MASTER THESIS

AUGMENTED GRAVITY MODEL: INSTITUTIONS, INFRASTRUCTURE AND GLOBALIZATION IMPACT ON BILATERAL EXPORTS AMONG OECD COUNTRIES.

AUTHOR: TOM SCHOLTES

STUDENT NUMBER: 476859

ABSTRACT

This thesis investigates the influence of Institutions, infrastructure, and globalization on bilateral aggregate exports among countries that belong to the Organization for Economic Cooperation and Development (OECD). This thesis applies the gravity model for the period between 1995-2018 and uses fixed-effects with the Ordinary Least Squares (OLS) estimation method. After ensuring that estimations pass the RESET test for misspecification, this thesis observes a positive relationship between bilateral aggregate exports and when the reporter and partner country are both members of the European union or regional trade agreement. Moreover, the bilateral aggregate exports are higher among countries that have a common currency. This thesis's novelty is assessing exporter's economic and political globalization, state fragility, and the impact of exporter's innovation on bilateral aggregate exports. The results suggest that economic, political globalization, and exporter's innovation indexes positively contribute to increase bilateral aggregate exports; conversely, state fragility affects exports negatively. The institutional and infrastructure quality indicators reveal a mixed impact on bilateral aggregate exports, with road infrastructure quality having a substantial positive impact on the dependent variable. The most perplexing results stem from the negative impact of an increase in political stability and market openness on bilateral aggregate exports.

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1. INTRODUCTION

Natural sciences, such as biology or physics possess directly intuitive and hard scientific characters, these qualities have attracted social and economic sciences to adopt these relations or "laws" from natural sciences. Multitudes of examples can be found effortlessly — The use of logistic functions for technological diffusion originating from epidemic laws to Goodwin's growth cycles inspired by the dynamics of the biological system called the "prey-predator" model. From an empirical point of view, for economists, results of this adoption have been successful. The results of most empirical studies maintained a solid ground under various econometrics test employed to verify the robustness of these adoptions. Econophysics is defined as an interdisciplinary research field, which, to solve a problem in economics, applies methods and theories initially developed by physicists (Kutner et al., 2019). Jan Tinbergen was the first to obtain a Nobel Prize in Economics in 1969, adapting Newton's law of gravitation by replacing the mass with Gross Domestic Product (Garlaschelli, 2014) and the distance between masses with the distance between countries.

The gravity equation is known to be one of the most prominent empirical economic model; Using a single equation in which coefficients are statistically well defined and economically sound, the variations are well explained. (Frankel and Rose, 2002). The gravity equation has therefore been widely used to explore the determinants of bilateral trade flows. Early debates until the nineties focused on solving the theoretical framework after being hit by waves of skepticisms, detailed information on theoretical framework is found in the first sub-section of section two. The ongoing debates mostly focus on evaluating various estimation techniques performance.

Trade is seen as an engine of economic growth (Senhadji & Montenegro, 1999), thus, it is important to assess the impact of institutions, the quality of infrastructure and the impact of economic and political globalization on OECD countries' bilateral aggregate exports. The divergence in results from numerous papers findings on export determinants spurred curiosity on choosing this topic for the master thesis. Differences in outcomes befall due to heterogeneity in time-periods, sample sizes, and research models used for the study. This research study performs a comprehensive examination of the possible factors or determinants of OECD countries' trades using the data from 1995 to 2018, employing the gravity model with the traditional OLS estimation method. Besides commonly considered variables of gravity model GDP, Distance, and regional trade agreements, this research study expands its study to other factors, including OECD countries' stock FDI, exchange rate, EU, and common currency. Additionally, various standard dummy variables of trade costs are added to natural, manmade, and cultural differences.

There are at least two reasons, from a theoretical standpoint, how institutions can have a direct impact on trade. First, the quality of institutions acts as trade impeding or enhancing factors on bilateral trade, influencing the cost of international exchange, e.g., insecurity decreases the bilateral export volume by reducing the quantity of exports. Second, institutions are the origin of comparative advantage.

Borchert and Yotov (2017) claim that globalization can be seen anywhere but in estimates utilizing gravity model, discovering that manufacturing trade is affected by globalization. However, these authors did not measure globalization using clear, explicit indicators; authors interpret the change in magnitudes of distance, RTA, and contiguity impact on trade as proxies for economic globalization. This thesis examines the impact on global trade of political and economic globalization indexes. There are two dimensions of economic globalization in the employed index: economic flows, restrictions on capital and trade. The

economic flows sub-index contains trade, FDI, and portfolio investment data. The Restrictions sub-index acknowledges obscure import barriers, international trade taxes (as a share of current income), average tariff rates and an indicator for capital controls. Political globalization is based on the number of high-level commissions and embassies in a nation, the number of UN peacekeeping missions in which a country has participated, the number of international institutions to which a country belongs, and the number of bilateral or multilateral treaties signed. Borchert and Yotov (2017) conclude that further research needs to be conducted on globalization's influence on trade. The results of this thesis indicate significantly positive and substantial influence of economic and political globalization on aggregate bilateral exports for the full period (1995-2018) and the shorter period (2011-2018).

This thesis finds that bilateral aggregate exports are higher among European Union members, Regional Trade Agreement, and when countries export to a partner with a common currency. In addition, this thesis obtains mixed results regarding the effect of institutional variables, where, when the entire period is regarded (1995-2018), the rule of law and government size have a positive impact on exports. Conversely, political stability and market openness, have an adverse impact on aggregate bilateral exports. The influence of soft infrastructure, namely the internet usage and mobile subscriptions index, which is an indicator for the Information and Communications Technology (ICT) index, positively impacts the bilateral aggregate exports. Contrary to expectations, the impact of total infrastructure investment on the dependent variable is significantly close to zero. This thesis also finds that importers' average weighted Most Favored Nation (MFN) tariffs harm the bilateral aggregate exports. Preliminary evidence using a recent period (2011-2018) with alternative variables for the institutional and infrastructure quality indicate that the state fragility index is negatively related to exports. The exporter 's innovation index, by contrast, has a beneficial impact on exports. Alternative infrastructure quality variables using indexes for the quality of port, road , rail and air transport indicators reveal that exports are significantly affected only by the port and road infrastructure indexes. The port infrastructure improvement hurts exports while the road infrastructure doubles in terms of magnitude of the impact and switches signs to positive.

The thesis is set as follows: The following section initiates with a historical overview of the theoretical framework (2.1) subsequently, followed by presenting the main determinants of trade found in the literature (2.2) then subsequently narrows focus on institutions, infrastructure and the impact of globalization on bilateral trade flows in sub-section 2.3. The last sub-section (2.5) of section 2 states the objective of the research, hypothesis and summarizes variables investigated in the main and alternative specification (robustness table). The third section describes the data, while the section four explains the methodology by providing the gravity equation, econometrics specification and a summary of the benefits of using Ordinary Least Squares (OLS) with fixed effects. The fifth section is about the diagnostics, examines the data structure and pre-estimation tests are conducted. Subsequently in section six, output interpretation of the regression results of the main and robustness table are presented. Subsections 6.3 and 6.4 summarizes the main findings illustrating the constraints of the study and provides suggestions for further research. The last section (7) ends with a conclusion.

2. LITERATURE REVIEW DRAFT

2.1 HISTORICAL OVERVIEW OF THE THEORETICAL FRAMEWORK

Tinbergen(1962), in his seminal work, introduced the gravity equation by using the analogy of the Newtonian gravitation theory, which approximates bilateral trade flows around two nations. Planets, by their sizes and proximity, are mutually attracted. Trade is similarly commensurate with nations' respective Gross Domestic Products (GDP) and geographical vicinity. Alternative micro-foundation was employed by Arango (1985) for the earliest applications to the economics of Newtonian law of gravity, studying the immigration flows.

In finding theoretical and economic foundations for the gravity equation with Constant Elasticity of Substitution (CES) assumption and differentiation of goods by origin, Anderson(1979) is the pioneer, highlighting the significance of the general equilibrium effects of trade costs. Anderson (1979) carried out the initial effort to derive the gravity equation from the theoretical model using the Armington assumption in which goods are differentiated by place of origin with the expenditure system of Cobb Douglass where each good is produced by one nation. The reduced form of bilateral trade was subsequently derived by Bergstrand (1985) utilizing CES preferences over the assumption by Armington of differentiation of goods.

Bergstrand (1985 and 1989) demonstrates that the theory developed by Paul Krugman (1980) of monopolistic competition is the gravity model's direct implication. Bergstrand (1990) replaced product differentiation by the provenance of a product with product differentiation between producing companies based on the assumption of monopoly competition, introducing prices into the model and the hypothesis of Linder. In Krugman's model, consumers' preference for a variety is why identical firms trade differentiated goods. Armington models have an undesirable feature, which assumes that goods are differentiated by production location. The monopolistic competition serves to overcome this aspect. Each country specializes in producing different sets of goods, and the firm location is endogenously determined.

In the past, eminent international trade models included the Hecksher-Ohlin model (Bergstrand, 1985; Deardorff, 1998), which relies on differences in factor endowments between countries as a justification for trade. Deardorff (1998) demonstrates that trade is explained by conventional factor proportions, which in turn explains the gravity model. In addition, Deardorff (1998) also reveals that the long-established Heckscher-Ohlin-Samuelson framework with full country-level production specialization and homogeneous goods could also derive the gravity equation's fundamental form. On top of the monopolistic competition assumption, Helpman (1987) derived the premise for the assumption of increasing returns to scale with product differentiation at the company level. The new and old theories were mediated by Deardorff (1998) through asserting that the gravity equation could be extracted from standard trade theories. The gravity equation obtained from Helpman's (1987) monopolistic competition was used by Hummels and Levinsonhn (1995) to estimate bilateral trade of OECD countries trading differentiated manufacturing products. The simple model explained 90 percent of the variation in trade flows among OECD countries with the assumption that goods were differentiated. After the random selection of non-OECD countries, the post-robustness check concluded that the variation in flows of trade among these countries was similar to that of OECD members, leading to the verdict that hidden factors drive the empirical success of the gravity equation in its rudimentary form.

The gravity equation also arises from the Ricardian sort of model. The Ricardian model rests on technological discrepancies across countries to explain trade. It was previously assumed that models from

Heckscher-Ohlin and Ricardian could not provide a basis for the gravity model, i.e., the power and stability of the gravity equation to explain bilateral trade flows. Eaton and Kortum (2002) produced the most eminent structural gravity theory in economics, deriving gravity from a Ricardian structure with intermediate goods on the supply side.

Chaney and Helpman (2008) acquired the gravity equation from international trade theory wherein firms are heterogeneous, and trade differentiated goods. Specifications and variables employed in the model ought to be derived from economic theory[1], thereby drawing appropriate inferences from estimations using the gravity model. This requirement of having solid theory backed empirical models rationale motivated various researchers to build a solid theoretical foundation of the gravity equation (Bacchetta et al., 2012). A range of trade theories may give rise to gravity models (Feenstra et al., 2001; Evenett and Keller , 2002; and Feenstra, 2004). Feenstra et al. (2001) argued that on exporter-importer nation-size factors, diverse theoretical models predict dissimilar elasticities, which depended on whether products were differentiated or homogeneous. Anderson and van Wincoop (2003) based the hypothesis of product differentiation with respect to their place of origin, creating an augmented model of Anderson (1979). Differentiated products indicate that a surge in the exporter 's revenue has a greater proportional effect on exports than the domestic market effect, with homogeneous goods having a reverse effect on the domestic market. The primary contribution of Anderson and van Wincoop (2003) is the addition into the original Anderson (1979) model the multilateral resistance terms for the sender and the recipient that proxy for undetected trade barriers to exist, especially emphasizing the role of heteroskedasticity. As assumptions Anderson and van Wincoop (2003) employed CES, model of monopolistic competition with solitary economy. Melitz (2003) highlighted the diversity of companies in terms of their export behaviour. Catalyzing the theoretical foundation for the presence of zero trade flows in the data. Helpman et al. (2008) with selection on which markets to enter as heterogeneous firms and these authors introduced a two-stage estimation process that factors in extensive and intensive trade margins and is responsible for setting up a framework that justifies the existence of zero trade flows. Chor (2010) and Costinot et al. (2012) with Ricardian model on sector level. Unresolved empirical application problems of the gravity equation were unraveled by Garcia, Pabsorf, and Herrera (2013). The dataset of authors covers 80 percent of world trade using the gravity equation predicated by the theoretical model of Anderson and van Wincoop (2003), a wide range of estimators are compared, claiming that in the presence of heteroskedasticity non-linear estimators produce more accurate results. They conclude that, when zero tade flows are present, the Sample Selection Model of Heckman and Poisson Pseudo-Maximum Likelihood (PPML) are the leading models for the gravity equation specification. Inclusion of export probability as a first step to circumvent the gravity parameter estimation inconsistency caused by sample selection bias due to zero trade flow values. Asset accumulation importance using dynamic framework (Olivero and Yotov ,2012; Anderson et al., 2015; and Eaton et al., 2016). For a broad class of general equilibrium models of trade, Allen et al.(2014) demonstrated the uniqueness and existence of the trade equilibrium that derives adequate conditions for gravity's prevalent power. Caliendo and Parro (2015) link the gravity model to sectoral input-output framework. Armington model applied to sector level trade data by Anderson and Yotov (2016).

[1] Summary figure of the main theoretical foundation pillars of gravity model can be found in the Appendix G (Figure 8)

2.2 DETERMINANTS OF BILATERAL TRADE FLOWS

For decades, the identification of primary sources of international trade flows has been a topic of significant interest to academics. Wang, Wei, and Liu (2010) include Foreign Direct Investment(FDI) stocks, Research & Development (R&D) proxy, factor endowment similarity. The authors obtain highly significant results, although the authors did not include trade costs except geographical distance. Cieslik (2009) formally obtained the assumption of complete specialization is an insufficient prerequisite for the use of incomplete specialization models from monopolistic and neoclassical competition to obtain the gravity equation. Cieslik's (2009) findings show that factor proportions and country size variables are key determinants of bilateral trade mass; The impact of these determinants is model-specific. The researcher concludes that if there is variation of relative factor endowments between partners, ignoring the factor endowments can lead bias caused by omitting variables considered to be important. The complete specialization assumption, as the study indicates, may be appropriate for developed economies, in this thesis, the largest OECD countries are considered, thus the appropriate assumption is of complete specialization as the sample mostly includes developed countries. When low and middle-income countries' trade is examined, the incomplete specialization assumption is appropriate.

