe changes in our base coefficient.

The sharp decrease in the EVC coefficient observed in model 2 after introducing base year income per capita as a standard control (Acemoglu et al., 2001) supports the previous argument. EVC. The coefficient of interest remains significant in the presence of population, which has a negative and insignificant negative coefficient suggesting that countries with larger populations tend to have lower income per capita. From models 4 and 5 respectively, we can see that countries further from the equator are more prosperous and land locked countries have about fifty-five percent less income per capita than their coastal counterparts when we hold everything else constant [$e^{-0.8} - 1 = -55.07$].

If some countries have high income per capita but low EVC values- or zero EVC due to high linguistic diversity, then language influence is not completely responsible for prosperity. This also raises some concerns regarding the assumptions made by Melitz and Toubal (2014) when estimating their measure of linguistic proximity: their technique assigs a 0 linguistic proximity to countries with a high linguistic diversity index. Their rational is that countries with so many native languages without a majority native language cannot be assigned a distinct linguistic identity. However, these 0 values have

a spillover effect in our network since such nodes as South Korea where there are five Seoul dialects, and many countries in Sub Saharan Africa with a 0 LP end up with a 0 EVC from the linear combination of a 0-row vector with the eigen vector, v.

This is not a reliable way of dealing with countries that have high linguistic diversity because in the same way that languages spoken by most people in a nation affect trade through a different mechanism than minority languages and need to be treated differently (Melitz, 2008), the countries with high linguistic diversity indexes also need to be treated differently when estimating LP to capture the possibility that these countries can communicate with other minority languages from different countries. Specifically, in the context of Sub-Saharan Africa for instance, cities sharing borders in contiguous countries tend to share almost similar native languages, that, while considered minority, influence the cultural interaction between residents of these cities.

Table 3. OLS estimates of EVC on GDP Per Capita

Log per capita GDP 2019	Model 1	Model 2	Model 3	Model 4	Model 5
(Intercept)	7.33 ***	2.19 ***	8.52 ***	7.29 ***	7.56 ***
	(0.20)	(0.17)	(1.08)	(0.20)	(0.21)
EVC	20.57 ***	3.43 ***	20.20 ***	17.24 ***	19.41 ***
	(2.49)	(0.97)	(2.51)	(2.63)	(2.45)
Log per capita GDP 2000		0.82 ***			
		(0.02)			
Log Population			-0.06		
			(0.05)		
DISTEQ				0.01 **	
				(0.00)	
Landlocked					-0.80 **
					(0.26)
N	147	145	147	147	147
R^2	0.32	0.92	0.33	0.37	0.36

Note. * indicates $p < .05$. ** indicates $p < .01$. EVC is the eigenvector centrality. Lop Pop is the natural log of total population from 2000-2019. DISTEQ is the distance from the equator which is the latitude of a given country. Landlocked is a dummy variable which takes a value of 1 if a country is not coastal or 0 otherwise

Table 3 Continued

Log per capita GDP 2019	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11
(Intercept)	8.41 ***	7.32 ***	7.47 ***	7.23 ***	2.60 ***	3.50 ***
	(0.26)	(0.20)	(0.20)	(0.20)	(0.17)	(0.24)
EVC	10.88 ***	21.35 ***	14.94 ***	18.23 ***	-3.21 **	1.65
	(2.80)	(2.58)	(2.76)	(2.47)	(1.18)	(1.76)
AFRICA	-1.50 ***					
	(0.26)					
NAMERICA		-0.35				
		(0.31)				
EUROPE			1.04 ***			
			(0.26)			
Integration				2.70 ***		
				(0.73)		
HDI					9.23 ***	
					(0.30)	
HCI						9.03 ***
						(0.51)
N	147	147	147	147	147	147
R^2	0.45	0.33	0.39	0.38	0.91	0.79

Note. * indicates $p < .05$. ** indicates $p < .01$. EVC is the eigenvector. AFRICA, NAMERICA, and EUROPE are dummy variables which take a value of 1 if a country is in Africa, Europe, or North America respectively or 0 otherwise- the reference category is all other continents. Integration is the ratio of total exports to GDP over the period 2000- 2019. HDI is the Human Development Index and HCI is the Human Capital Index.

Table 3 Continued

Log per capita GDP 2019	Model 12	Model 13	Model 14	Model 15	Model 16	Model 17
(Intercept)	7.97 ***	8.24 ***	7.92 ***	8.13 ***	8.13 ***	8.12 ***
	(0.17)	(0.12)	(0.19)	(0.13)	(0.14)	(0.14)
EVC	12.72 ***	6.76 ***	12.27 ***	7.68 ***	9.19 ***	9.35 ***
	(2.10)	(1.60)	(2.37)	(1.74)	(1.73)	(1.77)
Political stability	0.99 ***					
	(0.10)					
Government Effectiveness		1.29 ***				
		(0.07)				
Accountability			0.85 ***			
			(0.11)			
Regulatory Quality				1.28 ***		
				(0.08)		
Rule of Law					1.16 ***	
					(0.08)	
Corruption control						1.12 ***
						(0.08)
N	147	147	147	147	147	147
R^2	0.59	0.79	0.52	0.75	0.73	0.72

Note. * indicates $p < .05$. ** indicates $p < .01$. EVC is the eigenvector. Political Stability, Government Effectiveness, Accountability, Regulatory Quality, Rule of Law, and Corruption Control are measures of government quality and range from -2.5 to +2.5

The coefficient of NAMERICA in model 7 is insignificant. This could be due to the way countries are assigned to North America, in the Iso classification of countries by continents. Countries in central America as well as the Caribbean are all considered part of North America, which can confound the regional effects of North America with Central America. Conversely AFRICA and EUROPE have significant coefficients, -1.5 and 1.04 respectively. This means that African countries have a GDP per capita which is 77.69% less than that of countries in other continents, on average, while those in Europe have almost double the income per capita of non-European countries on average. We should be

careful to note that this result can be influence by outliers like Norway, with GDP per capita of over USD $75000 in 2019.

The country specific measures capturing sound government are all positive and significant and the coefficient of integration, capturing the degree of economics openness to international trade, is also positive, confirming the findings of Rodrik et al. (2002) that good institutions and increased shares of imports are crucial to determining income levels around the world.

Strength and Per Capita GDP

Table 4 below shows the relationship between GDP per capita and node strength. The base coefficient shows that when the strength increases by one-unit, per capita income will increase by approximately seven percent. This is small compared to the base EVC coefficient of 20.57. Strength remains positive and significant for all the controls except with HDI in Model 10 where it is negative. The coefficient is strongest in the base model and when population is controlled for in Model 3. Population has an insignificant effect here as in Table 3. Strength is minimum (0.01) in model 2 but significant at 0.15 level, where per capita income in 2000 is controlled for. This also happens to be the model with the highest R-squared. The coefficient for per capita income in 2000 is 0.82 and significant at one percent. This means that when we hold strength constant the income per capita will increase by twenty seven percent from the base year. Base year income per capita accounts for changes in per capita income over time and is a standard control of Solow models.

In models 4 and 5, which controls for geographic variables we notice that holding strength constant countries further away from the equator have higher income per capita

and landlocked countries have lower income per capita on average when compare to coastal countries. Additionally, countries in Europe export more on average when compared to other continents, holding everything constant. Although North America and Africa has negative coefficients, Africa exports less than North America and all other continents, as seen from the respective coefficients, -1.54 and -0.26 and the coefficient of NAMERICA in model 7 is not significant.

Population has the expected negative sign in model 3, since larger countries tend to have a lower per capita income- from the formula calculating GDP per capita. Including the HDI leads to a negative coefficient for strength, and then a null effect which is insignificant, when HCI is controlled for. Strength is positive and significant in the presence of integration, which is also positive and significant. The integration suggests that increasing the propensity to export also increases the income per capita when we hold everything else constant. This justifies the motivating mechanism mentioned earlier in chapter one.

The next set of control variables are government quality indicators. All the measures have a positive significant relationship with per capita income in the presence of strength, and they are all significant at the 0.1% level. Strength is also significant at the same level in the models 12 to 17.

The strongest government indicators when we hold strength constant are Government Effectiveness and Regulatory Quality in 13 and 15 respectively. Strength is bigger when we control for political stability, and the results show that strength increases per capita income by five percent holding political stability constant. The differing coefficients confirm that the measures of good governance have separate relationships

with economic development and should be examined individually rather than using an aggregate index of government quality. Using an aggregate measure reduces interpretability and makes it difficult to identify which measures of government quality impact development most.