A positive association between bilateral trade flows and the total population of a country is reported by Matyas (1997). Through a higher population leading to greater import demand. Research results from Bendjilali (2002) contradict the results of the aforementioned Matyas (1997), indicating that a larger population leads to bulky domestic market as well as a smaller export market or a larger import market. Other authors present different results (i.e., Brada and Mendez, 1983; Pelzman, 1977). The general agreement among scholars is that the population and bilateral trade flows are positive.

To evaluate the European Union and Mercosur trade, Lehmann and Zarzoso (2003) utilized the gravity model and attempted to assess the possible impact of agreements of trade among these two trade blocs. A panel data was used to analyse the effects variables that do and do not vary over time on a sample of 20 countries. Authors state that the Random Effects model is less preferred than the The Fixed Effects model. Authors find exchange rates, infrastructure, and income differences to be substantial determinants of bilateral trade flows. Lehmann and Zarzoso (2003) utilize a Two-step estimation to estimate dummy coefficients and time-invariant parameters in a fixed-effects model.

Franker and Rose (1998), Rose (2000) estimate that monetary unions induce trade. This theory has led to the creation of the Optimum Currency Areas (OCA) concept of “endogeneity”. Over time, European Monetary Union progresses into OCA Franker and Rose (1998). Rose and Stanley (2005) indicate that the introduction of the euro has a significant and highly significant impact on trade between the members of the EMU, and

that the combination of these estimates signifies an 8-23% increase in trade during its first years of creation. Rose (2017) estimates that when the sample includes more than just EMU countries, the euro 's influence on trade is even more substantial. Micco et al . (2003) found that, based on the membership of the EMU, the EMU encourages trade by 8 to 16 percent, and this effect has been growing steadily. Serlenga and Shin employ gravity equation to estimate the impact of European Monetary Union (EMU) for 15 european union member states. They do not recognize a significant impact from EMU membership, they realise the time frame of the sample ending too soon (in 2001). By means of expectations, trade costs, and friction reduction,

Bergin and Lin(2012) find that the EMU has a significant effect on trade. Camarero, Herrera and Tamarit (2018) conclude that economic approaches and dataset dimensions largely influence results.

Camarero Herrera and Tamarit (2018) investigated the impact of the euro on trade with 28 countries while using 1990-2013 period making the use of gravity model. To correct any possible bias that potentially arises from unobserved time-varying heterogeneity or multilateral resistance variables (Baldwin and Taglioni, 2006). Authors include time-varying fixed effect in their gravity specification. Furthermore, Camarero Herrera and Tamarit (2018) investigate if FDI and trade are substitutionary or complementary by including inward and outward stocks into their specification. Researchers conclude that Foreign Direct Investment (FDI) has a strong positive impact on trade, stating that omitting FDI would bias the euro's introduction upward.

There is a lack of strong agreement among studies that recognize the influence of cultural distances on trade. A positive relation between cultural distance and trade is reported by Guiso et al . (2005), while Tadesse and White (2007), Linders et al. (2005) and Boisso and Ferrantino (1997) report that trade is inhibited by greater cultural distance. It is therefore desirable to understand how cultural divergences between people in different countries can affect the successful completion of transactions.

Many scholars have researched the effect of exchange rate fluctuations on international trade, discovering that in reaction to the lower risk-adjusted expected earnings they are confronted, literature expects traders to turn their attention to the domestic market if traders are risk-averse, or if hedging is too expensive, or even impractical (Thursby and Thursby ,1987; Akhtar and Hilton, 1984). As a result, Arize (1997) notes that a rise in fluctuations in the exchange rate contributes to a decrease in trade. Chowdhury(1993) states the absence of a clear consensus on this matter. A beneficial relationship between trade and exchange rate fluctuations is pointed out by Sercu and Vanhulle (1992). In this case, trade is considered an option held by the firm, emphasizing that with volatility, the option's value can rise.

Further studies highlight the substantiality of risk aversion of the traders. The results from Doğanlar (2002) indicate that export volume and exchange rate volatility are negatively related since this variability negatively affects the expected marginal utility. Froot and Stein(1991) was the initial advocate to debunk the common belief that the exchange rate would not have a significant role in the FDI decision of an MNE. Before this work, the assumption was that an increase in domestic currency value would lead to cheaper costs, which would lower nominal returns in the home currency (Blonigen, 2005). In this way, the advantages and disadvantages would counteract each other. Empirical evidence provided by Froot and Stein(1991) reveals that currency appreciation leads to an increase in FDI activities of MNEs. In imperfect capital markets, internal capital is more costly to borrow via external sources than within the firm. Consequently, wealth is straightaway impacted by the exchange rate. Withal, Cross-border acquisitions increase with the depreciation of the home currency. Using FDI and exchange rate in the same estimation method might result in a correlation between FDI and exchange rate, e.g., Schiavo(2007) delve in finding the effects of a currency union on FDI, discovering that cross-country investment flows may increase by a currency union's negative impact on exchange rate uncertainty. The author ensures his results by controlling for the exchange rate, ultimately finding a beneficial and impactful coefficients for the influence of euro. The use of FDI stocks for their estimation model is justified by Camarero, Herrera, and Tamarit (2018) because it offers a better estimate of the long-run behavior of investment decisions, related to capturing the complex and growth consequences of economic integration. In addition, Baldwin et al.(2008) note that

uncertainty in the exchange rate impacts short-run variations in FDI flows; FDI stocks are thus more relevant. Other scholars present different benefits of stock compared to flows. In the first step investors from abroad choose the stock of capital, Next, capital stocks take into account financing done at the local level of the markets. Ergo, a stronger approximation of resource ownership (Devereux and Griffith , 2002). Benassy-Quéré et al. (2007, p.769) states that Handful takeovers might result in smaller volatility when FDI stocks are considered compared to flows in smaller countries. FDI stocks variable was used by a handful of researchers. (Aizenman and Ilan, 2006; Albuquerque et al., 2005)

2.3 EXTENSION OF THE GRAVITY MODEL

INSTITUTIONS

To reduce the gap between north-south, WTO imposed specific tools that increase market access through which supposedly trade develops, such as Non-Tariff Measures and North-South Tariffs. The shift in focus to determinants of market access to developing countries ignored other essential factors, such as improvements in physical infrastructure and country institutions.

Anderson and Marcouiller (2002) show that the quality of institutions of countries ehences the volume of bilateral trade. Other researcher discover that improvement in institutional and governance conditions strongly and positively shape trade flows amount countries (De Groot et al., 2004). Ranjan et al. (2005) focus on enforcing contracts that differ in institutions as an essential factor for trade volume. Using proxies for the contract enforcement on a gravity equation, authors find a positive and more considerable impact on differentiated goods than homogeneous goods. Nunn(2007) uncovers that contract enforcement shapes the patterns of international trade more so than the sum of skilled capital and labour endowments of a country. An econometric panel-data model was used by Martin and Velazquez (2002) to evaluate the interrelationship of growth and trade in order to explain possible causes for bilateral trade amongst members of OECD. Their findings show that the increase in quantities of material Capital & immaterial Capital (Human & Technological) that a country possesses has a positive and significant impact on the export-to-import ratio between partners. In addition , this research illustrates that FDI improves the export / import ratio of the reporter country. Authors find that accumulation of technological capital increasing traffic of direct investments and a surge in transport infrastructure leads to an increase in trade, however human and physical capital impact negatively, contrary to their expectations. Authors justify these unforeseen predictor variables sign stemming from the existence of issues of multicollinearity. To avoid the problems, Martin and Velazquez (2002) used the principal component analysis to incorporate these new factors as indexes, achieving satisfactory results. The upward trend of the elasticity of the relative stock of foreign investment and immaterial capital is observed. The influence of the comparative size covariate has two channels through which it impacts the export / import ratio economies of scale leads to positive influence while external demand effect pulls the ratio towards the negative influence cause by variation in comparative size.

Depken and Sonora(2005), using two periods only from 1999 to 2000, investigate the impact of economic freedom on US consumers' imports and exports. Depken and Sonora (2005) find that the volume imported from the USA's importer is positively affected by the importer's institutional quality. Levchenko(2007) argues that a comparative advantage source stems from institutional quality differences, arguing that it is a crucial determinant of trade. Helble et al. (2007) examine how trade is impacted by institutional transparency of the trading climate in Asia-Pacific. They find that transparency negatively affects trade costs through simplification and predictability of regulations.

Various authors have also shown the positive effects of democratic institutions on trade. Yu (2010), on an augmented gravity model, estimates democracy's impact on trade and finds that democratization significantly and positively affects trade contributing to around 3% to the growth of bilateral trade. Yu (2010) claims that democracy has two major channels through which trade is affected by democracy. The first trade inducing channel is through democratization in the exporting country, leading to a reduction in trade costs via tariffs, product quality, improvement in institutions, and the level of trust in the product, increasing bilateral trade. However, as regressand authors logged the industrial direction bringing goods inside to country j from country i, conversely, democratization in the importing country might reduce imports demanded through increased trade barriers in the form of increased tariffs. Yu (2010) utilises panel data set with a democratic proxy on the augmented gravity equation to handle the endogeneity of covariates. The author finds evidence for democracy as a conducive trade variable. After applying different tools for econometric robustness and applying on the product level trade flows specifications, without aggregation, this verdict holds. The author used a dataset of one hundred one hundred fifty-seven IMF member nations for the period from 1962-1998. For the period under analysis, Yu (2010) estimates that democratization fosters trade by around 23 percent, explaining approximately 3-4 percent of the whole gain in the total unidirectional imports over the four decades of 534 percent. Subsequent researchers found that estimation bias can be avoided by considering the potential endogeneity of democracy. Various authors use infant mortality as a proxy for the democratic regime probability of attaining and sustaining a form of the regime (Eliya, 1994; Barro, 1999; Marshal and Jaggers, 2002; and, Przeworski, 2005). Other influential papers confirm the fostering impact of institutions on trade (Anderson and Marcouiller, 2002; de Groot et al.,2004; Francois and Manchin, 2013; and Álvarez et al., 2018). However, these papers cannot correctly identify country-specific variables' impact due to transformed exporter-importer bilateral institutions or by not adequately controlling structural multilateral resistance terms. These authors combine the institutional indexes of the importer and exporter sides. However, it is confusing to interpret the estimates of dyadic institutional indicators' effect on trade.

INFRASTRUCTURE

The relevance of infrastructure, assuming no energy cost and transport is overlooked by many global trade theories, which is not appropriate in the basic realities where in international trade, the infrastructure actually plays a significant role(Djankov et al. 2010). The following researchers argue that a 10% increase in overall infrastructure investments contributes 5% to exports as discovered by Hoekman and Nicita (2008); The lower supply of infrastructure contributes to greater production costs and economic activity delays and ultimately lowering profitability of firms (Martinez-Zarzose, 2007; Duval and Utoktham 2009).

Several scientific studies and papers document the relationship between efficient logistics/transport, supply of transport and international trade. (e.g., Limao and Venables, 2001; Arvis et al.,2012). The benefits of an enhanced infrastructure network to promote competitiveness and economic growth have been endorsed by certain scholars (Camagni and Capello, 2013; Vickerman, 1995; Arvis et al., 2012; Purwanto, 2010; Merk,2012). Graham (2012) finds that air connectivity plays a substantial role in promoting international trade. Regional competitiveness and trade openness are affected by martime and land modal transport solutions (Handy, 2005; Cosar and Demir, 2016; Wilmsmeier et al., 2006). Moreover, logistics is a critical element linking international production chains and transport networks (e.g., Hesse and Rodrigue, 2006; World Bank, 2012; Bensassi et al. 2015). Eighty percent of global trade entails maritime services in 2016 (UNCTAD, 2016). Port infrastructure is therefore a key element of a given region's potential and predisposition for international trade and connectivity.(e.g., Ducruet and Notteboom, 2012; Ducruet and

Itoh, 2016; Guerrero et al., 2016). The significance of international openness and transport endowment for key transport modes is thoroughly documented(e.g., Lopez-Bazo and Moreno, 2007; Arbues et al., 2015)

Bougheas et al. (1999), employing European countries, provides evidence for infrastructure being linked to transport costs, consequently to trade. Moreover, Limao and Venables (2001) link infrastructure to total trade cost, finding that 40% and 60% of transport costs stem from infrastructure to coastal and landlocked countries. Wilson et al. (2004) divide trade facilitation into four aspects: e-business, ports, regulations, and customs. The authors indicate that one-sided trade facilitation results in disproportionate gains in exports of the country that improved relative to imports. Nordas and Piermartini (2004) separate infrastructure into the quality of telecommunications, roads, railroads, airports, and ports and find the latter having the most significant trade impact. Behar et al. (2009) focus on logistics; in their examination, one deviation from the standard in logistics results in a surge of about 46 percent in exports for their sample's average-sized developing country. The beneficial impact of trade enablement and infrastructure indexes on exports has been found by Iwanow and Kirkpatrick in 2008. In the export performance of developing nations, Portugal-Perez and Wilson in 2012 differentiate between soft and hard infrastructure. Their results suggest the positive impact of trade enablement on the performance of exports.

Using the Poisson Pseudo-Maximum Likelihood (PPML) estimator, Botasso et al . (2018) assess the influence of maritime infrastructure on trade by estimating Brazil's exports to thirty major trading partners for the period 2009-2012, finding that a rise in port infrastructure causes a rise in Brazilian exports. The impact is varied and reduced on with respect to imports. Rehman, Noman, and Ding (2020), using the Pooled Mean Group estimator, aggregate and sub-indices of infrastructure are found to have a continual and significant effect on trade. Their findings suggest that infrastructure positively promotes tradeStraub (2011), Roller and Waverman (2001), Limao and Venables (2001) and Hoffmann (2003) choose infrastructure proxies, such as density of road, railway, air transport infrastructure facilities, mobile and broadband telecommunications and electricity consumption facilities. In order to produce a set of summary indexes Francois and Manchin (2013) employ Principal Component Analysis (PCA).

TRADE COST

Yu (2010) divides the cost of trade into two separate categories: the cost of artificial and natural trade. Dummies from the Currency Union, the General System of Preferences (GSP) and the Regional Trade Agreement are included in artificial trade. By reducing trade uncertainty, which in turn could be handled as a reduction of artificial trade costs, multilateral trade deals can promote trade (Rose, 2004). Yu (2010) considers geographical distance and shared frontiers as natural trade costs. (Garcia, Pabsorf and Herrera, 2013).Sharing border, religion, access to water, and RTA are used in addition to physical distance, affecting transaction costs. Border effects was first introduced by Aitken (1973), Accessibility of infrastructure and island-landlocked effects (Rose, 2000), historical colonial relationship (Frankel and Wei, 1998). Exchange rate or risk of currency (e.g., Frankel and Wei, 1993), Economic policy or trade policy (Coe and Hoffmaister, 1999). Economic improvement (e.g., Frankel, 1997), and factor endowment of exporter relative to importer (e.g., Frankel et al., 1995)

Highly prominent paper was written regarding trade costs highlighting the importance of including relative trade costs into the gravity model through theoretical results. Authors claim that relative trade costs determine bilateral trade and this paper was written by Anderson and van Wincoop (2003). As explained by Anderson and van Wincoop (2003), The tendency of country y to import from country x is determined

by the trade costs of country y to x in relation to its "resistance" to imported goods as a whole (weighted average trade costs) and the average "resistance" faced by exporters in country x; not merely by the absolute trade costs around nations x and y. These authors show that by using "Multilateral Trade Resistance," ceterus paribus, two nations encircled by other trade partners, such as China and India bordered Nepal and Bhutan, will trade less with each other as more alternatives exist. Therefore, confined nations, such as New Zealand and Australia, trade more with each other, with isolation and resistance being negatively correlated.

The 'gravity equation' was used in combination with econometric techniques to estimate the ex-post partial (or direct) effects on bilateral trade flows of national borders, language, currency unions, economic integration agreements, and other trade cost measures as found by Bergstrand and Egger (2011). The most common way to measure Geographic distances are between the two capitals or predominant countries or cities respectively or the great circle formula (Wei, 1996; Head and Mayer, 2000). To capture trade costs, several variables are generally used. Empirical studies typically proxy trading costs with distance between two countries. Generally, nevertheless, several additional factors are also used, including island dummies, or a dummy variable indicating that a country is surrounded entirely by land-countries, and common boundaries. These dummy variables are used to convey the assumptions that transport costs increase with distance and that for landlocked countries and island nations they are higher, but for neighboring countries they are lower. To capture information costs, dummies for a common language, neighborhood, or other relevant cultural characteristics such as colonial history are used. For trade between countries whose business practices, competitiveness, and delivery reliability are well known to each other, search expenses are likely lower. Companies in neighboring countries, countries with a common language, or other relevant cultural characteristics are likely to know more about each other and truly comprehend each other's business practices than companies that operate in conditions and climate that are less similar.

For this simple fact, in countries where the business environment is acquainted to them, companies are more likely to search for suppliers or clients in that country. Due to the presence of regional trade agreements, tariff barriers are generally included in the form of dummies. Few studies use bilateral tariff data, with the unavailability of data over time being one justification. Melitz (2007) examines the effect of distance on bilateral trade by questioning the general hypothesis that distance is an impediment to trade. The researcher examines the proposition that the North-South difference fosters global trade if the distance is controlled. Authors believe that the effect of distance on bilateral issues has decreased substantially since the Second World War. Ultimately, by studying their impact on the country's fixed effects in their primary model, the paper examines the impact of internal distance and remoteness on trade, both variables being county-specific. It turns out that remoteness has a smaller impact than internal distance. Smaller countries are more open to trade with foreign countries than larger nations. A significantly positive coefficient on the common border is obtained by the author, indicating a proclivity to indulge in foreign trade with the closest foreigners without regard to miles. Likewise, the massive effect of internal distance indicates the unique importance of proximity. Disdier and Head (2008) analyze the magnitude of the distance effect on bilateral commerce by compiling a database of 1467 estimates from 103 papers. The authors find that the mean effect is around 0.9, between 0.28 and 1.55, a 10 percent increase in distance reduces bilateral trade by 9 percent; however, the authors conclude that the puzzle of the inherent high distance effects remains unresolved.

2.4 TOP THREE ERRORS

2.4.1 THE GOLD MEDAL ERROR

The Gold Medal Error is also referred to as the misinterpretation of Anderson and van Wincoop, in which Anderson and van Wincoop (2003) developed a cross-section modeling approach to control omitted variables with individual fixed effects (Baldwin and Taglioni, 2006). Many authors applied this technique excessively on the panel data framework, without considering the time dimension, e.g., Flam and Nordstrom, 2006 or Glick and Rose, 2002. Country dummies (importers and exporters) only eliminate the average impact, neglecting the time dimension in the residuals, leading ultimately to biased results. Consequently, the time related dimension needs to be treated appropriately in addition to time-invariant control dummies by adding country-time varying fixed effects to control for unobserved determinants of the country pair trade relationship. This thesis includes models with country-time fixed effects to control for MRT (Column 1 of the robustness table). Kernel density plot shape of the model with time-varying country fixed effects is dissimilar to the dependent variable plot (Appendix D: Figure 5). Thus this thesis decided to employ in the main table time-invariant country[2] fixed effects, to capture all time-invariant observable and unobservable characteristics of a country (Column 1 of the main table). The fixed effects by country pair (Column 2 of the main table) decrease the extent of the gold medal error by eliminating the cross-sectional correlation between omitted Π and P, the terms for multilateral resistance.

2.4.2 THE SILVER MEDAL ERROR

Baldwin and Taglioni (2006) allude to further minor problems, termed as The Silver Medal Error. This type of error stresses the potential errors arising from the response variable's definition, claiming that the average procedure is wrong. The problem occurs when instead of the average of the log of the logs of the average is used in the bilateral trade variable. Large bilateral imbalances lead to an upward bias. This is demonstrated in the Appendix H: Table 11 when the column 1 (incorrect procedure) is compared to column 2 (correct procedure) we can observe than the coefficients are reduced showing the upward bias of logging the average trade of product flows.

2.4.3 THE BRONZE MEDAL ERROR

The Bronze Medal Error applies to the price deflator, all prices are recorded in the gravity equation in terms of a numeral that is equal for all countries, resulting in no price illusion. That being said, using US CPI (as in the case of Glick and Rose (2002)), many authors deflate GDP and trade flows. This thesis employs BACI trade flow data, which reconciles exporter and importer trade flows and transforms the dependent variable to avoid biases. Baldwin and Taglioni (2006) state that incorporating dummies related to time into the regression contributes to rectifying the bronze medal error.

[2] Time-varying country fixed effects lead to perfect collinearity with time-varying observable country-specific variables leading to the omission of variables of interest (institutions, infrastructure, and globalization) variables during the estimation.

2.5 HYPOTHESIS AND CONCEPTUAL FRAMEWORK

The following section presents 7 different hypotheses. Subsequently, all these hypotheses are tested using the Gravity model applied bilateral aggregate export flows. The analysis is based on the impact of subsequent variables on OECD countries' bilateral aggregate exports from 1995 to 2018. Namely, the European Union, common currency[3], regional trade agreements, institutions, infrastructure, globalization, exporters' inward/outward stock of FDI, and importer's Most Favoured Nation tariffs.

H1: *The EU members' exports are higher among each other than with non-EU partners.*

H2: *The Regional Trade Agreements (RTA) result in increased aggregate exports between the exporter and the importer that are member of a common RTA.*

H3: *Common currency expands trade between the exporter and importer through reduced transaction fees, absence of foreign exchange risks.*

H4: *Improvements in the quality of institutions of the exporter promote the increases in bilateral aggregate exports.*

H5: *Enhancing the exporter's infrastructure quality boosts bilateral trade through efficiency gains and decreases in implicit trade costs.*

H6: *The exporter's globalization boosts bilateral trade through increased special interdependencies between elements of the global economy and their level of integration.*

H7: *An increase in most favored nation tariffs negatively impact bilateral trade.*

Research objectives: First, the objective of this thesis is to identify the impact on bilateral aggregate exports of institutions, infrastructure and globalization. Second, this thesis investigates the impact of standard and additional bilateral trade cost (dyadic) variables' impact on bilateral aggregate exports, such as when both countries are members of RTA or European union, sharing a common currency, and the impact of bilateral inward as well as outward stock of FDI on bilateral trade. Third, the impact of Most Favored Nation(MFN) tariff rates, which is the average of weighted product import tariffs by each partner country to the world on bilateral trade flows, are examined. The exporter's state fragility and innovation indexes are examined in the robustness table, and explicit indexes for infrastructure quality indicators are scrutinized. Lastly, this thesis concludes by highlighting the limitations of this study and gives suggestions for further studies and conclusion based on the obtained results

[3] Factors supporting the intensification of trade are the elimination of transaction costs and foreign exchange risk. In the case of non-cash transactions, the common currency was introduced on 1 January 1999 and in cash form on 1 January 2002 and became a legal tender initially in 12 EU countries (out of the EU-15). Slovenia joined the monetary union in 2007, followed in 2008 by Cyprus and Malta, in 2009 by Slovakia, in 2011 by Estonia, in 2014 by Latvia, and in 2015 by Lithuania (currently there are 19 EMU members). Fifty RTAs were in force during 1990. This figure jumped to two hundred and eighty in 2017. These negotiations have an impact on tariffs, behind-the-border regulations such as intellectual property rights, competition policies , and rules for members of the agreement.

3. DATA

In order to reconcile the declarations of exporters and importers in COMTRADE, the Base Analytique du Commerce International (BACI) has been designed by the Centre d 'Etudes Prospectives et d'Informations Internationales (CEPII). For more than 200 countries from 1995 to 2018, the BACI database provides trade data at the 6-digit HS level. Because the construction and processing of the BACI database takes time and is based on original data from other primary sources, such as COMTRADE, the BACI data is publicly available with a time lag of one or two years relative to COMTRADE. This thesis employs BACI's trade database, which reconciles wedge between exporter and importer reports and removes the re-exports, as the dependent variable aggregate bilateral exports[4] from country i to country j as the dependent variable reported in US dollars. The export values are aggregated by product flows of each country pair for each year unidirectionally. Using total trade[5] instead of exports leads to an inability to control MRTs, making the model theoretically inconsistent, implying that the results are unreliable or meaningless. The dataset contains annual data from the following 36 countries: Australia, Austria, Belgium, Canada, Chile, Colombia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States. Preceding list of countries belong to Organization for Economic Co-operation and Development (OECD). The dataset covers the time-period 1995–2018. Hence, we have a balanced panel with dimension $N = 36 \times 35 = 1260$ (all possible bilateral combinations of countries) and $T = 24$ years. The period is long enough to capture the effects of the introduction of both the euro and the recent economic crisis. Appendix: Data presents the descriptive statistics for the included variables.

By reviewing and analyzing various works that employed the gravity model on estimating bilateral trade flows using the gravity model, this thesis noticed that only a few used BACI, which is a global trade database at the product level. BACI trade database reconciles data disseminated from the UN Comtrade database by removing transport costs from the reported imports, assessing the reliability of each country's reporting by creating an indicated that includes reporting distance among partners(the log of the ratio of mirror flows) and breaks it down using weighted variance analysis. The relative reliability is then controlled for the effects of geographical and sectoral specialization—the reconciliation controls for discrepancies in reports between an importer and an exporter. Exports are reported Free On Board(FOB) while imports by Cost for Insurance and Freight(CIF). In theory, the reports of exports from country i to j should be identical to imports from country i to j, except for CIF extra cost. However, this is false because customs pay extra attention to the import origin as it impacts tariffs, but not for export's end destination. The second issue is misreporting and underreporting, which leads to wedge in reports between exporter and importer (Gaulier and Zignago, 2010). Luxembourg is merged with Belgium in BACI trade databases. The theory suggests that taking the logarithm of total trade (imports plus exports) or the average from both directions of exports leads to misleading results as the theoretical gravity model literature suggests, the flows must be unidirectional.

Gross domestic product (GDP) is expressed in current United States Dollars (USD) was extracted from the Worldbank. Population weighted distance in kilometers and dummy variables contiguity, common official

[4] The regression table for proving the difference between first logging then averaging vs averaging then logging is illustrated in the Appendix. The upward bias caused by first averaging product trade flows by country pair then transforming to logarithms compared to first transforming to logarithms and only then proceeding to averaging the logarithms is shown in the Appendix: H, Table 11

[5] Total trade = exporter + imports

language, colonial relationship, common colonizer, and same country are extracted from CEPII. Regional Trade Agreements were extracted from Mario Larch's Regional Trade Agreements Database from Egger and Larch (2008). Currency Union dummy was obtained from de Sousa (2012) website.

As main variables for Institutional Quality, this thesis groups nine[6] variables obtained from the Heritage foundation based on four categories illustrated in the Economic freedom Index 2020. The three categories are the rule of law, government size, and market openness. The World Governance Indicators (WGI)[7] is used to acquire the exporter's political stability. This thesis constructs the Principal Component Analysis(PCA), similar approaches to Zhang and Fan (2004), Mollick et al. (2006), Stone and Bania (2009), Calderon and Serven (2010), Donaldson (2010), and Francois and Manchin(2013) for the sub-components indicators of infrastructure and institutions are highly correlated within each set of infrastructure and institutions, including all sub-components into the equation would likely lead to multicollinearity problem. PCA[8] allows generating a set of summary indices. PCA is highly useful in identifying patterns in data; this allows the writer to reduce the number of dimensions while minimizing information loss. Based on Eigenvalues, components bigger than one are selected. This thesis's robustness section model retains components that correspond to market-oriented institutional and legal orientation. While the second institutional component mainly represents the size of the government, indicating interventionism and liberalism. Political stability was obtained from the world governance indicators to capture a more extended period without missing years; the political stability index was interpolated for 1997, 1999, and 2001. The difference in actual vs. interpolated values is illustrated graphically in Figure 9 of the Appendix section I.

As for the Infrastructure Quality, this thesis explores the Information and Communication Technology (ICT) dimension by including Fixed telephone subscription (per 100 people) and constructs a new variable using PCA combines internet usage(% of the population) with Mobile cellular subscriptions (per 100 people), the data was extracted from the World Bank's World Development Indicators (WDI) database. As for physical infrastructure, the total transport infrastructure investment in USD was extracted from OECD. Total infrastructure investment in USD was acquired from OECD. Air transport freight data was extracted from WDI. The alternative variables used in the robustness section, i.e., Quality of railroad, port, air, and road indicators was complied by The Global Economy from the World Economic Forum. Most Favored Nation (MFN) trade tariffs and subsidies were drawn from WDI; this thesis[9] uses average weighted tariffs as recommended by Yotov et al., (2016). Bilateral stock inward and outward FDI data was extracted from UNCTAD.