Table 4. OLS estimates of Strength on GDP Per Capita

Log per capita GDP 2019	Model 1	Model 2	Model 3	Model 4	Model 5
(Intercept)	7.28 ***	2.17 ***	8.55 ***	7.25 ***	7.52 ***
	(0.21)	(0.17)	(1.09)	(0.21)	(0.22)
Strength	0.07 ***	0.01 ***	0.07 ***	0.06 ***	0.07 ***
	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
Log per capita GDP 2000		0.82 ***			
		(0.02)			
Log Population			-0.07		
			(0.05)		
DISTEQ				0.01 **	
				(0.00)	
Landlocked					-0.83 **
					(0.26)
N	147	145	147	147	147
R^2	0.31	0.92	0.31	0.35	0.35

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. Strength is the node strength representing the sum of linguistic proximities with adjacent countries. Log Pop is the natural log of total population from 2000-2019. DISTEQ is the distance from the equator which is the latitude of a given country. Landlocked is a dummy variable which takes a value of 1 if a country is not coastal or 0 otherwise

Table 4 continued

Log per capita GDP 2019	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11
(Intercept)	8.42 ***	7.28 ***	7.44 ***	7.19 ***	2.61 ***	3.47 ***
	(0.27)	(0.21)	(0.20)	(0.20)	(0.17)	(0.24)
Strength	0.04 ***	0.07 ***	0.05 ***	0.06 ***	-0.01 **	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)
AFRICA	-1.54 ***					
	(0.26)					
NAMERICA		-0.26				
		(0.32)				
EUROPE			1.09 ***			
			(0.26)			
Integration				2.74 ***		
				(0.73)		
HDI					9.28 ***	
					(0.29)	
HCI						9.13 ***
						(0.51)
N	147	147	147	147	147	147
R^2	0.44	0.31	0.38	0.37	0.91	0.79

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. Strength is the node strength representing the sum of linguistic proximities with adjacent countries. AFRICA, NAMERICA, and EUROPE are dummy variables which equal 1 or 0.

Table 4 continued

Log per capita GDP 2019	Model 12	Model 13	Model 14	Model 15	Model 16	Model 17
(Intercept)	7.93 ***	8.24 ***	7.87 ***	8.11 ***	8.12 ***	8.10 ***
	(0.18)	(0.13)	(0.19)	(0.14)	(0.14)	(0.15)
Strength	0.05 ***	0.02 ***	0.04 ***	0.03 ***	0.03 ***	0.03 ***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Political Stability	1.00 ***					
	(0.10)					
Government Effectiveness		1.29 ***				
		(0.07)				
Accountability			0.86 ***			
			(0.11)			
Regulatory Quality				1.29 ***		
				(0.08)		
Rule of law					1.17 ***	
					(0.08)	
Corruption						1.12 ***
						(0.08)
N	147	147	147	147	147	147
R^2	0.59	0.79	0.52	0.74	0.73	0.72

Note. * indicates $p < .05$. ** indicates $p < .01$. EVC is the eigenvector. Political Stability, Government Effectiveness, Accountability, Regulatory Quality, Rule of Law, and Corruption Control are measures of government quality and range from -2.5 to +2.5

Language Influence and Exports

This section looks at the relationship between EVC and Exports of services. Figure 6 shows a positive relationship between the two variables meaning that as the country's influence grows in the network its exports are expected to increase. Figure 6 also shows Italy and Moldova have the highest EVC, although Italy exports significantly more than Moldova. This is intriguing but also suggests that EVC centrality is not the sole determinant of trade- an observation which will lead us to control for country-specific variables from the gravity model.

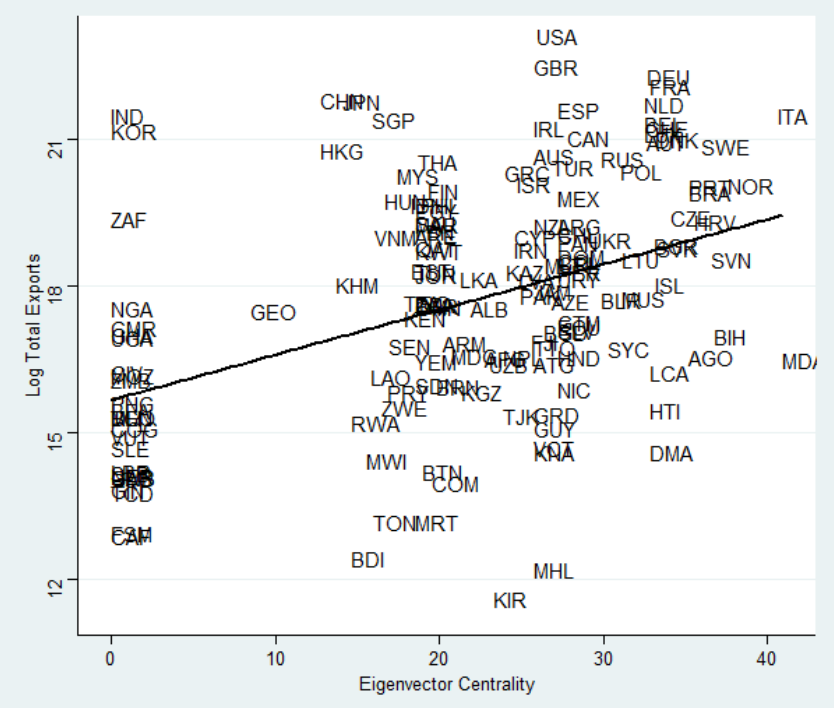

Figure 6. *Log Total Exports and Eigenvector Centrality*. Source: CEPII and Comtrade, 2021

Table 5 below presents the OLS estimates of eigenvector centrality on total exports. Model 1 is the base model, and the following models are robustness checks. The base model shows a positive relationship between eigenvector centrality and exports. When EVC increases by one unit log of total exports increases by approximately twenty-six percent. When integration is included in the model, the coefficient of EVC reduces to 24.30 but still remains significant, while integration is non-significant. Model 3 controls for geographic and regional factors. EVC is not significant. Among the regional factors, only the coefficient for DISTEQ and AFRICA are significant. African countries are seen to export about seventy four percent less than other continents $[e^{-1.38} - 1]x100 = -74.85$. Going one degree away from the equator increases the total exports by two percent, an expected finding given the geographical location of most top exporting countries in Figure 6. Controlling for landlocked status reveals that those countries experience about sixty-six percent less trade than their coastal counterparts, holding EVC constant. In this model, EVC is still positive and significant at one percent.

Model 5 through 10 control for each of the measures of government quality. The coefficient for political stability is not significant but the remaining variables are positive and significant, with government effectiveness having the biggest magnitude. EVC stays positive in all the regressions that control for government quality, although insignificant in the case of government effectiveness and regulatory quality. These findings suggest that government quality is positively correlated with services exports when centrality is held constant.

The EVC is negative but non-significant when we control for HDI and HCI in models 11 and 12 respectively, but positive when we control for average years of education

in model 13, although it remains insignificant. The positive coefficients of HDI, HCI and Education suggest that total exports increase as development, living standards, and average years of schooling increases. The Log population and GDP are both significant at 0.1% . Both measures are used to control for the size and level of production in an economy and have been found to be positively associated with trade, in the literature. Their respective EVC coefficients are also positive and significant at one percent. The model with log GDP has the highest R-squared of 0.85, showing that eighty-five percent of the variation in a country's exports is explained by its influence in a network of native languages, and its GDP. On its own however, EVC explains only eighteen percent of the variance in total exports and with Integration it explains only nineteen percent, a possible reason why the coefficient of Integration is not significant. The positive significant relation between GDP and export explains the phenomenon by which bigger countries tend to trade with bigger countries more.

Table 5. OLS estimates of EVC on Total Exports

Log Total Exports	Model 1	Model 2	Model 3	Model 4
(Intercept)	15.75 ***	15.69 ***	16.70 ***	16.05 ***
	(0.36)	(0.36)	(0.49)	(0.38)
EVC	25.72 ***	24.30 ***	10.98	24.22 ***
	(4.48)	(4.63)	(5.90)	(4.47)
Integration		1.66		
		(1.37)		
DISTEQ			0.02 *	
			(0.01)	
AFRICA			-1.38 **	
			(0.48)	
NAMERICA			-1.03	
			(0.58)	
EUROPE			0.64	
			(0.61)	
landlocked				-1.08 *
				(0.47)
N	153	153	153	153
R^2	0.18	0.19	0.34	0.21

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. EVC is the eigenvector centrality. AFRICA, NAMERICA, and EUROPE are dummy variables which take a value of 1 if a country is in Africa, Europe, or North America respectively or 0 otherwise- the reference category is all other continents. Integration is the ratio of total exports to GDP over the period 2000- 2019.