[6] Due to large number of missing data two out of twelve variables were excluded for the construction of PCA indexes. Namely, judicial effectiveness and labor freedom. For more information please refer to Appendix: I, Matrix of correlations

[7] In its original form, the WGI ranges from -2.5 to 2.5; the higher the values, the stronger the perception for a given index. In this thesis, due to the necessity of the logarithmic transformation of covariates, the negative values lead to undefined, consequently missing values; thus, the Political stability index is transformed from 0 to 5. A lower number of missing values motivated this thesis to employ economic freedom index variables for institutional indexes instead of employing the Rule of law, Government effectiveness, Control of Corruption, Regulatory Quality, Voice, and accountability from the WGI indicators.

[8] Within a set of independent variables, PCA or Principal Component Analysis explains patterns of correlations. PCA and Factor Analysis are similar but differ in the assumption of the nature of the variables and their analytical method of treatment.The main objective of PCA is to use only a few factors to imitate the data structure, while Factor Analysis helps to find out the correlation of variables through factors (e.g. Hair et al. 2013; Matsunaga 2010; Mulaik 2009). The sampling adequacy of the correlations is measured by the Kaiser-Meyer - Olkin (KMO); if the KMO is below 0.50, then we can accept the sample; otherwise, the composition of variables needs to be modified. This thesis runs the command -factor, pcf- that runs a factor analysis and rescales the estimates to conform to a PCA; This technique makes it possible to presume the total variance as common rotated loading production allows to interpret the factors. Finally , this thesis assesses the Factor solution 's goodness-of-fit by checking the coherence of the reproduced and original correlations. More details are found in the Appendix: I, Variable Information.

[9] More information on variables can be found in Appendix A, Table 2.

4. METHODOLOGY

This thesis employs two sets of equations as the main model OLS with individual and year fixed effects, pair and year fixed effects. The details on the construction of institutions and infrastructure indexes are detailed in the Appendix: Variable Information.

The use of panel-data has several advantages:

1. It allows the application of the pair-fixed-effects methods to handle problems related to trade policy variables' endogeneity.
2. It leads to increased estimation efficiency.
3. Panel data permits for comprehensive and flexible treatment and estimation of the effects of the covariates.

In this section, 4.1 will introduce the reader to the Gravity model equation, 4.2 will present the econometric specification used for the analysis. Lastly, section 4.3 will introduce the reader to the linear estimation method and fixed effects.

4.1 GRAVITY MODEL EQUATION

Gravity equation's multiplicative formulation:

$$X_{ij,t} = GS_{i,t}M_{j,t}\phi_{ij,t} \tag{1}$$

where $X_{ij,t}$ is the value of exports in monetary terms from i to j, $M_{j,t}$ connotes all specific factors related to the importer encompassing the total importer's demand (such as the importing country's GDP), and $S_{i,t}$ includes exporter-specific variables (such as the GDP of the exporter) representing the total amount that exporters are willing to supply. In contrast to the physical world G is a variable that does not depend on i or j, such as the level of world liberalization. G is not a constant ,varies over time. Finally, $\phi_{ij,t}$ reflects the ease of access to the market j from the exporter i (i.e. the inverse of bilateral trade costs).

Anderson and van Wincoop demonstrate that in the setting of N countries universe with differentiated goods by the country of origin, gravity equation which is well-specified takes the following form:

$$X_{ij,t} = \frac{Y_{i,t}Y_{j,t}}{Y}\frac{t_{ij,t}}{\Pi_{i,t}\mathrm{P}_{j,t}}^{1-\sigma} \tag{2}$$

Log-linearizing and adding the error term $\varepsilon_{ij,t}$ leads to:

$$lnX_{ij,t} = lnY_{i,t} + Y_{j,t} - lnY + (1-\sigma)ln\tau_{ij,t} - (1-\sigma)ln\Pi_{i,t} - (1-\sigma)ln\mathrm{P}_{j,t} + \varepsilon_{ij,t} \tag{3}$$

Where Y represents world GDP, $lnY_{i,t}$ and $Y_{j,t}$ represents the GDPs of the reporter and partner countries, in order to keep notations consistent, *i* means exporter while *j* means importer. $t_{ij,t}$ (corresponds to overall trade costs) is the cost that exporter *i*'s importer *j* will incur. The elasticity of substitution is $\sigma > 1$ and $\Pi_{i,t}$ and $\mathrm{P}_{j,t}$ symbolizes the reporter's and partner's facility to enter the market of each other or country *i*'s outward and country *j*'s inward multilateral resistance terms.

The fact that exports from country *i* to country *j* depend on trade costs across all potential export markets is captured by $\Pi_{i,t}$. The reliance on trade costs by all potential suppliers on imports into country *i* from country *j* is captured by $\mathrm{P}_{j,t}$. These two terms addressing the problems with the intuitive gravity model, the

endogeneity concerns. This model picks up the effect of trade cost changes on one pair of countries through relative price effects on trade flows on all the other pairs. Omitting these variables leads them to be correlated with trade costs, leading to omitted variables bias. Finding a way to correct for the endogeneity issue is one of the focus of this thesis. The equation (3) represents the gravity of gravitas model is the theoretical reference model[10] used for this thesis.

4.2 ECONOMETRIC SPECIFICATION

OLS form:

$$\begin{aligned}\log(X_{ijt}) = {} & \beta_0 + \beta_1 \log(GDP_{it}) + \beta_2 \log(GDP_{jt}) + \beta_3 \log(Distance_{ij}) + \beta_4 Contiguity_{ij} + \beta_5 CommonLanguage_{off_{ij}} \\ & + \beta_6 SameCountry_{ij} + \beta_7 EU_{ijt} + \beta_8 RTA_{ijt} + \beta_9 CommonCurrrency_{ijt} + \beta_{10} Colony_{ij} \\ & + \beta_{11} CommonColonizer45_{ij} + \beta_{12} BilateralInwardFDI_{ijt} + \beta_{13} BilateralOutwardFDI_{ijt} \\ & + \boldsymbol{\beta}' \log(\boldsymbol{INS_{it}}) + \boldsymbol{\beta}' \log(\boldsymbol{INF_{it}}) + \beta_{14}\text{EconomicGlobalization} + \beta_{15}\text{PoliticalGlobalization} \\ & + \beta_{16} \log(1 + MFNTariffs_{jt}) + \pi_i + \chi_j + \omega_{ij} + \gamma_t + \varepsilon_{ijt}\end{aligned} \tag{4}$$

Here: $\log(X_{ijt})$ is the average of individual product flows that are first logarithmically transformed and denotes flows of bilateral aggregate exports from exporter *i* to importer *j* at time *t*. X_{ijt} is the simple average of individual product flows by country pair. β_0 refers to the world output.

$\log(GDP_{it})$, $\log(GDP_{jt})$ are nominal gross [11]domestic products transformed to logarithmic form.

τ_{ijt} is bilateral trade cost, composed of natural barriers (bilateral distance, contiguity.), manmade trade costs (free trade agreements, European Union, common currency), and cultural barriers (common language, colonial links).

$$\begin{aligned}(1-\sigma)\ln(\tau_{ijt}) = {} & \beta_3 \log(Distance_{ij}) + \beta_{13} Contiguity_{ij} + \beta_{14} CommonLanguageOFF_{ij} + \beta_{14} SameCountry_{ij} + \beta_{15} EU_{ijt} \\ & + \beta_{16} RTA_{ijt} + \beta_{17} CommonCurrrency_{ijt} + \beta_{24} CommonColonizer45_{ij}\end{aligned} \tag{5}$$

$\log(Distance_{ij})$ is the bilateral distance between capitals of the trading partners *i* and *j* in logarithmic form. $Contiguity_{ij}$ is a dummy variables taking the value of one if both countries share a border. $CommonLanguageOFF_{ij}$ is a dummy variable which, if equal to one, captures the common official language and otherwise equals zero, and $SameCountry_{ij}$ indicates if countries were or are same country. $CommonColonizer45_{ij}$ indicates country i and j had a share a common colonizer after 1945. It is impossible to isolate and estimate the elasticity of substitution σ from the trade cost elasticity (β terms) for the trade cost function. The reason for this is that these two terms are always multiplied together. $BilateralInwardFDI_{ijt}$ and $BilateralOutwardFDI_{ijt}$ symbolize Bilateral Inward and outward FDI stock of the exporter.

$\boldsymbol{INS_{it}}$ is vector of four institutional quality indexes for the exporter. Namely, rule of law, political stability, government size and market openness. $\boldsymbol{INF_{it}}$ is a vector of Infrastructure quality indexes for the exporter. Specifically, Air transport of freights, Total infrastructure investment, and ICT indicators i.e. PCAInternetMobileSubs which represents the mobile subscription and internet usage combined using PCA method. $MFNTariffs_{jt}$ represents importer's applied overall average weighted MFN Tariffs.

[10] For more information on the basic assumptions of the Gravity of gravitas please refer to the Appendix Traditional Specifications

[11] In the appendix Section 3 Miscellaneous, the correlation of the basic variables Trade GDP and distance can be found in a table and graphic format. GDP must be in nominal terms as real terms would not appropriately capture the MRTs.

Country specific dummies π_i, χ_j are included to take into account for other characteristics of a country that do not vary in time such e.g. country area. The use of country-specific effects has an additional benefits unrelated to the consistency with theory. A country's systemic propensity to export large quantities relative to its GDP and other observed trade determinants may be systematic. e.g. the Netherlands and Belgium. Large chunk of international trade passes through Rotterdam and Antwerp. The production location should, in theory, be used as the exporting country and the importing country as the consumption location. In practice, reporting issues make it challenging to explicitly control this factor, so there is reason to expect trade flows from and to these nations to be overestimated. For this purpose, the individual fixed effects control by accounting for any non-observable effects that contribute to changing the overall level of a country's exports or imports. Lastly, ω_{ij} represents country pair fixed effects that allows to control for bilateral trade costs between countries that do not vary in time.

ε_{ijt} represents a random disturbance term (error term), OLS minimizes the sum of squared error ε_{ijt}. Conditions under which the OLS is statistically useful can be found under Appendix H. If all the required properties hold, the OLS estimates are efficient, consistent, and unbiased.

4.3 LINEAR ESTIMATION METHOD

OLS regressions, in the presence of autocorrelation and heteroskedasticity, produce biased and inconsistent results. In Gravity literature, OLS is the most frequently used regression method. This thesis controls these issues through robust and clustered errors within country pairs, unwinding the assumption of independent errors from each other. The robust option does not entirely control for autocorrelation and heteroskedasticity challenges in the data. The clustering option by country pair enables the error terms within pairs to be correlated, models that fail to account for data clustering significantly downplays standard errors (e.g., Moulton, 1990)

The use of individual fixed effects for exporters and importers helps the model to control for all country-specific characteristics not varying in time. The gravity model is no longer able to estimate the impact of any variables that are falling to this category, namely, time-invariant country-specific observable variables. Feenstra (2002) and Feenstra (2016) proffers introducing exporter and importer fixed effects take into consideration for each specific country's MRT. Dummies' coefficients of the reporter and the partner countries are supposed to reflect each country's multilateral resistance.

Following Hummels (2001) and Feenstra (2004), the importance of including fixed time-varying effects for exporters and importers was highlighted. Anderson and Yotov (2012) and expanded by Yotov et al.,(2016) and Baier et al., (2017), claim that when multilateral resistance and size variables are replaced by an appropriate set of fixed effects, econometric concerns about omitted variables and exogeneity dissipate. Authors that used country-time[12] fixed effects were interested in discriminatory trade policy measures such as regional trade agreements (Bergstrand, Larch, & Yotov, 2015; Egger, Francois, Manchin, & Nelson, 2015) via Poisson pseudo-maximum likelihood(PPML), to control for MRT. The inclusion of time-varying country fixed effects therefore allows all unnoticed and observed heterogeneity to be captured, which simultaneously addresses the golden error presented by Baldwin and Taglioni (2006). However,

[12] In equation (3), the fixed effects are equal to: $\pi_{it} = \log Y_{it} - log\Pi_{it}$; $\chi_{jt} = \log Y_{jt} - log\mathrm{P}_{jt}$; these fixed effects are analyzed in the robustness Table column 1.

infrastructure and institution variables are time-varying country specific effects and are omitted due to being perfectly collinear with these fixed-effects. For this reason, this method is not displayed in the main Table.

The pair of fixed effects offer a versatile and detailed account of the effects of all time-invariant bilateral trade costs since, in addition to the information obtained by the regular gravity variables, the pair of fixed effects have been shown to hold systemic information about trade costs (Egger and Nigai, 2015; Agnosteva et al., 2014). Pair fixed effects allow all time-invariant bilateral trade costs to be recorded and, in addition to the information obtained by the standard gravity variables, these effects contain information regarding systematic trade costs (Agnosteva et al., 2014; Egger and Nigai, 2015). The downside to using fixed effects to country pairs is that any time-invariant bilateral determinants of trade flows will not be detected since the constant forces of the pair would absorb the latter. The assumption of an unknown constant heterogeneous component over time and affecting each pair of countries in various ways holds when the fixed effects estimator is selected. To achieve unbiased estimates, this unobserved heterogeneity should be controlled (Garcia, Pabsorf, and Herrera, 2013). By using country-pair specific fixed effects, Rose and Wincoop(2001) control other measurable features between each pair of countries to control for Multilateral resistance.

After estimating OLS, this thesis conducts several tests, namely, RESET for specification, a failure in this test indicates for misspecification of the model. Robust OLS partially controls for heteroskedasticity. Autocorrelation, however, can be liable for failing the RESET test. Thus, meaning that even if coefficients indicate sound economic justification, nevertheless, statistically meaningless.

5 ANALYSIS

In this section, various tests are conducted to scrutinize the main and robustness models' heteroskedasticity, normality, multicollinearity, auto and cross correlations.

DIAGNOSTICS

Before we proceed to regression analysis, several diagnostics tests are performed to study the underlying dataset. This thesis first starts by scrutinizing if the residuals of the regression are normally distributed and uncorrelated. The rejection of these assumptions would mean that the regression results could be heavily biased. Moreover, these diagnostic tests allow procuring necessary information to adjust the regression. The dependent variable is the aggregate logarithm of over 5000 product export flows from country I to country j of the 1992 product nomenclature Harmonized System (HS92 with 6-digit numerical codes) for each country i.

Brooks(2008) claims that in a regression analysis, constant error terms are termed as homoscedastic. Should this not be the case, they are said to be heteroskedastic (Harvey, 1976). A proven test called the heteroskedasticity test was uncovered by White(1980); the null hypothesis is that the error variances are equal, which would imply that acceptance of the null hypothesis, a p-value > 0.10 implies at 90 percent level homoskedasticity. Conversely, the rejection of the null hypothesis, a p-value of 0.00, indicates that the alternative hypothesis is that the variances in the disturbance are a multiplicative function of at least one variable (Berry and Feldman, 1985). In the case of null hypothesis rejection, unrestricted heteroskedasticity is accepted. Breusch-Pagan[13] linear heteroskedasticity test and unrestricted heteroskedasticity test show that the null homoskedasticity hypothesis is rejected.; thus, heteroskedasticity must be accepted. The residuals' non-randomness is demonstrated using residuals and the plot of the fitted values[14]. The plot provides further evidence for the presence of heteroskedasticity; the spread of the residuals does not seem to be constant across the whole graph. The normality[15] tests of Shapiro-Wilk W and Skewness/Kurtosis tests indicate that those variables are non-normal. Histogram of residuals versus normal curve overlay displays that the distribution is slightly higher in kurtosis and skewed to the left.

The Lagrangian Multiplier test and Sargan-Hansen over-identifying restriction tests show that the fixed effects model is preferred over random effects in the main model selected for the regression set (equation 5). In both tests, the null hypothesis of the constant error term and random effects are preferred are rejected. Moreover, the likelihood-ratio test demonstrates that by adding individual, time fixed effects, the model's goodness-of-fit increases, nesting the latter model within a model that adds pair fixed effects increase the goodness-of-fit even more. Nevertheless, the regression analysis omits essential time-invariant observed variables. Thus, this thesis controls individual[16] and time fixed effects on column 1, enabling the control of country characteristics that do not vary in time, while allowing the observed country-time fixed effects to be observable. In column 2, pair and year fixed effects are controlled. To confirm the no fixed effects rejection, this thesis uses F-test for individual and time fixed effects' joint significance. The error component model's test rejects the significance of one and two-sided random effects, also rejecting the presence of serial correlation at a 95% level and the null hypothesis of the variance of disturbances with the serial

[13] Diagnostics output are shown under Appendix - Diagnostics: Heteroskedasticity tests
[14] The plot can be found under Appendix - Diagnostics: Figure 1
[15] Normality test and figures are found under Appendix – Diagnostics : Normality tests
[16] Individual, time fixed effects are separate effects, not to be confused with country-time fixed effects; this thesis prefers to name country time-invariant fixed effects as individual fixed effects.

correlation being zero jointly is also rejected. The modified Wald test shows the presence of GroupWise heteroskedasticity under the fixed effects model.

Consistent but inefficient estimates of the regression coefficients and biased standard errors result from serial correlation in the disturbances (Baltagi et al., 2007). The Wooldridge test shows that the statistically important first-order autocorrelation violates the assumption of classical regression that the covariance between the terms of the error is zero (Brooks, 2008). This is confirmed with Inoue and Solo (2006) LM test, alternative of the serial correlation of 1st order is accepted. The clustering pattern of the residuals of a fixed effect model as is shown in the figure Appendix B: Figure 3, demonstrate the positive autocorrelation. The regression of covariates and lagged residuals on residuals display an R-squared larger than 0. A well-behaved Gauss-Markov error term should have an R-squared of 0. The Breusch-Godfrey test indicates the presence of autocorrelation at a 1% level. To correct autocorrelation, it is therefore needed to use clustering at the panel level as discussed by Wooldridge (2002) and Baltagi (2001).

A crucial implicit assumption of the OLS estimation method is that all regressors are not (highly) correlated with one another. Table 5 of the Appendix depicts the correlation matrix of the regressors. The highest correlation between the log of distance and common is negative (-74%), which is explained through the selected sample of OECD countries and the recent period 1995-2018, where colonized countries are clustered in eastern Europe and are colonized by Russia. Other countries further from ex-USSR are further located geographically. Correlation between inward and outward FDI stock is 64%, other high correlations are between pairwise time-invariant dummy variables, the highest being the variables related to colonial and historical ties. The correlation matrix can be found in Appendix B, Table 6.

This thesis employs the Variance Inflation Factors (VIF) (Table 6) to verify if the multicollinearity is present in the underlying data. If the constant VIF score is less than 10, then this indicates the absence of severe multicollinearity issues in the regression analysis. Variables between 5 and 10 can be investigated. Both cases point out the presence of multicollinearity in the dataset, Books (2008, p.171) defines it as *"The relationship between two or more explanatory variables is not negligible, but not perfect."* and suggests three ways of managing the existence of multicollinearity. If the model adequate, then multicollinearity can be ignored. Thus, this thesis tests the adequacy of the model for each regression through Regression Equation Specification Test (RESET) by Ramsey (1969). RESET tests whether the powers of fitted values significance when they are included in the original regression. The variables causing the multicollinearity need to be dropped. Exchange rate, subsidies, regulatory efficiency, and social globalization are omitted from the model due to VIF scores being higher than 10. However, after removing these three variables, the VIF scores were at the acceptable range with a mean VIF score of 2.33 and the highest score of 4.85 for the exporter's GDP.

The diagnostics test for the robustness Table starts by analyzing heteroskedasticity. White's and Breusch-Pagan heteroskedasticity tests indicate that the model is heteroskedastic. As graphic evidence, this thesis provides the scatter plot of residuals vs. fitted values (Appendix E: Figure 6). The normality[17] tests of Shapiro-Wilk W and Skewness/Kurtosis tests indicate that those variables are non-normal. Histogram of residuals versus normal curve overlay displays that the distribution is slightly higher in kurtosis and skewed to the left. Autocorrelation tests of Breusch-Godfrey and Inoue and Solo indicate an autocorrelation's presence in the data. Mean VIF is 3.316, and max VIF is 7.50, indicating that the multicollinearity issue is

[17] Normality test and figures are found under Appendix B & E – Diagnostics: Normality tests

below the threshold of 10. The correlation matrix (Appendix E: Table 10) indicates no strong correlation between variables. Breusch and Pagan Lagrangian random effect multiplier test, where the null hypothesis is rejected; thus, we should not use random effects. Lagrangian multiplier and Sargan-Hansen tests indicate that fixed effects are the preferred model. The individual and time fixed effects or pair and time fixed effects are preferred over no fixed effects model as indicated by the likelihood tests (Appendix B) .

6. RESULTS AND DISCUSSION

In this section, 6.1 interprets results from the main table, while 6.2 interprets results from the robustness table in detail. Sub-section 6.3 summarizes the main findings from both tables. Finally, sub-section 6.4 highlights the limitations of this study and provides suggestions for further studies.

The output of OLS[18] estimation with individual and year fixed effects is displayed in the left column, while the right column shows the main model with pair and year fixed effects, only the latter passes the reset test (Appendix: Tables).

6.1 INTERPRETATION OF MAIN TABLE

All regressions are tested for signs of misspecification using the RESET test. If the null hypothesis is rejected, then signs of misspecification are existent. For the OLS method with individual and year fixed effects, the RESET test does not pass. Robust standard errors partially control heteroskedasticity; autocorrelation can be why the method fails to pass the RESET[19] test. Only the model with fixed effects for country pair fixed effects and years fixed effects passed the RESET test on the main specification. Passing the RESET test indicates that the square of fitted values has no significant explanatory power when added to the regression, leading to the correctly specified model's assumption. Thus column 2 serves as the reliable model for evaluating regressors impact sign and magnitude on bilateral aggregate exports.

In the main table, the first column includes individual and year fixed effects; the time-invariant unobserved and observed variables of exporter and importer are controlled, e.g., geographical location, access to the sea, or being landlocked. This thesis controls for time-specific unobserved variables such as the financial crisis of the dotcom bubble or 2008 crisis by including the time fixed effects. This thesis deems the inclusion of fixed effects as a critical aspect for the interpretation of the coefficients. The GDP coefficients are positive and statistically significant, indicating that the size effects, as indicated in the gravity literature, the size of the importer is more strongly affected than the size of the exporter, 0.85 vs. 0.51 percent, respectively. Standard gravity dummies have the awaited signs and are statistically significant except for the dummy which indicates if countries are contiguous with one another, displaying insignificance due to the inclusion of fixed effects. The common dummy language variable is positive in column 2 of the main table, and should be interpreted as follows:

$$\%\ impact\ on\ aggregate\ bilateral\ exports = [e^{\widehat{Comlang}} - 1] * 100 = [e^{0.23} - 1] * 100 = 25\%$$

This percentage implies that bilateral exports are 25 percent higher when exporters and importers share a common official language. Countries that were in colonial relationship export 30% more among each other relative to countries which did not have a colonial relationship in the past. A common colonizer increases exports between these countries by, on average, 1546% among each other. E.g., This could be explained for Baltic countries where the economic cooperation and strengthening of ex-USSR countries such as, Latvia, Lithuania, and Estonia after the fall of the Soviet Union increased commercial relationship to dissociate from Russia. Countries merged in the past, e.g., such as Czechia and Slovakia, were called Czechoslovakia, and this historical tie increases aggregate exports between them by 105.65% on average ceterus paribus. If both countries are in RTA, their bilateral aggregate exports increase by around 36.62% than if they were not in RTA. Being the European Union and exporting to another European Union (EU) is

[18] The use of OLS is justified through being the most common regression method in the Gravity literature. The second reason is that the heteroskedasticity and autocorrelation can be partly controlled through robust regression clustered by country pairs, relaxing the error's independence from one another.

[19] The output results of RESET tests are found under Appendix C : Fitted Values Vs the Dependent Variable And Reset Test.

10.74% more than to or from a non-EU country with significance at a 95% level. The coefficient for common currency seems to be negative under time-invariant country fixed effects of -7.98% among countries with common currency with a significance at 90% level; however, when pair fixed effects are included, the impact of sharing a currency that is common for both countries is positive.
As for institutional quality indicators, the government size, which is a factor constructed using PCA comprised of exporter's tax burden, government spending, and fiscal freedom, positively impacts bilateral aggregate exports of 0.078% increase in the dependent variable. The rule of law, which comprises property rights and freedom from corruption index, 1 percent surge leads to an increase in aggregate bilateral exports of 0.051%. These variables follow the theoretical rationale that an increase in institutional quality reduces uncertainty about the enforcement of contracts and overall economic governance, which in turn reduces transaction costs, among many other positive motivations (De Groot et al., 2004),. Unexpectedly two variables representing the political stability and market openness. The 1 percent increase in political stability index relates to a decrease in aggregate exports by 0.37%. The market openness was also constructed using the PCA method and contains financial investment and trade freedom, separate inclusion of these variables are examined in the robustness table for the period 2011-2018. The high correlation between these variables led to the decision to employ the PCA method. Thus, the market openness factor negatively impacts aggregate bilateral exports by 0.065%. Economic and political globalization indexes seem to positively, and high magnitude affects the regressand by 1.58% and 1.39%, respectively. This thesis finds a positive impact of internet usage and mobile subscriptions of 0.26% as a measure of the exporter's soft infrastructural aspects. The exporter's total transport infrastructure investment has a negative and tiny impact on the dependent variable by 0.01%. The increase in importer's average weighted most favored nation tariffs has, as expected, a negative impact on aggregate bilateral exports of 0.185%. The R-square suggests that the covariates explain 91.4% of the variations in the dependent variable.

Column 2 of the main table passes the RESET test, which implies that pair and year fixed effects lead to a correctly specified model. The fixed effects by country pair decrease the extent of the gold medal error by eliminating the cross-sectional correlation between omitted Π and P, the terms for multilateral resistance. Thus, coefficients displayed under this column are closer in magnitude and sign to the concerned variables' actual relationship. The magnitude of exporter's size impact increases from 0.51% to 0.56%, while country pair specific unobservable variables are controlled, the impact of observable dyadic variables are omitted due to perfect collinearity with pair fixed effects. Regional trade agreement (RTA) decreases in magnitude from 36.62% to 7.33%, a decrease of 80%. Joining the European Union has a more considerable impact on exports, going from 10.74% to 13.43%, increasing the magnitude of 25%. At the same time, common currency switches signs from negative to positive, with a positive impact of 4.89%. As for the coefficients of institutional quality variables, government size impact slightly decreases to 0.073% from 0.078%, Market openness negative impact decreases to 0.048% from 0.065%, losing significance from 95% to 90% level significant, economic globalization's coefficient increases to 1.92% increase in exports for an increase by 1 percent, meanwhile the political globalization's coefficient decreases to 1.08%. The rule of law becomes insignificant. Internet usage and mobile subscriptions, and total infrastructure investment retain their magnitude and signs while the latter surges in significance level to 95%. Freight transportations impact remains at around a negative 0.01% impact on aggregate bilateral exports for an increase in 1% of the variable. The increase in political stability affects slightly less by 0.32% or a decrease in impact by 16.4%. FDI stock loses impact on exports, being nearly zero (0.0043%), where only inward FDI stock is significant. This dramatic change could be explained by using pair fixed effects controls for the effects of all time-

invariant bilateral trade costs, hinting that inward and outward FDI stock are correlated with bilateral trade costs. The R-square increases and explain 97.4% of the variations in the dependent variable. Appendix D: The kernel density estimates of the distributions of the predicted values from columns 1 and 2 of the main table and the observed data are shown in Appendix D: Figure 4. The logarithm of aggregate exports is distributed and slightly right-skewed. A one-to-one comparison of the two columns shows that the models are slightly right-skewed, with different magnitudes of bias present. The distribution of OLS with fixed effects in pairs and years differs greatly from the first column in kurtosis (it shows a high and positive kurtosis and therefore a smaller variance) with a more heavy bias. Column 1 employing the individual and year fixed effects highly resembles in kurtosis to the observed data.