Table 5 continued

Log Total Exports	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
(Intercept)	16.02 ***	17.06 ***	16.32 ***	16.93 ***	16.69 ***	16.63 ***
	(0.38)	(0.30)	(0.37)	(0.31)	(0.34)	(0.34)
EVC	22.48 ***	6.35	17.67 ***	7.61	12.51 **	13.32 **
	(4.75)	(3.88)	(4.75)	(4.00)	(4.28)	(4.37)
Political stability	0.43					
	(0.22)					
Government effectiveness		1.83 ***				
		(0.17)				
Accountability			0.86 ***			
			(0.22)			
Regulatory quality				1.82 ***		
				(0.19)		
Rule of law					1.39 ***	
					(0.19)	
Corruption control						1.27 ***
						(0.19)
N	153	153	153	153	153	153
R^2	0.20	0.53	0.26	0.49	0.39	0.37

Note. * indicates $p < .05$. ** indicates $p < .01$. EVC is the eigenvector. Political Stability, Government Effectiveness, Accountability, Regulatory Quality, Rule of Law, and Corruption Control are measures of government quality and range from -2.5 to +2.5

Table 5 continued

Log Total Exports	Model 11	Model 12	Model 13	Model 14	Model 15
(Intercept)	9.61 ***	9.99 ***	9.90 ***	-1.74 *	2.03
	(0.63)	(0.57)	(0.81)	(0.70)	(1.41)
EVC	-4.88	-2.28	3.08	11.61 ***	28.98 ***
	(4.43)	(4.09)	(4.78)	(2.01)	(3.51)
HDI	11.98 ***				
	(1.12)				
HCI		13.58 ***			
		(1.18)			
Education			0.65 ***		
			(0.08)		
Log GDP				0.90 ***	
				(0.04)	
Log Population					0.71 ***
					(0.07)
N	153	153	153	153	153
R^2	0.54	0.56	0.42	0.85	0.50

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. EVC is the eigenvector centrality. Log Pop is the natural log of total population from 2000-2019. HDI is the Human Development Index and HCI is the Human Capital Index

Exports and Strength

Figure 7 shows that there is also a positive relationship between strength and total exports. In social network this means that when a country has a strong neighborhood it will experience increasing exports. In other words when the native language in country (i) is proximate to the set of next neighbors in the language network, exports will be impacted in a positive way. From the figure, Italy has very strong ties with its neighbors with neighbors in the network and associated high level of exports while Moldova also has a slightly higher strength but much lower exports. This suggests that strength cannot be the only driver of exports and that the relationship observed from the base model in Table 5 will not be causal. We also notice that all the countries that were assigned 0 LP by construct have clustered to a 0 strength- obviously, since they have no neighborhood. They however have varying levels of exports, with India and South Korea dominating the cluster, followed by South Africa (ZAF).

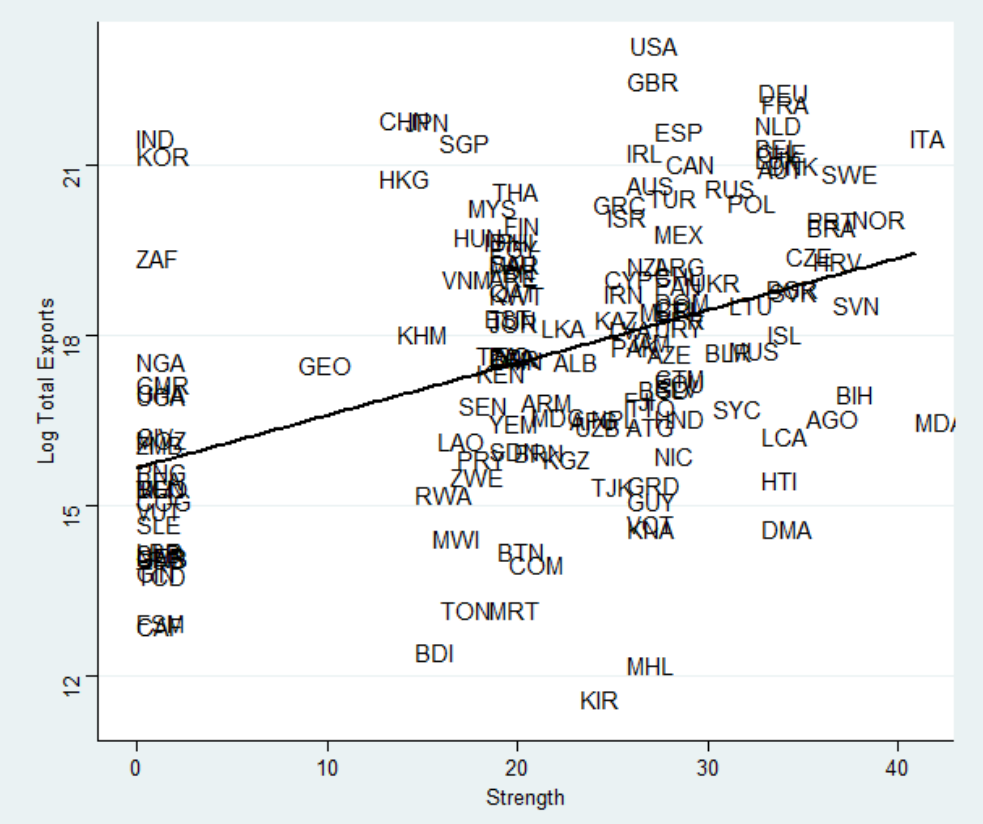

Figure 7. *Log Total Exports and Strength*. Source: Comtrade and CEPII, 2021

The countries below 18 points of Log total exports are mostly in Sub-Saharan Africa, and form sub clusters, but still in a remarkably ordered way -South Africa greater than Nigeria, Nigeria greater than Sierra Leone (SLA), SLA greater than Cameroon. This could be based on a possible combination of factors including national prosperity and possible institutional factors. This suggest that even when linguistic influence is associated with increasing exports, a certain level of national prosperity and institutional strength is required to reach certain thresholds of international trade. As a result, countries like the UK, USA and Netherlands (NLD) are seen to export more than all a majority of the sample.

The most visible apparent clusters are between developed countries to the top right of the plot and LEDCs at the bottom left.

Table 6 shows results for regressions of strength on total exports and the controls. The relationship between strength and exports is positive in the base model. Without controls, increasing strength by one unit leads to a nine percent increase in total exports. There is no change to the strength coefficient once Integration is controlled for. The relationship stays positive when all other controls are included except in Model 11 and 12, which are insignificant. The controls in these models are HDI and HCI respectively. Strength is also positive and insignificant in Models 3, 6, and 13 where the respective controls are regional, Government effectiveness, and Accountability.

Although the strength coefficient is not significant in the presence of geography and regional variables, the coefficients of these controls are consistent with those found in the literature. DISTEQ increases the total exports by two percent, while countries in Europe export a little more than twice on average compared to other continents $[e^{0.72} - 1]x100 = 105.4$, while countries in Africa export less than all other continents on average, compared to those in Europe.

Consistent with EVC findings, landlocked countries export sixty-seven percent less than their coastal counterparts on average. There is a positive significant relationship between exports and political stability, accountability, regulatory quality, rule of law and corruption control. Holding Log GDP and Log Population constant, strength increases exports by four percent and ten percent respectively. Controlling for population explains eighty-five percent of the variance in the total exports compared to the eighteen percent in the base model.

Table 6. OLS estimates of strength on Exports

Log Total Exports	Model 1	Model 2	Model 3	Model 4
(Intercept)	15.67 ***	15.61 ***	16.70 ***	15.97 ***
	(0.38)	(0.38)	(0.50)	(0.39)
Strength	0.09 ***	0.09 ***	0.04	0.09 ***
	(0.02)	(0.02)	(0.02)	(0.02)
Integration		1.68		
		(1.38)		
DISTEQ			0.02 *	
			(0.01)	
AFRICA			-1.40 **	
			(0.48)	
NAMERICA			-0.95	
			(0.57)	
EUROPE			0.72	
			(0.60)	
Landlocked				-1.11 *
				(0.47)
N	153	153	153	153
R^2	0.18	0.19	0.33	0.21

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$ Strength is the node strength representing the sum of linguistic proximities with adjacent countries. DISTEQ is the distance from the equator which is the latitude of a given country. Landlocked is a dummy variable which takes a value of 1 if a country is not coastal or 0 otherwise. . AFRICA, NAMERICA, and EUROPE are dummy variables which take a value of 1 if a country is in Africa, Europe, or North America respectively or 0 otherwise- the reference category is all other continents. Integration is the ratio of total exports to GDP over the period 2000- 2019.

Table 6 continued

Log Total Exports	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
(Intercept)	15.94 ***	17.02 ***	16.24 ***	16.87 ***	16.63 ***	16.57 ***
	(0.40)	(0.31)	(0.38)	(0.32)	(0.35)	(0.36)
Strength	0.08 ***	0.02	0.06 ***	0.03 *	0.05 **	0.05 **
	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)
Political stability	0.46 *					
	(0.22)					
Government effectiveness		1.83 ***				
		(0.17)				
Accountability			0.88 ***			
			(0.22)			
Regulatory quality				1.81 ***		
				(0.19)		
Rule of law					1.39 ***	
					(0.19)	
Corruption control						1.27 ***
						(0.19)
N	153	153	153	153	153	153
R^2	0.20	0.53	0.26	0.50	0.39	0.37

Note. * indicates $p < .05$. ** indicates $p < .01$. Political Stability, Government Effectiveness, Accountability, Regulatory Quality, Rule of Law, and Corruption Control are measures of government quality and range from -2.5 to +2.5

.

Table 6 continued

Log Total Exports	Model 11	Model 12	Model 13	Model 14	Model 15
(Intercept)	9.64 ***	10.00 ***	9.87 ***	-1.79 *	2.04
	(0.63)	(0.56)	(0.81)	(0.70)	(1.42)
Strength	-0.02	-0.01	0.01	0.04 ***	0.10 ***
	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)
HDI	11.94 ***				
	(1.11)				
HCI		13.59 ***			
		(1.18)			
Education			0.66 ***		
			(0.08)		
Log GDP				0.90 ***	
				(0.04)	
Log Population					0.71 ***
					(0.07)
N	153	153	153	153	153
R^2	0.53	0.56	0.42	0.85	0.50

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. Education is the average years of adult education. HCI and HDI are the Human Development Index and Human Capital Index respectively.

Transportation Services

Table 7 shows the regressions of EVC on travel. The base coefficient shows a positive relationship, which remains consistently positive for all the controls except for HDI, HCI, and average years of education, where EVC is not significant. Some of the relationships are more significant than others: EVC in Models, 3,6, and 8 are only significant at the five percent level while it is significant at one percent in Model 9 and at 0.1 percent in the remaining models. Integration and Distance from the equator and not significant in the presence of EVC, and only the coefficient for AFRICA is significant in the regional controls. Landlocked countries are still seen to export less than their coastal counterparts on average, and all the measures of government quality are significant and positively correlated with travel exports when holding EVC constant. The HCI and HDI are both significant, with coefficients of 10.83 and 11.96 respectively. Increase in the average years of education by one unit is seen to increase the travel exports by about eighty percent when holding EVC constant. Log GDP and Log Population both have positive correlations with the exports although Log GDP explains more variance in travel exports when compared to population. Among the measures of government quality, the biggest coefficient comes from Regulatory quality (1.68) while the least comes from political stability (0.46). Here, controlling for population explains more than seventy percent in the variance of total exports from the travel industry, while adding integration explains the least variance.

Table 7. OLS Estimates of EVC on Transportation Exports

Log Transportation Exports	Model 1	Model 2	Model 3	Model 4
(Intercept)	14.31 ***	14.27 ***	15.32 ***	14.63 ***
	(0.45)	(0.45)	(0.58)	(0.47)
EVC	22.43 ***	21.50 ***	8.80	20.84 ***
	(5.53)	(5.73)	(7.10)	(5.54)
Integration		1.08		
		(1.70)		
DISTEQ			0.02 *	
			(0.01)	
AFRICA			-1.55 **	
			(0.58)	
NAMERICA			-2.38 ***	
			(0.70)	
EUROPE			0.65	
			(0.73)	
Landlocked				-1.14
				(0.58)
N	153	153	153	153
R^2	0.10	0.10	0.31	0.12

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. EVC is the eigenvector centrality. Log Pop is the natural log of total population from 2000-2019. DISTEQ is the distance from the equator which is the latitude of a given country. Landlocked is a dummy variable which takes a value of 1 if a country is not coastal or 0 otherwise

Table 7 continued

Log Transportation Exports	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
(Intercept)	14.73 ***	15.88 ***	14.95 ***	15.66 ***	15.44 ***	15.38 ***
	(0.47)	(0.38)	(0.47)	(0.40)	(0.42)	(0.43)
EVC	17.29 **	-0.85	13.34 *	1.59	6.51	7.41
	(5.81)	(4.87)	(5.91)	(5.12)	(5.32)	(5.41)
Political stability	0.69 *					
	(0.27)					
Government effectiveness		2.21 ***				
		(0.22)				
Accountability			0.97 ***			
			(0.27)			
Regulatory quality				2.09 ***		
				(0.24)		
Rule of law					1.67 ***	
					(0.24)	
Corruption control						1.53 ***
						(0.24)
N	153	153	153	153	153	153
R^2	0.13	0.46	0.17	0.40	0.32	0.30

Note. * indicates $p < .05$. ** indicates $p < .01$. EVC is the eigenvector. Political Stability, Government Effectiveness, Accountability, Regulatory Quality, Rule of Law, and Corruption Control are measures of government quality and range from -2.5 to +2.5

.

Table 7 continued

Log Transportation Exports	Model 1	Model 2	Model 3	Model 4	Model 5
(Intercept)	6.46 ***	7.23 ***	7.23 ***	-5.05 ***	0.08
	(0.76)	(0.70)	(1.01)	(1.17)	(1.90)
EVC	-16.67 **	-11.97 *	-4.95	6.81 *	25.81 ***
	(5.31)	(5.06)	(5.94)	(3.38)	(4.73)
HDI	15.31 ***				
	(1.34)				
HCI		16.68 ***			
		(1.46)			
Education			0.79 ***		
			(0.10)		
Log GDP				1.00 ***	
				(0.06)	
Log Population					0.74 ***
					(0.10)
N	153	153	153	153	153
R^2	0.52	0.52	0.35	0.69	0.35

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. EVC is the eigenvector centrality. HDI and HCI are Human Development Index and Human Capital Index.

Transportation and Strength

Table 8 shows the regressions for transportation exports and strength. These results are almost a scaled down version of the EVC regressions. For instance, strength is consistently in the base models and across all controls except for the HDI, HCI, and Education. The presence of integration makes almost no difference to the model, while the coefficient of AFRICA (-1.32) is the same as in Table 7. Controlling for Landlocked keeps the coefficient of strength unchanged although Landlocked is significant. The coefficient indicates, as in the EVC case that coastal countries export more travel services on average when compared to the landlocked countries. The DISTEQ is insignificant, while the government indicators are all positive and significant. Similar to the EVC regression, the biggest coefficient is on regulatory quality. The coefficient of strength remains the same (0.05) but significant when we control for rule of law, corruption control, and GDP. Additionally, controlling for population explains the variance in travel exports by seventy three percent, the maximum R-squared when compared to the initial eighteen percent from the base model and the subsequent nineteen percent from Model 2. Models 3, 6, and 8 all yield coefficients of strength that are significant at the five percent level. It is also remarkable that the standard errors all take values of either 0.02 or 0.01. Overall, the relationship between strength and travel exports is seen to be consistently positive.

Table 8. OLS Estimates of Strength on Transportation Exports

Log Transportation Exports	Model 1	Model 2	Model 3	Model 4
(Intercept)	14.21 ***	14.17 ***	15.32 ***	14.53 ***
	(0.46)	(0.47)	(0.60)	(0.49)
Strength	0.08 ***	0.08 ***	0.03	0.08 ***
	(0.02)	(0.02)	(0.02)	(0.02)
Integration		1.07		
		(1.70)		
Latitude (DISTEQ)			0.02 *	
			(0.01)	
AFRICA			-1.56 **	
			(0.58)	
NAMERICA			-2.32 ***	
			(0.68)	
EUROPE			0.71	
			(0.72)	
Landlocked				-1.16 *
				(0.58)
N	153	153	153	153
R^2	0.10	0.10	0.30	0.12

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. AFRICA, NAMERICA, and EUROPE are dummy variables which take a value of 1 if a country is in Africa, Europe, or North America respectively or 0 otherwise- the reference category is all other continents. Integration is the ratio of total exports to GDP over the period 2000- 2019. Landlocked is binary, 1 for non-coastal countries and 0 otherwise.

Table 8 continued

Log Transportation Exports	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
(Intercept)	14.63 ***	15.83 ***	14.84 ***	15.58 ***	15.36 ***	15.29 ***
	(0.48)	(0.39)	(0.48)	(0.41)	(0.44)	(0.44)
strength	0.06 **	-0.00	0.05 *	0.01	0.03	0.03
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Political stability	0.70 *					
	(0.27)					
Government effectiveness		2.19 ***				
		(0.22)				
Accountability			0.97 ***			
			(0.27)			
Regulatory quality				2.07 ***		
				(0.24)		
Rule of law					1.66 ***	
					(0.24)	
Corruption control						1.52 ***
						(0.23)
N	153	153	153	153	153	153
R^2	0.14	0.46	0.17	0.40	0.32	0.30

Note. * indicates $p < .05$. ** indicates $p < .01$. EVC is the eigenvector. Political Stability, Government Effectiveness, Accountability, Regulatory Quality, Rule of Law, and Corruption Control are measures of government quality and range from -2.5 to +2.5

Table 8 continued

Log Transportation Exports	Model 11	Model 12	Model 13	Model 14	Model 15
(Intercept)	6.58 ***	7.29 ***	7.26 ***	-5.07 ***	0.05
	(0.76)	(0.70)	(1.00)	(1.17)	(1.91)
Strength	-0.06 **	-0.04 *	-0.02	0.03 *	0.09 ***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)
HDI	15.12 ***				
	(1.34)				
HCI		16.58 ***			
		(1.46)			
Education			0.79 ***		
			(0.10)		
Log GDP				1.00 ***	
				(0.06)	
Log Population					0.74 ***
					(0.10)
N	153	153	153	153	153
R^2	0.51	0.52	0.35	0.69	0.35

Note. * indicates $p < .05$. ** indicates $p < .01$. HDI and HCI are the Human development and human capital index respectively.