6.2 INTERPRETATION OF THE ROBUSTNESS TABLE

In this section, alternative variables that define Institutional and infrastructure quality are explored. Market openness is decomposed to its subcomponents used to create the market openness index. The political stability is replaced by the state fragility index created using the PCA method. Moreover, the addition of the exporter's innovation index results in a positive impact on the regressand, and its inclusion allows the model to pass the RESET test for time varying country fixed effects and pair and year fixed effects models. Moreover, this index could be considered as an indicator belonging to institutional quality. The infrastructure quality consists of ports, road, railroad, and air transport infrastructure quality; due to data availability from 2009-2018, the dataset was not used for the main table as the main table considers the impact of variables over the period from 1995-2018. The infrastructure quality dataset was obtained from theglobaleconomy.com[20] which compiled the Global competitiveness index published annually by World Economic Forum. The subcomponents of market openness are investment, trade and financial freedom indexes, Principal Component Analysis (PCA) for the main table. The decomposition is done to evaluate which components are harming aggregate bilateral exports. The fragile state index measures the vulnerability in before the conflict, while the conflict is taking place, and the post-war aftermath effects. Using the PCA method, this index was built and consists of 11 variables that make up the global economy 's fragile state index[21]. However, instead of taking the simple sum of the fragile state index components, this thesis prefers using the PCA method, which allows replicating the data structure using only two factors. The effect on the regressand could lead to biased inferences when using a simple average or sum. The fragile state index was obtained from the Fund for Peace.

Globaleconomy.com, which compiles sources from Cornell University, WIPO, and INSEAD, obtained the exporter 's innovation index. The Innovation Input Sub-Index and the Innovation Output Sub-Index make up this index. The sub-index of inputs is based on five pillars: human capital and research, infrastructure, institutions, sophistication of business, and sophistication of markets. The sub-index of outputs is based on two pillars: outputs of knowledge and technology and creative outputs. Each pillar is divided into sub-pillars, and individual indicators are made up of each sub-pillar. Only factors with eigenvalues greater than one are included as indexes in all PCA constructions. The output results from estimation using OLS are shown in the Appendix: Robustness Table.

[20] A team of economists headed by Neven Valev, a Ph.D. economist with extensive research experience, is hosting this website. Their objective is to disseminate knowledge about the world economy and to make it easier for international data to be used.

[21] Factionalized Elites Index, Group Grievance Index, Economic Decline Index, Uneven Economic Development Index, Human Flight and Brain Drain Index, State Legitimacy Index, Public Services Index, Security Threats Index, Human Rights and the State of Law Index, Demographic Pressure Index, Refugees and Displaced Persons Index, External Legitimacy Index,

Column 1 of the robustness table presents Ordinary Least Squares estimation method with time varying country specific while column 2 of the same table shows country pair and year fixed effects using OLS. Both columns pass the misspecification RESET test. Thus, the results from these models are assumed to be appropriately specified. Column 1, country-specific time-varying observable, and unobservable variables are controlled using country specific effects that vary in time meaning that the independent variables are less biased by omitted variable bias caused by MRT. The model shows that the 1% increase in distance between the two countries decreases exports by around 1.05%. Contrary to the main model, in this model where the time-span for the analysis is reduced to 8 years (2011-2018), the contiguity is significant at a 90% level, where bordering countries export 19.36% more than with the partners with which they did not have common borders. Aggregate exports among partners that have a common language are 28.27% higher and significant at the 95% level. Countries that had a colonial historical relationship and after 1945 common colonizer saw their aggregate exports to be 47.85% and 1586.09% higher, respectively, than exports among countries that did not have these colonial ties. Countries that were one country in the past saw their exports to be 60.16% higher than countries that did not have this historical tie. When both countries are members of RTA or EU aggregate bilateral exports are higher by 41.62% and 46.67%, respectively. The model explains 91.4% variations in the response variable.

Column 2 presents the output of the estimation model using OLS with pair and year fixed effects. GDP have a positive impact of 0.48% and 0.61% for the exporter and the importer, respectively. The regional trade agreement is insignificant while the European Union is omitted as no new countries that belong to OECD countries in 2020 joined the EU after 2011, thus using time-invariant pair fixed effects, this variable is omitted. The impact of government size on aggregate bilateral exports is negative for 2011-2018, where an increase in 1% in government size leads to a decrease in aggregate bilateral exports by 0.04%. After dissecting the main table's market openness to its three subcomponents, namely, investment, trade, and financial freedom, this table shows that trade freedom is insignificant. The investment and financial freedom impact the regressand negatively by 0.23% and 0.19%, respectively. The exporter's economic and political globalization impacts bilateral aggregate exports by 2.68% and 1.30%, respectively, at a significance level of 99% for the former and 90% significance for the latter. The rule of law of the exporter increases aggregate bilateral exports by around 0.10%. As for the infrastructure quality, only the port and road infrastructure quality are significant and are opposite signs concerning their impact on the dependent variable. An increase in port infrastructure quality leads to a decrease in aggregate bilateral exports by 0.41%, while the quality of road infrastructure increases the dependent variable by 0.96%. MFN tariffs from importers have a detrimental effect of 0.27 percent on aggregate exports. The fragile state factors of exporters 1 and 2 have a negative and significant influence on aggregate bilateral exports, where the increase in the fragility of exporters leads to a decrease in exports of 0.11% and 0.063% respectively for factor 1 and factor 2. The first factor's eigenvalue is 7.15, whereas the latter has an eigenvalue of 1.05. Therefore, factor 1's weighted impact includes more variables than the latter. The exporter's innovation index increase by 1% leads to increased bilateral aggregate exports of 1.39%. The model explains 99% of the variations in the bilateral aggregate exports.

6.3 BRIEF SUMMARY TABLE

Except for column 1 for the main table, all the other columns pass the RESET test, indicating that they are well specified and absence of significant non-linearity in the model. We observe the coefficients obtained in the main and robustness table are aligned to the standard gravity variables in terms of signs and magnitudes. The exporter's GDP impact is less than the impact of the importer's GDP on aggregate bilateral

exports. The higher coefficient of the importer's GDP impact is in line with the literature. The standard benchmark coefficient for distance is 1%, which is in line with the obtained results. Contiguity is insignificant in column 1 for 1995-2018; however, the impact of contiguity becomes significant in the robustness table. Other dummy trade cost variables slightly change in magnitude but not in signs between main and robustness tables. In the main table, the Regional trade agreement impact on the dependent variable is reduced when the pair fixed effects are introduced, meaning that there can be a significant impact of time-invariant unobservable variables that over causing potentially inflated impact under the column 1 and subsequent 80% decrease in impact in column 2 of the main table. However, RTA is insignificant in the robustness table. The main reason for this could be the lack in the variation of the variable due to a shorter period.

The common currency positively impacts bilateral aggregate exports when the cross-sectional correlation between omitted Π and P, multilateral resistance terms are included. The inward and outward FDI stock positively impacts the dependent variable; however, this effect disappears when pair fixed effects are included. The government size had a positive impact of around 0.07% for the period 1995-2018, however for the period 2011-2018, the impact was reversed in signs of -0.04%, potentially indicating that exporter's tax burden, government spending, and fiscal freedom lead to reduced exports for the period post housing crisis of 2008. The constructed market openness and when the subcomponents are examined in the main and robustness table, respectively, their impact is consistently negative. This finding is counterintuitive and against the expectations of market openness and investment and financial freedom leading to a surge in firms' exports. Economic and political globalization have consistently positive impacts on the aggregate bilateral exports, Moreover, for the period post-2011, the influence of economic globalization is increased, and the political globalization impact is reduced. The rule of law in the main table is important only when the characteristics of time-invariant and time-fixed effects of countries are controlled. The effect of this variable is insignificant when fixed country pair effects are used.

Contrary to expectations, the infrastructure investment did not induce to a rise in aggregate bilateral exports. The importer's MFN tariffs negatively impact the aggregate bilateral trade flows on all tables that are compatible with the thesis' hypotheses and the intuitional expectations. In the main table, political stability has detrimental influence on the aggregate bilateral exports; this finding is contrary to ex-ante expectations. The four dimensions of infrastructure quality were introduced in the Robustness table, namely, port, road, railroad, and air transport. The findings of this table indicate that rail and air transport infrastructures have a negligible impact on aggregate bilateral trade flows. The road infrastructure has an impact close to unity where 1% increase in road quality leads to an almost 1% surge in the dependent variable (0.96%), while contrary to expectations, the quality of port facilities affects negatively aggregate bilateral exports by 0.41%. Because of the high correlation of the state fragility index sub-indexes, the construction of two indexes with values greater than 1 shows a negative relationship between the rise in the fragility of countries and the aggregate bilateral exports, e.g., through brain drain, uneven economic development, and other factors that compose the fragility index (Appendix I).

6.4 LIMITATIONS:

The biggest limitation of this thesis with regards to estimation was the computational limitation. Examining the relationship between the disaggregated bilateral exports (45,424,948 observations) and the covariates of interest from the main and robustness specifications would have been interesting to investigate. Employing the disaggregated dataset of the dependent variable would allow the utilization of product-

specific fixed effects of the harmonized system at two-digits. This type of fixed-effect would permit controlling the heterogeneity and the impact of product-specific factors that are not accounted by the employed covariates in the econometric specification. Moreover, Disaggregated export flows would allow examining the differential impact of the covariates of interest (EU, common currency, institutional and infrastructure quality, economic and political globalization, and MFN tariffs) on each product category.

Another major limitation is the missing values and variables only starting after 2007 or 2011, such as the four dimensions of infrastructure quality (port, road, railroad, and air transport), state fragility index, innovation index, which would have been interesting to examine for the period 1995-2018 instead of 2011-2018.

Cheng and Wall (2005) state that some variables take longer than one year to adjust when fixed effects are pooled over consecutive years. Thus, it would be interesting to examine the dataset in time intervals. However, variables such as European Union and common currency can face the dilemma of choosing when the variable is equal to 1 in the interval, e.g., 3-year interval. Further studies need to employ intervals.

The examination of a more extended period with a lagged impact of some variables such as EU, Common currency, infrastructure investment, political stability, and market openness would be fascinating to examine. Perhaps the impact of these variables, in the long run, is not small or negative, e.g., transport infrastructure investment's effect on exporter might not be immediate. Including the lagged variable leads to a reduced number of observations; thus, other essential variables examined would have less variation. Therefore, this thesis decided not to use lagged variables. For further studies, it could be thought-provoking to examine the influence of the market openness, investment, and financial freedom and total infrastructure investment variables on the total production of a country or examining the impact of these variables on exports relative to internal trade by including intra-national trade.

7. CONCLUSION

The impact of the RTA and the EU among the members of these agreements was positive from the output results of the Ordinary Least Squares estimation method used for this thesis when the period studied was from 1995 to 2018. However, the impact of RTA and EU cannot be conclusively interpreted for the period 2011-2018 as they only have a massive impact on aggregate exports if country-specific time-varying fixed effects are included, yet, when time-invariant pair and year fixed effects are utilized, the impact is insignificant for RTA and omitted for EU due to the absence of variation in time. This thesis does not conclude that in general, the improvement in institutional quality leads to the betterment of aggregate bilateral exports as is shown by the market openness index and political stability when the subcomponents of market openness index are included for the recent period (2011-2018) the investment and financial freedom hurt exports while the trade freedom was insignificant. The government size had mixed results in terms of the time period that was examined, having a positive impact for the whole period while negative for the recent time period. The substantial and consistent positive impact of economic and political globalization on aggregate bilateral exports for the entire period (1995-2018) and the recent period (2011-2018) is indicated by the noteworthy contribution of this thesis. As Borchert and Yotov (2017) suggested, further investigations of globalization on trade is recommended. Another important contribution is investigating and finding significant impacts of exporter's state fragility and innovation index on bilateral aggregate exports.

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APPENDIX:

TABLES

MAIN TABLE

	OLS + Individual and time FE		OLS + Pair and time FE	
Log of exporter's GDP	0.509***	(0.044)	0.555***	(0.043)
Log of importer's GDP	0.849***	(0.042)	0.862***	(0.041)
Log of Distance	-1.076***	(0.054)		
Contiguity	0.0557	(0.096)		
Common language	0.232**	(0.095)		
Colonial relationship	0.263*	(0.135)		
Common colonizer	2.801***	(0.142)		
Same country in the past	0.721***	(0.214)		
Regional Trade Agreement	0.312***	(0.054)	0.0707**	(0.034)
European Union	0.102**	(0.048)	0.126***	(0.034)
Common currency	-0.0832*	(0.045)	0.0477**	(0.023)
Log of inward FDI stock	0.0226***	(0.004)	0.00409**	(0.002)
Log of outward FDI stock	0.0227***	(0.005)	-0.00153	(0.002)
Log of Government size	0.0775***	(0.014)	0.0725***	(0.012)
Log of Market openness	-0.0649**	(0.029)	-0.0475*	(0.027)
Log of exporter's economic globalization index	1.578***	(0.311)	1.923***	(0.293)
Log of exporter's political globalization index	1.393***	(0.357)	1.080***	(0.360)
Log of Rule of law	0.0505*	(0.030)	0.0357	(0.028)
Log of Internet usage and mobile subscriptions	0.257***	(0.033)	0.271***	(0.033)
Log of exporter's freight transportation in kg	-0.0081***	(0.003)	-0.00538*	(0.003)
Log of exporter total infrastructure investment	-0.00522	(0.004)	-0.00856**	(0.004)
Log of importer's most favored nation tariffs	-0.185***	(0.048)	-0.209***	(0.046)
Log of exporter's political stability	-0.377***	(0.088)	-0.315***	(0.083)
Constant	-12.71***	(1.972)	-22.67***	(1.964)
Number of observations	26511		26511	
RESET test	0		0.854	
R-squared	0.914		0.974	

Note: Figures in parentheses are robust standard errors. The dependent variable is the logarithm of exports in all cases. * significant at 10%; ** significant at 5%; *** significant at 1%. All the other columns are clustered by country pairs. Individual fixed effects here means that exporter and importer time invariant unobserved and observed factors are controlled through the usage of these fixed effects. The time period considered in this table is from 1995-2018.