Travel Exports

Tables 9 and 10 concern travel exports. Tables 9 is for EVC while 10 is for strength. We can see that in Table 9 and 10 the base relationship between transportation exports and each centrality measure is positive, although the coefficient of EVC in Table 9 (22.43) is much bigger than that of strength in the base mode of Table 10. The overall coefficients of EVC are also bigger than strength, for the same relationships. Neither EVC or strength are significant when we control for the regional variables and geography. Whereas. Distance from the equator is significant and associated with a two percent increase in the level of transportation exports.

Including the controls in each case produces mixed signs. It is nonetheless intriguing to notice that controls take the same signs in both Tables, given a control. For instance, controlling for Landlocked, accountability, political stability, GDP, and population, produces positive significant coefficients in both Tables while controlling for HDI and HCI yields negative coefficients for EVC and strength, which are significant at the same one percent and five percent, respectively. Education has the same coefficient in both Tables and is also significant. The measures of government quality have positive significant coefficients in both strength and EVC regressions and are significant at the same levels. The magnitudes are also very close; for instance, Accountability is exactly 0.97 in both Tables, while POL is 0.69 in Table 9 and 0.7 in Table 10. The standard errors are also the same when we control for measures of government quality in each Table.

This trend carries over into the R-squared since they have about the same values in each Table. The base model has a value of 0.1 while the largest value comes from controlling for population.

Table 9. OLS Estimates of EVC on Travel Services

Log Travel	Model 1	Model 2	Model 3	Model 4
(Intercept)	14.64 ***	14.59 ***	15.58 ***	14.94 ***
	(0.36)	(0.36)	(0.51)	(0.38)
EVC	26.10 ***	25.00 ***	13.20 *	24.57 ***
	(4.44)	(4.59)	(6.16)	(4.42)
Integration		1.30		
		(1.36)		
DISTEQ			0.01	
			(0.01)	
AFRICA			-1.32 **	
			(0.50)	
NAMERICA			-0.48	
			(0.60)	
EUROPE			0.57	
			(0.64)	
Landlocked				-1.10 *
				(0.46)
N	153	153	153	153
R^2	0.19	0.19	0.27	0.22

Note. * indicates $p < .05$. ** indicates $p < .01$. EVC is the eigenvector. Integration is the ratio of total exports to GDP over the period 2000- 2019. AFRICA, NAMERICA, and EUROPE are dummy variables which take a value of 1 if a country is in Africa, Europe, or North America respectively or 0 otherwise- the reference category is all other continents. Landlocked is a dummy variable which takes a value of 1 if a country is not coastal or 0 otherwise

Table 9 continued

Log Travel	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
(Intercept)	14.91 ***	15.82 ***	15.15 ***	15.72 ***	15.49 ***	15.42 ***
	(0.38)	(0.32)	(0.37)	(0.32)	(0.34)	(0.35)
EVC	22.66 ***	8.60 *	18.81 ***	9.38 *	14.11 **	15.02 ***
	(4.69)	(4.07)	(4.75)	(4.12)	(4.35)	(4.44)
Political stability	0.46 *					
	(0.22)					
Government effectiveness		1.66 ***				
		(0.18)				
Accountability			0.78 ***			
			(0.22)			
Regulatory quality				1.68 ***		
				(0.19)		
Rule of law					1.26 ***	
					(0.19)	
Corruption control						1.13 ***
						(0.19)
N	153	153	153	153	153	153
R^2	0.21	0.47	0.25	0.46	0.36	0.34

Note. * indicates $p < .05$. ** indicates $p < .01$. EVC is the eigenvector. Political Stability, Government Effectiveness, Accountability, Regulatory Quality, Rule of Law, and Corruption Control are measures of government quality and range from -2.5 to +2.5

Table 9 continued

	Model 11	Model 12	Model 13	Model 14	Model 15
(Intercept)	9.08 ***	9.56 ***	9.36 ***	-1.00	2.41
	(0.67)	(0.61)	(0.83)	(0.93)	(1.49)
EVC	-1.57	1.44	5.69	13.49 ***	29.01 ***
	(4.66)	(4.41)	(4.90)	(2.68)	(3.69)
HDI	10.83 ***				
	(1.18)				
HCI		11.96 ***			
		(1.27)			
education			0.59 ***		
			(0.09)		
Log GDP				0.81 ***	
				(0.05)	
Log Population					0.64 ***
					(0.08)
N	153	153	153	153	153
R^2	0.48	0.49	0.38	0.73	0.45

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. EVC is the eigenvector centrality. HDI and HCI are the human development index and human capital index respectively.

Table 10. OLS estimates of Strength on Travel Exports

Log Travel Exports	Model 1	Model 2	Model 3	Model 4
(Intercept)	14.54 ***	14.50 ***	15.55 ***	14.86 ***
	(0.37)	(0.38)	(0.52)	(0.39)
Strength	0.09 ***	0.09 ***	0.05 *	0.09 ***
	(0.02)	(0.02)	(0.02)	(0.02)
Integration		1.31		
		(1.37)		
DISTEQ			0.01	
			(0.01)	
AFRICA			-1.32 **	
			(0.50)	
NAMERICA			-0.40	
			(0.59)	
EUROPE			0.65	
			(0.62)	
Landlocked				-1.13 *
				(0.46)
N	153	153	153	153
R^2	0.18	0.19	0.27	0.22

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. Strength is the sum of linguistic proximities of a node with adjacent nodes. AFRICA, NAMERICA, and EUROPE are dummy variables which take a value of 1 if a country is in Africa, Europe, or North America respectively or 0 otherwise- the reference category is all other continents. Landlocked is a dummy variable which takes a value of 1 if a country is not coastal or 0 otherwise

Table 10 continued

Log Travel Exports	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
(Intercept)	14.84 ***	15.77 ***	15.06 ***	15.65 ***	15.42 ***	15.35 ***
	(0.39)	(0.33)	(0.38)	(0.33)	(0.36)	(0.36)
Strength	0.08 ***	0.03 *	0.07 ***	0.04 *	0.05 **	0.05 ***
	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)
Political Stability	0.48 *					
	(0.22)					
Government Effectiveness		1.66 ***				
		(0.18)				
Accountability			0.80 ***			
			(0.22)			
Regulatory Quality				1.67 ***		
				(0.19)		
Rule of Law					1.26 ***	
					(0.19)	
Corruption Control						1.14 ***
						(0.19)
N	153	153	153	153	153	153
R^2	0.21	0.47	0.25	0.46	0.37	0.34

Note. * indicates $p < .05$. ** indicates $p < .01$. Political Stability, Government Effectiveness, Accountability, Regulatory Quality, Rule of Law, and Corruption Control are measures of government quality and range from -2.5 to +2.5

Table 10 continued

Log Travel Exports	Model 11	Model 12	Model 13	Model 14	Model 15
(Intercept)	9.10 ***	9.55 ***	9.33 ***	-1.06	2.41
	(0.66)	(0.61)	(0.83)	(0.93)	(1.49)
Strength	-0.00	0.01	0.02	0.05 ***	0.10 ***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)
HDI	10.79 ***				
	(1.17)				
HCI		11.96 ***			
		(1.27)			
Education			0.59 ***		
			(0.09)		
Log GDP				0.81 ***	
				(0.05)	
Log Population					0.63 ***
					(0.08)
N	153	153	153	153	153
R^2	0.48	0.49	0.38	0.73	0.44

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. HDI and HCI are the Human Development and Human Capital Index respectively. Strength is the node strength representing the sum of linguistic proximities with adjacent countries.

Communication Exports

Tables 11 and 12 relate to communication exports. In Table 11, there is a positive relationship between EVC and exports of communications services, for all the models. The base model shows a 33.27 coefficient which is significant at the 0.01 percent level. Controlling for integration increases the EVC to 35.01 at the same significance level. Integration yields a negative non-significant coefficient, and the entire Model 3 yields insignificant coefficients. EVC is significant in the presence of Landlocked, but the coefficient for political stability, accountability, rule of law and corruption control are insignificant although EVC remains significant in their respective models. Regulatory quality is more significant than government effectiveness when we hold EVC constant, but the EVC in Model 6 (20.55), with GE as its control is bigger in magnitude when compare to model 8 where quality of regulations is the control (20.03). EVC remains significant in the presence of GDP per capita and population. The highest R-squared is 0.28, which comes from controlling for the population of the countries. The R-squared values are lower overall than the previous Tables so far, suggesting the reduced explanatory capacity of our independent variables when examining communications exports.

In Table 12 where strength is the main variable of interest, the coefficient of the base model is 0.12, significant at the 0.1 percent level. The Table follows the same trends as in Table 11: the entire model controlling for geography and regional factors yields insignificant coefficients. Only government effectiveness and regulatory quality are significant among the measures of government quality, and when either is held constant, increasing strength by one unit leads to an eight percent and seven percent increase respectively in the level of exports. Overall, the relationship between strength and

communications exports stays positive and Model 14 has the highest explanatory power with an R-squared of 0.29, same as in Table 11 when we control for GDP

TABLE 11. OLS estimates for EVC on Communications Exports

Log Communication Services	Model 1	Model 2	Model 3	Model 4
(Intercept)	10.44 ***	10.51 ***	10.98 ***	10.22 ***
	(0.68)	(0.69)	(0.97)	(0.72)
EVC	33.27 ***	35.01 ***	22.34	34.37 ***
	(8.42)	(8.72)	(11.83)	(8.52)
Integration		-2.03		
		(2.59)		
DISTEQ			0.02	
			(0.02)	
AFRICA			-0.71	
			(0.96)	
NAMERICA			-1.98	
			(1.16)	
EUROPE			1.22	
			(1.22)	
Landlocked				0.79
				(0.89)
N	153	153	153	153
R^2	0.09	0.10	0.17	0.10

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. AFRICA, NAMERICA, and EUROPE are dummy variables which take a value of 1 if a country is in Africa, Europe, or North America respectively or 0 otherwise- the reference category is all other continents. Landlocked is a dummy variable which takes a value of 1 if a country is not coastal or 0 otherwise.

Table 11 Continued

Log Communication Services	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
(Intercept)	10.38 ***	11.30 ***	10.78 ***	11.30 ***	10.97 ***	10.86 ***
	(0.73)	(0.73)	(0.74)	(0.72)	(0.73)	(0.73)
EVC	33.98 ***	20.55 *	28.47 **	20.03 *	25.88 **	27.35 **
	(9.03)	(9.35)	(9.33)	(9.28)	(9.23)	(9.27)
Political Stability	-0.10					
	(0.43)					
Government Effectiveness		1.21 **				
		(0.42)				
Accountability			0.51			
			(0.43)			
Regulatory Quality				1.33 **		
				(0.44)		
Rule of Law					0.78	
					(0.41)	
Corruption Control						0.61
						(0.40)
N	153	153	153	153	153	153
R^2	0.09	0.14	0.10	0.15	0.11	0.11

Note. * indicates $p < .05$. ** indicates $p < .01$. Political Stability, Government Effectiveness, Accountability, Regulatory Quality, Rule of Law, and Corruption Control are measures of government quality and range from -2.5 to +2.5

Table 11 Continued

Log Communication Services	Model 11	Model 12	Model 13	Model 14	Model 15
(Intercept)	7.95 ***	6.33 ***	6.79 ***	-6.33 *	-8.06 **
	(1.57)	(1.41)	(1.78)	(2.71)	(3.05)
EVC	20.85	13.30	19.17	19.75 *	37.67 ***
	(10.94)	(10.17)	(10.47)	(7.80)	(7.58)
HDI	4.86				
	(2.76)				
HCI		9.69 **			
		(2.94)			
Education			0.41 *		
			(0.18)		
Log GDP				0.87 ***	
				(0.14)	
Log Population					0.96 ***
					(0.16)
N	153	153	153	153	153
R^2	0.11	0.15	0.12	0.29	0.28

Note. * indicates $p < .05$. ** indicates $p < .01$. EVC is the eigenvector centrality. Education is the average years of adult education.

Table 12. OLS Estimates for Strength on Communications Services

Log Communication Services	Model 1	Model 2	Model 3	Model 4
(Intercept)	10.31 ***	10.38 ***	10.93 ***	10.10 ***
	(0.71)	(0.71)	(1.00)	(0.75)
Strength	0.12 ***	0.13 ***	0.08	0.12 ***
	(0.03)	(0.03)	(0.04)	(0.03)
Integration		-2.02		
		(2.59)		
DISTEQ			0.02	
			(0.02)	
AFRICA			-0.71	
			(0.96)	
NAMERICA			-1.84	
			(1.14)	
EUROPE			1.35	
			(1.20)	
landlocked				0.75
				(0.89)
N	153	153	153	153
R^2	0.09	0.10	0.16	0.10

Note. * indicates $p < .05$. ** indicates $p < .01$. AFRICA, NAMERICA, and EUROPE are dummy variables which take a value of 1 if a country is in Africa, Europe, or North America respectively or 0 otherwise- the reference category is all other continents. Landlocked is a dummy variable which takes a value of 1 if a country is not coastal or 0 otherwise. DISTEQ is the latitude of a country which measures the distance from the equator. EVC is the eigenvector centrality.

Table 12 continued

Log Communication Services	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
(Intercept)	10.27 ***	11.21 ***	10.67 ***	11.19 ***	10.86 ***	10.75 ***
	(0.75)	(0.76)	(0.76)	(0.74)	(0.76)	(0.76)
strength	0.12 ***	0.08 *	0.10 **	0.07 *	0.09 **	0.10 **
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Political stability	-0.06					
	(0.42)					
Government effectiveness		1.21 **				
		(0.42)				
Accountability			0.55			
			(0.42)			
Regulatory quality				1.33 **		
				(0.43)		
Rule of law					0.79	
					(0.41)	
Corruption control						0.62
						(0.40)
N	153	153	153	153	153	153
R^2	0.09	0.14	0.10	0.15	0.12	0.11

Note. * indicates $p < .05$. ** indicates $p < .01$. Political Stability, Government Effectiveness, Accountability, Regulatory Quality, Rule of Law, and Corruption Control are measures of government quality and range from -2.5 to +2.5

Table 12 continued

Log Communication Services	Model 11	Model 12	Model 13	Model 14	Model 15
(Intercept)	7.86 ***	6.28 ***	6.73 ***	-6.41 *	-8.07 **
	(1.55)	(1.40)	(1.77)	(2.70)	(3.06)
Strength	0.08	0.05	0.07	0.07 *	0.14 ***
	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)
HDI	4.86				
	(2.74)				
HCI		9.66 **			
		(2.94)			
Education			0.40 *		
			(0.18)		
Log GDP				0.87 ***	
				(0.14)	
Log Population					0.96 ***
					(0.16)
N	153	153	153	153	153
R^2	0.11	0.16	0.12	0.29	0.28

Note. * indicates $p < .05$. ** indicates $p < .01$. HDI and HCI are the Human development and human capital index respectively.

Financial Services

The next Tables, 13 and 14, show how EVC and strength relate to exports of financial exports respectively. In the base mode for strength in Table 14, increasing strength by one unit leads to a fourteen percent increase in the financial services, while the base model in Table 13 suggests that increasing centrality more than doubles exports. The significant relationships between EVC and financial exports, and strength and financial exports are positive. The negative relationships are not significant: these are found in models 11 and 12 of Tables 13 and 14 respectively. There only significant positive relationships between EVC and financial exports and strength and financial exports are in each base model and models 2, 4, 5, and 15, for the respective Tables. Otherwise, controlling for geography and region, government quality, accountability, regulatory quality, HDI, and average years of education yields insignificant positive relationships. Both EVC and strength are positive and significant when you control for population but not significant when we control for GDP. Additionally, controlling for Population increases the coefficient of EVC from 35.63 in Model 1 to 41.84 in Model 15 of Table 1. All the measures of government quality except political stability, are significant in the presence of EVC and strength.

The R-squared valued are very similar in both Tables: controlling for population in model 14 of each Table yields the same value, 0.42, in both cases, which is also the maximum r-squared in each case.

Table 13. OLS estimates of EVC on exports of Financial Services

Log Financial Services	Model 1	Model 2	Model 3	Model 4
(Intercept)	9.28 ***	9.17 ***	11.33 ***	9.19 ***
	(0.85)	(0.86)	(1.17)	(0.91)
EVC	35.63 ***	32.97 **	4.90	36.05 ***
	(10.59)	(10.95)	(14.18)	(10.73)
Integration		3.11		
		(3.25)		
DISTEQ			0.02	
			(0.02)	
AFRICA			-2.68 *	
			(1.15)	
NAMERICA			-2.70	
			(1.39)	
EUROPE			2.68	
			(1.47)	
Landlocked				0.31
				(1.12)
N	153	153	153	153
R^2	0.07	0.08	0.22	0.07

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. AFRICA, NAMERICA, and EUROPE are dummy variables which take a value of 1 if a country is in Africa, Europe, or North America respectively or 0 otherwise- the reference category is all other continents. Landlocked is a dummy variable which takes a value of 1 if a country is not coastal or 0 otherwise. DISTEQ is the latitude of a country which measures the distance from the equator. EVC is the eigenvector centrality.