ROBUSTNESS TABLE

	OLS + Country-time FE		OLS + Pair and time FE	
Log of exporter's GDP			0.479***	(0.080)
Log of importer's GDP			0.612***	(0.075)
Log of Distance	-1.054***	(0.060)		
Contiguity	0.177*	(0.101)		
Common language	0.249**	(0.102)		
Colonial relationship	0.391***	(0.143)		
Common colonizer	2.825***	(0.145)		
Same country in the past	0.471**	(0.219)		
Regional Trade Agreement	0.348***	(0.122)	-0.0879	(0.055)
European Union	0.383***	(0.110)		
Common currency	-0.110	(0.068)	0.0457	(0.035)
Log of Government size			-0.039***	(0.013)
Log of exporter's Investment freedom			-0.230**	(0.100)
Log of exporter's Trade freedom			-0.511	(0.314)
Log of exporter's Financial freedom			-0.193**	(0.083)
Log of exporter's economic globalization index			2.680***	(0.606)
Log of exporter's political globalization index			1.301*	(0.736)
Log of Rule of law			0.102**	(0.050)
Log of quality of port infrastructure index			-0.414*	(0.216)
Log of quality of road infrastructure index			0.958***	(0.200)
Log of quality of railroad infrastructure index			-0.220	(0.244)
Log of quality of air transport infrastructure index			0.0357	(0.293)
Log of importer's MFN tariffs			-0.267***	(0.076)
Log of Exporter's Fragile State Factor 1			-0.111***	(0.030)
Log of Exporter's Fragile State Factor 2			-0.0626**	(0.030)
Log of exporter's innovation index			1.384***	(0.313)
Constant	28.67***	(0.554)	-14.34***	(3.464)
Number of observations	7987		7987	
RESET test	0.382		0.409	
R-squared	0.914		0.990	

Note: Figures in parentheses are robust standard errors. The dependent variable is the logarithm of exports in all cases. * significant at 10%; ** significant at 5%; *** significant at 1%. All the other columns are clustered by country pairs. The dependent variable is in levels for PPML estimation method. Country-time fixed effect means that the model controls for exporter and importer time varying fixed effects. The time period considered in this table is from 2011-2018 due to the absence of the data for earlier period, these indicators could not be used for the main model.

A: DATA

TABLE 1 - DESCRIPTIVE STATISTICS

Summary statistics

	N	Std. Dev.	min	max	kurtosis	skewness	t-value
Aggregate Trade (in USD)	30234	1.523e+10	1237.19	3.410e+11	159.05	10.5	48.14
Log of Aggregate Trade	30234	2.37	7.12	26.55	3.21	-.34	1465.34
Average Trade	30234	3831120.7	1237.19	88272664	146.31	9.76	67.38
Log of Average Trade	30234	1.01	7.12	15.39	4.62	1.11	1801.7
Log of Exporter's GDP	30234	1.65	22.23	30.66	2.91	-.11	2780.91
Log of Importer's GDP	30234	1.65	22.23	30.66	2.91	-.11	2779.84
Distance (Population weighted in kilometers)	30234	1.17	4.09	9.88	2.21	-.25	1201.94
Contiguity	30234	.24	0	1	15.09	3.75	43.44
Common Language	30234	.25	0	1	13.43	3.53	45.88
Colonial Relationship	30234	.18	0	1	28.03	5.2	32.29
Common Colonizer (post 1945)	30234	.07	0	1	207.96	14.39	12.03
Same Country (in the past)	30234	.13	0	1	52.79	7.2	23.71
Regional Trade Agreement	30234	.47	0	1	1.53	-.73	248.56
European Union	30234	.45	0	1	1.92	.96	109.34
Common Currency	30234	.3	0	1	7.77	2.6	59.11
Log of exporter's inward FDI stock	30234	3.89	-6.91	13.35	1.88	.57	149.64
Log of exporter's outward FDI stock	30234	3.92	-6.91	13.38	1.83	.51	153.45
Government Size (constructed using PCA)	28309	1	-4.35	1.53	4.3	-1.16	.02
Regulatory efficiency (constructed using PCA)	30201	1	-8.24	.47	64.16	-7.79	0
Market Openness (constructed using PCA)	30234	1	-8.18	.5	62.29	-7.6	0
Globalization Index (constructed using PCA)	28974	1	-4.2	1.31	4.91	-1.39	0
Rule of Law (Constructed using PCA)	30234	1	-7.35	.7	40.62	-5.53	0
Log of Internet users and mobile subscriptions (Constructed using PCA)	29849	1	-4.35	.88	6.26	-1.91	-.03
Log of Fixed Broadband Subscriptions	30234	.45	1.77	4.32	3.41	-.97	1405.52
Log of Air transport (in kilograms)	30234	4.22	0	17.58	4.82	-1.52	488.02
Log of Railroad lines (total length in kilometers)	25194	.56	1.76	5.31	3.66	.25	1064.45
Density of Road (km per one hundred square km)	22779	.91	2.29	6.24	2.86	-.5	747.82
Total inland transport infrastructure investment (in constant USD per inhabitant)	30234	2.14	0	7.15	3.38	-1.34	367.35
Subsidies and other transfers (Current LCU)	28695	2.62	-.57	12.66	3.43	.57	333.05
Most Favored Nation tariff rate (weighted mean of all products %)	29675	.33	.92	2.88	4.8	1.48	840.44

TABLE 2 - DETAILED VARIABLE INFORMATION

Variable description (Brief)	Source	Detailed description	Accronym used in the Do-file
Property Rights (0-100)	Heritage.org	Measures the degree to which laws within a country protect and enforce private property rights	PCARuleOfLaw
Freedom from corruption (0-100)		Indicates the level of corruption, higher index lower level of corruption	
Tax Burden (0-100)		Measures the tax burden imposed by government, from all forms of taxation including indirect taxes, payroll, sales and value-added taxes % of GDP	PCAGovSize
Fiscal Freedom (0-100)		Measures the government caused tax burden, which comprises the highest marginal tax rate, individual income and the highest marginal corporate income tax rate as a percentage of GDP	
Government Spending (0-100)		Government spending of all sorts, including on infrastructure, public goods	
Business Freedom (0-100)	Heritage.org	Business freedom is based on ten indicators from the Doing Business Study of the World Bank, i.e. business procedures, time ,cost, minimum capital, license acquisition. It is generally a measure of the ease of doing business and the associated bureaucratic load.	PCARegulEfficiency

Monetary Freedom (0-100)	Heritage.org	Based on two factors: the most recent three-year weighted average inflation rate and price controls. Without microeconomic intervention, a higher index refers to price stability	PCAMarketOpeness
Trade Freedom (0-100)		The trade-weighted average tariff rate and non-tariff barriers (investment, quantity, customs and regulatory constraints, price, direct government intervention) are the subcomponents.	
Investment Freedom (0-100)		A variety of restrictions on investing are evaluated (land ownership, burdensome bureaucracy, expropriation of investments with no appropriate compensation, Forex controls, security issues, capital controls) For each restriction in the investment regime of a country, points are deducted from a perfect score of one hundred.	
Financial Freedom (0-100)		Measures, from a financial point of view, the extent of government regulation of financial services, state intervention in banks and other indirect or direct ownership, the extent of capital market development, the influence of government on the allocation of credit and openness to foreign competition. A higher index shows banking effectiveness, a lack of control and interference by the gov.	

Economic globalization index (0-100)	Theglobaleconomy.com (The Swiss Institute of Technology in Zurich)	Capturing real economic flows as well as trade and capital constraints, the sub index of constraints includes hidden import barriers, mean tariff rates, international trade taxes, and an index of capital controls	PCAGlobalization
Political globalization index (0-100)		This index is based on the amount of commissions and embassies in a nation, the amount of international organizations to which a country belongs, the quantity of UN peacekeeping missions for which a country has participated, and the quantity of treaties signed bilaterally and multilaterally.	
Social globalization index		This index is composed of three dimensions: cultural proximity, information flows and personal contacts, sub index of personal contacts includes international telecommunications tariffs, tourism intensity, transfers, foreign population. The sub-index on information flows includes number of household with television set, trade in newspapers and number of internet users. The sub-index on cultural proximity includes, trade in books and number of McDonald's and Ikea located in a country	
Nominal GDP in current USD	databank.worldbank.org World Development Indicators (WDI)	Nominal Gross domestic product (in current USD)	EXP_GDP IMP_GDP

Individuals using the internet (% of population)	databank.worldbank.org (WDI)	Individuals who in the last 3 months have utilised the Internet (from any location) are Internet users.	lEXP_InternetUsers
Mobile cellular subscriptions	databank.worldbank.org (WDI)	Mobile cellular phone subscriptions are public mobile phone service subscriptions	lEXP_MobileSubs
Common currency	httpjdesousa.univ.free.frdata.htm#CurrencyUnions	Common currency such as euro.	CommonCurrency
Tariff rate, most favored nation, weighted mean, all products (%)	WDI	MFN clause are revelations provided by its members on the concessions, privileges or immunities granted to another nation in a trade agreement. MFN tariffs are what nations promise to levy on imports from other World Trade Organisation members.	EXP_MFN IMP_MFN
Political stability index	The world bank (WGI)	The Political Stability assesses evaluations of the likelihood of destabilizing or overthrowing the status quo with respect to the regime in charge by violent or illegitimate channels, including highly politicized cruelty and terrorist acts.	ADJlEXP_PoliticalStability
Air transport, freight in metric tons times kilometers traveled	databank.worldbank.org (WDI)	Air cargo is the volume of cargo, express and diplomatic bags carried at each stage of the flight (the aircraft's operation from take-off to its next touch down), quantified in tonnes of kilometers traveled.	lEXP_AirTransportKG
Population weighted distance in kilometers	Cepii.fr	The distance between the two countries, based on the bilateral distances between the two countries' largest	ldistw

		cities, is weighted by the proportion of the city's population in the total population of the country.	
Contiguity	CEPII.FR	Common borders between a set of countries	contig
Common official primary language	CEPII.FR	Indicates whether two nations share a common official language	comlang_off
Colonial link	CEPII.FR	Depicts whether the country pair has ever had a colonial connection	colony
Common colonizer after 1945	CEPII.FR	This indicates whether the country couple ever had a shared colonizer after 1945 (colonial tie)	comcol
Were the same country in the past	CEPII.FR	Indicates if the country pair were one country in the past (historical tie)	smctry
Regional Trade Agreement	Mario Larch's Regional Trade Agreements Database	bilateral regional trading arrangements as notified to the WTO	rta
European Union	Gravity CEPII	Indicates if the country pair both belong to European Union	eu
Common Currency	José de Sousa (http://jdesousa.univ.free.fr/data.htm)	Indicates if the country pair both use common currency	comcur
Fragile state index	Fund for Peace	Index tests susceptibility in circumstances of conflict before, after and after. The index comprises twelve indices: security apparatus, factionalized elites, party grievances, economic decline, unequal economic development, human flight and brain drain, state legitimacy, public services, human rights and the rule of law, population pressures, migrants and IDPs, and foreign intervention.	EXP_FRAGILE1 EXP_FRAGILE2

		The higher the index 's value, the more the country is "fragile."	
Innovation Index	Theglobaleconomy.com (Cornell University, INSEAD, and the WIPO)	This index includes input and output sub-indexes. Institutions, technology, intellectual resources, and research are dependent on feedback. The output is based on technology and knowledge, and creativity.	lEXP_InnovationIndex
Quality of port infrastructure	Theglobaleconomy.com (World Economic Forum)	Questionnaire participants are asked to score the port and inland river system infrastructure in their country of service on a scale from one (underdeveloped) to seven (substantial and effective according to global standards).	lEXP_QualityofPortInfras
Quality of road infrastructure	Theglobaleconomy.com (World Economic Forum)	Questionnaire takers are asked to grade the roads in their nation wherever they work on a scale from one (underdeveloped) to seven (international standards are comprehensive and efficient).	lEXP_QualityofRoadInfras
Quality of railroad infrastructure	Theglobaleconomy.com (World Economic Forum)	In their country of service, survey takers are asked to rate the railroads on a scale from one (underdeveloped) to seven (comprehensive and competitive according to international standards).	lEXP_QualityofRailInfras
Quality of Air transport infrastructure	Theglobaleconomy.com (World Economic Forum)	Questionnaire participants are asked to rank passenger air travel in their region, where they operate on a scale ranging from one (underdeveloped) to seven (substantial and successful according to global standards).	lEXP_QualityofAirInfras

B: DIAGNOSTICS (MAIN TABLE)

HETEROSKEDASTICITY TESTS

Heteroskedasticity test by Cook-Weisberg / Breusch-Pagan of fitted values

Null Hypothesis: Variance that is constant

Variable: log of aggregate exports fitted values

Chi-square = 2991.59

Prob > chi2 = 0.0000

Heteroskedasticity test by Cook-Weisberg / Breusch-Pagan of fitted values

Null Hypothesis: Variance that is constant

Covariates: lEXP_gdp lIMP_gdp ldistw contig comlang_off colony comcol smctry rta eu comcur lstockFDIinward stockFDIoutward PCAGovSize PCAMarketOpeness EXP_EconGlobalization EXP_PoliticalGlobal EXP_SocialGlobalization PCARuleOfLaw PCAInternetMobileSubs lEXP_FixedTelSubs lEXP_AirTransportKG lEXP_TotInfraInvest lIMP_TariffMFN ADJlEXP_PoliticalStability

F(25 , 26485)= 113.26

Prob > F = 0.0000

Test developed by white, where the null hypothesis is Homoskedasticity

Alternative hypothesis: unrestricted heteroskedasticity

Chi-square(334) = 5657.13

Probability to have higher than Chi-square = 0.0000

Cameron & Trivedi's IM-test decomposition

	chi2	df	p
Heteroscedasticity	5657.130	334	0.000
Curve Skewness	601.980	25	0.000
Curve Kurtosis	57.970	1	0.000
The Total	6317.080	360	0.000