Table 13 continued

Log Financial	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
(Intercept)	9.53 ***	11.23 ***	10.58 ***	11.01 ***	10.72 ***	10.56 ***
	(0.91)	(0.86)	(0.89)	(0.86)	(0.87)	(0.89)
EVC	32.50 **	6.74	17.26	8.96	15.33	17.58
	(11.33)	(11.01)	(11.26)	(11.09)	(11.08)	(11.22)
Political Stability	0.42					
	(0.53)					
Government Effectiveness		2.74 ***				
		(0.50)				
Accountability			1.96 ***			
			(0.52)			
Regulatory Quality				2.67 ***		
				(0.52)		
Rule of Law					2.13 ***	
					(0.50)	
Corruption Control						1.84 ***
						(0.49)
N	153	153	153	153	153	153
R^2	0.07	0.23	0.15	0.21	0.17	0.15

Note. * indicates $p < .05$. ** indicates $p < .01$. Political Stability, Government Effectiveness, Accountability, Regulatory Quality, Rule of Law, and Corruption Control are measures of government quality and range from -2.5 to +2.5

Table 13 continued

Log Financial Services	Model 11	Model 12	Model 13	Model 14	Model 15
(Intercept)	0.74	-0.23	1.62	-18.82 ***	-16.87 ***
	(1.84)	(1.61)	(2.17)	(3.02)	(3.70)
EVC	-6.90	-10.55	6.01	12.96	41.84 ***
	(12.81)	(11.63)	(12.77)	(8.71)	(9.20)
HDI	16.65 ***				
	(3.23)				
HCI		22.39 ***			
		(3.36)			
Education			0.85 ***		
			(0.22)		
Log GDP				1.45 ***	
				(0.15)	
Log Population					1.36 ***
					(0.19)
N	153	153	153	153	153
R^2	0.21	0.28	0.15	0.42	0.31

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. EVC is the eigenvector centrality. Education is the average years of education. HDI and HCI are the human development index and human capital index.

Table 14. OLS estimates of strength on Financial exports

Log Financial Services	Model 1	Model 2	Model 3	Model 4
(Intercept)	9.09 ***	8.99 ***	11.24 ***	9.01 ***
	(0.89)	(0.89)	(1.20)	(0.94)
Strength	0.13 ***	0.12 **	0.02	0.13 ***
	(0.04)	(0.04)	(0.05)	(0.04)
Integration		3.07		
		(3.25)		
DISTEQ			0.02	
			(0.02)	
AFRICA			-2.63 *	
			(1.16)	
NAMERICA			-2.70 *	
			(1.36)	
EUROPE			2.66	
			(1.43)	
Landlocked				0.27
				(1.12)
N	153	153	153	153
R^2	0.07	0.08	0.22	0.07

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. AFRICA, NAMERICA, and EUROPE are dummy variables which take a value of 1 if a country is in Africa, Europe, or North America respectively or 0 otherwise- the reference category is all other continents. Landlocked is a dummy variable which takes a value of 1 if a country is not coastal or 0 otherwise. DISTEQ is the latitude of a country which measures the distance from the equator. EVC is the eigenvector centrality.

Table 14 continued

Log Financial Services	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
(Intercept)	9.35 ***	11.10 ***	10.35 ***	10.84 ***	10.56 ***	10.39 ***
	(0.94)	(0.89)	(0.91)	(0.89)	(0.91)	(0.92)
Strength	0.12 **	0.03	0.07	0.04	0.06	0.07
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Political stability	0.44					
	(0.53)					
Government effectiveness		2.71 ***				
		(0.49)				
Accountability			1.95 ***			
			(0.51)			
Regulatory quality				2.64 ***		
				(0.52)		
Rule of law					2.12 ***	
					(0.49)	
Corruption Control						1.83 ***
						(0.48)
N	153	153	153	153	153	153
R^2	0.08	0.23	0.15	0.21	0.17	0.15

Note. * indicates $p < .05$. ** indicates $p < .01$. Political Stability, Government Effectiveness, Accountability, Regulatory Quality, Rule of Law, and Corruption Control are measures of government quality and range from -2.5 to +2.5

Table 14 continued

Log Financial Services	Model 11	Model 12	Model 13	Model 14	Model 15
(Intercept)	0.84	-0.15	1.65	-18.86 ***	-16.94 ***
	(1.82)	(1.61)	(2.16)	(3.02)	(3.70)
Strength	-0.02	-0.03	0.03	0.05	0.15 ***
	(0.05)	(0.04)	(0.05)	(0.03)	(0.03)
HDI	16.34 ***				
	(3.22)				
HCI		22.15 ***			
		(3.36)			
Education			0.84 ***		
			(0.22)		
Log GDP				1.45 ***	
				(0.15)	
Log Population					1.36 ***
					(0.19)
N	153	153	153	153	153
R^2	0.21	0.28	0.15	0.42	0.31

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. Education is the average years of education. HDI and HCI are the human development index and human capital index.

CHAPTER SIX

Discussion and Conclusion

The main objective of this study was to examine the relationship between language centrality and total exports. Language centrality was measured through two metrics used to evaluate node influence in social network theory: eigenvector centrality and strength. In basic terms, strength measured a country's influence based on the quality of friends in its neighborhood. Here the most influential nodes are those with strongest ties to its neighbors, while the least influential countries have weak ties with their neighbors; eigenvector centrality measured a country's influence based on the importance of their friends in the network: the nodes with important (central) friends have a stronger EVC while those with less central friends have weaker EVC. We established that centrality is important for efficiently spreading information through a network. LP is based on native language, and native language fosters ethnic trust and cultural affinity (Fourie and Gallego, 2013) which increases international trade flows (Melitz and Toubal, 2014). The results from regressions of EVC on total exports reveal that when a country's influence increase in a network the exports will also increase. This kind of influence is achieved by being strongly connected to many other nodes that are themselves central in the network (Lohmann et al., 2010). In the case of network, this means connection to a country that has strong linguistic ties with its neighborhood. As we noticed with both EVC and strength regressions on total exports, the positive relationship indicates that countries with a higher eigenvector centrality will have more exports than those with lower eigenvector centrality.

The relationship also holds for strength too, although the type of influence acquired from strength results from stronger connectivity within one's neighborhood and does not consider the external connections of the nodes in the neighborhood. More so, the large difference in magnitudes of the coefficients between EVC and strength implies that the effect of EVC is larger: countries export more if they are connected to influential languages that may or may not be similar to theirs, than simply being strongly connected to many languages that are similar to theirs.

Let us contextualize these results by comparing two countries using base model coefficients and the significant controls. Consider Norway, Canada, and Egypt, with EVCs of 0.127, 0.082, and 0.054 respectively. Given the base model, their respective average exports based on eigenvector centrality will be $[e^{15.75+25.72(0.127)}] = 181440802.238$ $[e^{15.75+25.72(0.082)}] = 57027262.447$, and $[e^{15.75+25.72(0.054)}] = 27753707.6988.$ But based on strength, the average total exports will be $[e^{15.67+0.05(55.21)}] = 100986762.312$ $[e^{15.67+0.05(34.14)}] = 35215609.7121,$ and $[e^{15.67+0.05(24.83)}] = 22109103.395$, respectively.

We notice that in each case the EVC exports are always bigger than the strength averages. Since both measures of centrality examine different types of centrality, it is important to consider what the implications are, in terms of economic policies. If the coefficients from the base models were causal, this would imply that countries would have to pay more attention to the EVC to maximize average exports. This might be a tricky policy to approach because the EVC from this network is based on native language, which is generational: therefore, suggesting that countries make their native languages more

similar to central ones is obviously not feasible. However, as seen in Melitz (2014), native language is a transmission mechanism for culture and ethnic trust, which reduce communications costs.

This raises the point of pidgins and creoles. The Chambers Dictionary (1993) defines pidgin as: any combination and distortion of two languages as a means of communication. And *pidgin English as* any lingua franca consisting of English and another language (Sebba, 1997). Linguistic proximity was developed as an index to control for non-official methods of communication like common native language, common spoken language, and common official language. Given that linguistic proximity is based on native languages, cultivating creole languages at the national level can enhance cultural ties with countries that have influential languages. Studies in studies in status stability appraisal (Neeley and Dumas, 2016) have shown that there are benefits associated with elevating to influential languages within social interactions such as access to expanded networks. Shifting towards creoles is also a viable option if the initial costs of officializing the influential native language is higher than the cost of acquiring its creole version. Creoles and pidgins are usually not included as part of the spoken languages when constructing indices of common spoken languages. However, and especially in the case of contiguous LEDCs, creoles are usually a mixture of native languages, and play a big role in facilitating communication between adjacent countries. This is a main reason why there is a problem with the linguistic proximity index constructed by Melitz and Toubal (2014). Since the index assigns a linguistic proximity of zero to all countries with a linguistic diversity index, there is no way to establish how an otherwise significant language interacts in the current

network of 195 countries. For instance, countries in Sub Saharan Africa share boundaries, and in most cases, there are spillovers between dialects.

The purpose of our analysis was to understand how the most exported service categories correlate with language influence. The focus was on transportation, travel, telecommunications, and financial services because it is believed that separate mechanisms drive the production and consumption of these services, and they are cited as the world's most exported services (UNCTAD 2020). These separate mechanisms can be seen at work between travel and financial services. Controlling for the regional and geographical factors in travel regressions reduced the base EVC coefficient from 26.10 to 13.20, at the five percent significance level but they were found to be not significant in the regression on financial services. This matches our intuition, as we would expect geographical factors to explain more variation in the exports of travel goods like tourism, rather than financial services than can be provided remotely or through applications and web services. Conversely, political stability was significant in further explaining the variance in financial services, when compared to transportation services. This phenomenon can be related to aversion by financial institutions to invest in politically unstable countries.

The results observed in the regressions on per capita income also suggest that prosperity is associated with the influence on the language network. As seen in Figure 4, Netherlands, which is the most influential country in the network based on EVC also has a high level of GDP, which was explained by EVC, its country size in terms of population and also the strength of its institutions. The positive relationship between EVC and levels of prosperity suggests a model whereby the language influence mostly leads to increase levels of per capita GDP through increase in exports. Again, in these regressions, EVC's

coefficients tended to dominate strength, indicating that influential neighbors are preferable to good friends within the context of a linguistic network.

Even though estimating these relationships with different network sizes might yield different estimates, the relationship between language influence and exports is expected to be positive. However, if the network is estimated and the OLS computed over different network sizes, it could be possible to observe the distribution of the base coefficients as the sample size approaches the total number countries in the largest network. But for this approach to be more accurate, the question of quantifying linguistic proximities for countries with high linguistic indexes needs to be answered.

APPENDIX

APPENDIX

TABLE 15. OLS estimates of EVC on Insurance Services

	Model 1	Model 2	Model 3	Model 4
(Intercept)	10.60 ***	10.51 ***	10.93 ***	10.69 ***
	(0.58)	(0.58)	(0.83)	(0.62)
EVC	26.71 ***	24.40 **	11.59	26.26 ***
	(7.18)	(7.41)	(10.05)	(7.28)
Integration		2.71		
		(2.20)		
DISTEQ			0.03	
			(0.02)	
AFRICA			-0.40	
			(0.82)	
NAMERICA			-0.28	
			(0.99)	
EUROPE			1.08	
			(1.04)	
Landlocked				-0.32
				(0.76)
N	153	153	153	153
R^2	0.08	0.09	0.16	0.09

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.EVC is the eigenvector centrality. Landlocked is a dummy variable which equals 1 if the country is non-coastal or 0 otherwise. AFRICA, NAMERICA and EUROPE are dummy variables for continents. Integration is the ratio of trade to GDP which measures openness to trade.

Table 15 continued

	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
(Intercept)	10.90 ***	12.18 ***	11.23 ***	12.04 ***	11.74 ***	11.61 ***
	(0.62)	(0.56)	(0.62)	(0.56)	(0.58)	(0.59)
EVC	23.02 **	3.31	17.79 *	4.50	10.71	12.51
	(7.65)	(7.13)	(7.81)	(7.18)	(7.35)	(7.48)
Political stability	0.49					
	(0.36)					
Government effectiveness		2.22 ***				
		(0.32)				
Accountability			0.95 **			
			(0.36)			
Regulatory quality				2.23 ***		
				(0.34)		
Rule of law					1.68 ***	
					(0.33)	
Corruption control						1.45 ***
						(0.33)
N	153	153	153	153	153	153
R^2	0.10	0.30	0.12	0.29	0.22	0.19

Note *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. Except EVC which is the eigenvector centrality, all other variables are measures of government quality and range from -2.5 to +2.5

Table 15 continued

	Model 11	Model 12	Model 13	Model 14	Model 15
(Intercept)	3.79 **	3.89 ***	4.81 **	-9.19 ***	-4.53
	(1.20)	(1.08)	(1.45)	(2.00)	(2.63)
EVC	-7.21	-5.91	4.32	10.75	30.31 ***
	(8.39)	(7.79)	(8.56)	(5.77)	(6.52)
HDI	13.28 ***				
	(2.12)				
HCI		15.82 ***			
		(2.25)			
education			0.64 ***		
			(0.15)		
Log GDP				1.02 ***	
				(0.10)	
Log Population					0.79 ***
					(0.13)
N	153	153	153	153	153
R^2	0.27	0.31	0.18	0.46	0.26

Note *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. HDI and HCI are the human development and human capital index respectively.

Table 16. OLS estimates of Strength on Insurance Services

	Model 1	Model 2	Model 3	Model 4
(Intercept)	10.54 ***	10.45 ***	10.94 ***	10.64 ***
	(0.60)	(0.61)	(0.85)	(0.64)
Strength	0.09 ***	0.09 **	0.04	0.09 ***
	(0.03)	(0.03)	(0.04)	(0.03)
Integration		2.76		
		(2.20)		
Latitude			0.03	
			(0.02)	
AFRICA			-0.42	
			(0.82)	
NAMERICA			-0.20	
			(0.97)	
EUROPE			1.17	
			(1.02)	
Landlocked				-0.36
				(0.76)
N	153	153	153	153
R^2	0.08	0.09	0.16	0.08

Note *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. Integration is the ratio of trade to GDP which measures the openness of a country to trade.

Table 16 continued

	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
(Intercept)	10.85 ***	12.18 ***	11.17 ***	12.01 ***	11.71 ***	11.58 ***
	(0.64)	(0.58)	(0.63)	(0.58)	(0.60)	(0.61)
Strength	0.08 **	0.01	0.06 *	0.02	0.04	0.04
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Political stability	0.52					
	(0.36)					
Government effectiveness		2.22 ***				
		(0.32)				
Accountability			0.98 **			
			(0.36)			
Regulatory quality				2.23 ***		
				(0.33)		
Rule of law					1.69 ***	
					(0.33)	
Corruption control						1.46 ***
						(0.32)
N	153	153	153	153	153	153
R^2	0.09	0.30	0.13	0.29	0.22	0.19

Note *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. . Political Stability, Government Effectiveness, Accountability, Regulatory Quality, Rule of Law, and Corruption Control are measures of government quality and range from -2.5 to +2.5

Table 16 continued

	Model 11	Model 12	Model 13	Model 14	Model 15
(Intercept)	3.82 **	3.90 ***	4.76 **	-9.25 ***	-4.48
	(1.19)	(1.07)	(1.45)	(2.00)	(2.64)
Strength	-0.03	-0.02	0.01	0.04	0.11 ***
	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)
HDI	13.32 ***				
	(2.10)				
HCI		15.92 ***			
		(2.25)			
Education			0.65 ***		
			(0.15)		
Log GDP				1.02 ***	
				(0.10)	
Log Population					0.78 ***
					(0.13)
N	153	153	153	153	153
R^2	0.27	0.31	0.18	0.46	0.25

Note*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. HDI and HCI are the human development index and human capital index respectively

Table 17. Estimates of EVC on Exports with All Control

Log Total Exports	Model 1
(Intercept)	-0.90
	(5.27)
EVC	-2.61
	(1.70)
Log GDP	0.60
	(0.52)
Log Population	0.28
	(0.53)
Log PCGDP	-0.26
	(0.53)
Integration	4.21 ***
	(0.38)
HDI	5.13 ***
	(1.33)
HCI	-0.03
	(1.20)
education	0.01
	(0.05)
DISTEQ	0.00
	(0.00)
landlocked	-0.38 **
	(0.12)
AFRICA	-0.18
	(0.16)
NAMERICA	0.19
	(0.19)
EUROPE	0.15
	(0.22)
Accountability	-0.02
	(0.11)
Political Stability	0.08
	(0.11)
Government Effectiveness	0.24
	(0.27)
Regulatory Quality	0.24
	(0.19)
Rule of Law	0.17
	(0.28)
Corruption Control	-0.20
	(0.22)
N	153
R^2	0.96

Note *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. EVC is the eigenvector centrality. Log PCGDP is the natural log of GDP per capita. Integration is the ratio of trade to GDP which measures openness to trade. Landlocked is a dummy variable which is 1 for non-coastal countries and zero otherwise. AFRICA, EUROPE, NAMERICA are binary variable which take values of 1 if the country belongs to the respective continent or 0 otherwise. HDI and HCI are the human development index and human capital index respectively. Accountability to Corruption Control are measures of government quality and range from -2.5 to +2.5.

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