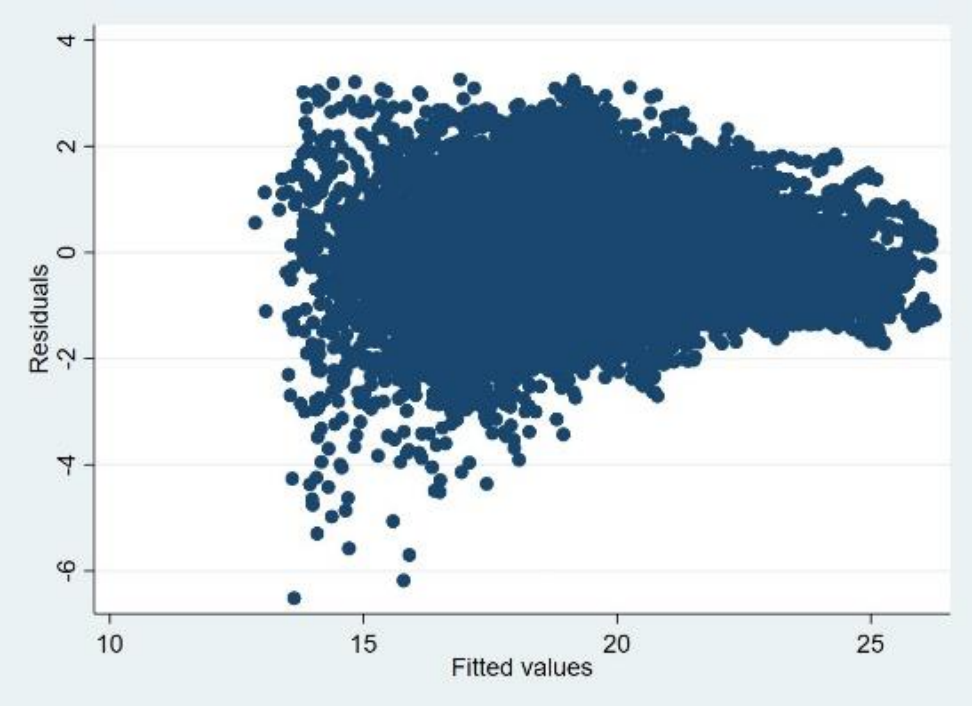
Test for the error component model

```
Tests for the error component model:

        lTradeSimple[pairid,t] = Xb + u[pairid] + v[pairid,t]
           v[pairid,t] = lambda v[pairid,(t-1)] + e[pairid,t]

        Estimated results:
                             |       Var     sd = sqrt(Var)
                             -------------------------------
                   lTradeSimple |   5.500413       2.345296
                              e |    .1416629      .37638133
                              u |    .4959733      .70425372

        Tests:
           Random Effects, Two Sided:
           ALM(Var(u)=0)          =96791.30 Pr>chi2(1) =  0.0000

           Random Effects, One Sided:
           ALM(Var(u)=0)          =  311.11 Pr>N(0,1)  =  0.0000

           Serial Correlation:
           ALM(lambda=0)          =    3.66 Pr>chi2(1) =  0.0557

           Joint Test:
           LM(Var(u)=0,lambda=0) = 1.1e+05 Pr>chi2(2) =  0.0000
```

Groupwise heteroskedasticity

```
Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (1225)  =  1.3e+06
Prob>chi2 =      0.0000
```

Figure 1 – Residuals vs fitted values plot



TESTS FOR NORMALITY

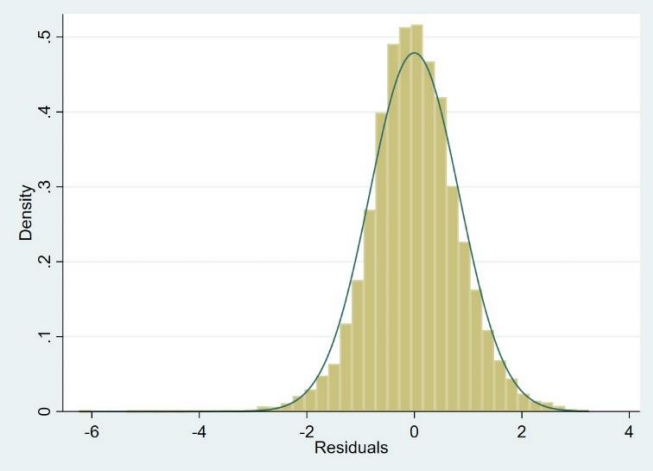
Normal data test developed by Shapiro-Wilk

Variable	Obs	W	V	z	Prob>z
residual	27,234	0.812	2167.108	21.060	0.000

Table 3 - tests for Normality shown by Kurtosis / Skewness

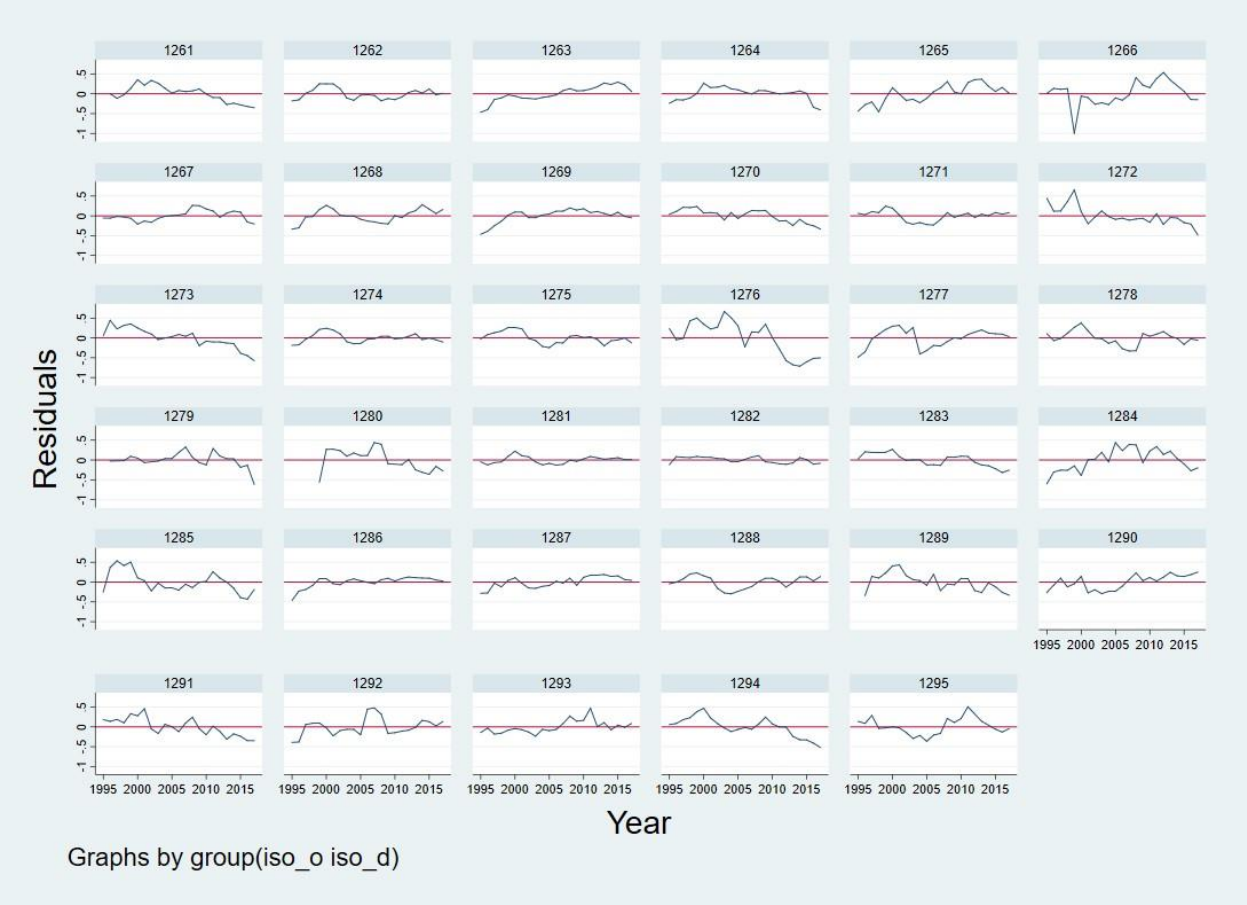
Variable	Obser	Pr(Skewness)	Pr(Kurtosis)	adj_chi2(2)	Prob>chi2
Log of aggr. exports	31,098	0	0	.	0
Exporter's GDP	31,079	0	0.001	69.08	0
Importer's GDP	31,078	0	0.001	70.25	0
Distance	31,098	0	0	.	.
Contiguity	31,098	0	0	.	.
Common lang.	31,098	0	0	.	.
Colony post-45	31,098	0	0	.	.
Common col.	31,098	0	0	.	.
Same country	31,098	0	0	.	.
RTA	31,098	0	.	.	.
EU	31,079	0	0	.	.
Common Cur.	31,098	0	0	.	.
FDI stock in.	31,098	0	0	.	.
FDI stock out.	31,098	0	0	.	.
Governmnt size	29,098	0	0	.	.
Market Open.	31,098	0	0	.	.
Econ. Glob.	29,802	0	0	.	.
Polit. Glob.	29,802	0	0	.	.
Rule of law	31,098	0	0	.	.
Internet & mobile	30,684	0	0	.	.
Air transport	31,098	0	0	.	.
Total Infrastructure Investment	31,079	0	0	.	.
Importer's MFN tariffs	30,523	0	0	.	.
Political Stability	31,098	0	0	.	.

Figure 2: Histogram of the residuals with overlay normal curve



AUTOCORRELATION

Figure 3: Autocorrelation of the residuals over the period 1995-2018 for United States of America (USA) with importing partner countries.



Regression of residuals on one period lagged residual with pair and time fixed effects and disturbances clustered by the pair of countries

	(1) uhat
l1.uhat	0.586***
	(0.0188)
_cons	-0.0172*
	(0.00680)
N	24853
Fixed effects	Country-time, Pair

Standard errors in parentheses, other covariates used in the main table are regressed but not displayed, to save space.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Wooldridge test on first order autocorrelation

```
. xtserial uhat if iso_o!=iso_d

Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,    1224) =    146.337
          Prob > F =      0.0000
```

Table 4: The Breusch-Godfrey test

	(1) uhat	
One period lagged residuals	0.570***	(0.0261)
Two period lagged residuals	0.0930***	(0.0212)
_cons	4.075***	(0.950)
Number of observations	23366	
R-squared	0.431	

Disturbances in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Other covariates employed in the main table are regressed but not displayed for conciseness

MULTICOLLINEARITY

TABLE 5 - VIF

Variance inflation factor

	VIF
Exporter's GDP	4.849
Rule of law	3.937
Distance	3.876
Political globalization	3.572
Economic globalization	3.425
Market openness	2.857
Political stability	2.537
FDI stock inward	2.535
EU	2.399
FDI stock outward	2.234
RTA	2.208
Fixed telephone subs.	2.208
Internet and mobile subs.	2.175
Air transport freight	2.057
Government size	2.045
Total infrastructure investment	1.701
Importer's GDP	1.666
Contiguity	1.615
Common currency	1.499
Importer's MFN tariffs	1.498
Same country	1.295
Common official language	1.289
Colony	1.205
Common colony	1.131
Mean VIF	**2.326**

TABLE 6 – CORRELATION MATRIX

	Log of aggr. exports	Exporter's GDP	Importer's GDP	Distance	Contiguity	Common language	Colony post-45	Common colonizer	Same country	RTA	EU	Common Cur.	FDI stock in.	FDI stock out.
Log of aggr. exports	1.00													
Exporter's GDP	0.53	1.00												
Importer's GDP	0.51	0.05	1.00											
Distance	-0.47	0.09	0.09	1.00										
Contiguity	0.43	0.03	0.03	-0.64	1.00									
Common language	0.35	0.10	0.10	-0.39	0.46	1.00								
Colony post-45	0.35	0.05	0.05	-0.53	0.50	0.57	1.00							
Common colonizer	0.33	-0.05	-0.05	-0.74	0.56	0.48	0.60	1.00						
Same country	0.32	-0.05	-0.06	-0.70	0.64	0.41	0.59	0.70	1.00					
RTA	0.20	-0.13	-0.14	-0.53	0.21	0.02	0.04	0.12	0.15	1.00				
EU	0.28	0.02	0.02	-0.37	0.14	-0.06	-0.02	0.01	0.07	0.44	1.00			
Common Cur.	0.33	0.05	0.04	-0.49	0.34	0.23	0.25	0.40	0.35	0.26	0.48	1.00		
FDI stock in.	0.57	0.40	0.41	-0.06	0.13	0.12	0.05	-0.10	-0.07	0.07	0.24	0.12	1.00	
FDI stock out.	0.58	0.51	0.31	-0.06	0.13	0.11	0.05	-0.10	-0.06	0.07	0.22	0.11	0.64	1.00
Rule of law	0.16	0.21	0.03	0.01	0.01	0.05	0.02	-0.01	-0.02	-0.03	0.04	0.04	0.18	0.24
Internet & mobile	0.23	0.22	0.17	-0.02	0.00	0.01	0.00	0.00	-0.01	0.15	0.22	0.15	0.28	0.29
Fixed telephone subs	0.19	0.26	-0.05	-0.04	0.02	0.07	0.03	-0.02	-0.03	-0.06	0.02	0.03	0.19	0.34
Air transport	0.21	0.54	-0.03	0.16	-0.01	0.12	0.03	-0.03	-0.06	-0.20	-0.15	0.01	0.14	0.19
Total infrast. Invest.	0.20	0.21	0.01	-0.12	0.07	-0.01	0.02	0.00	0.01	0.04	0.14	0.04	0.20	0.27
Importer's MFN tariff	-0.19	-0.11	-0.08	0.16	-0.05	0.00	-0.01	-0.01	-0.03	-0.18	-0.31	-0.19	-0.25	-0.17
Political Stability	0.10	-0.05	-0.02	-0.11	0.05	-0.02	-0.01	0.01	0.04	0.05	0.15	0.06	0.12	0.18

	Rule of law	Internet & mobile	Fixed telephone subs	Air transport	Total infrast. Invest	Importer's MFN tariff	Political Stability
Rule of law	1.00						
Internet & mobile	0.30	1.00					
Fixed telephone subs	0.24	0.14	1.00				
Air transport	0.08	-0.06	0.29	1.00			
Total infrast. Invest	0.18	0.24	0.35	-0.11	1.00		
Importer's MFN tariff	-0.15	-0.52	0.08	0.07	-0.05	1.00	
Political Stability	0.25	0.16	0.39	-0.16	0.48	0.04	1.00

Random effects vs Fixed effects

Lagrangian Multiplier test

```
Breusch and Pagan Lagrangian multiplier test for random effects

        lTradeSimple[pairid,t] = Xb + u[pairid] + e[pairid,t]

        Estimated results:
                             |       Var     sd = sqrt(Var)
                    ---------+------------------------------
                    lTradeS~e |   5.739679       2.395763
                            e |    .154554       .3931335
                            u |   .3379015       .5812929

        Test:   Var(u) = 0
                                 chibar2(01) =  1.3e+05
                              Prob > chibar2 =   0.0000
```

Sargan-Hansen - Test of overidentifying restrictions

By using the -xtoverid- command, which applies the approach of artificial regression demonstrated by Arellano (1993) and Wooldridge (2002, pp 290-91), in which a random effects model is re-estimated, supplemented with additional variables converted into deviations-from-mean form comprising the original regressors. Rejection means that, unlike the Hausman test, the fixed effect model is chosen, This test extends itself to heteroskedastic and clustered robust alternatives.

```
. xtoverid

Test of overidentifying restrictions: fixed vs random effects
Cross-section time-series model: xtreg re  robust cluster(pairid)
Sargan-Hansen statistic 2001.989  Chi-sq(41)  P-value = 0.0000
```

Likelihood-ratio test of no fixed-effects vs individual, and time fixed effects

```
Likelihood-ratio test                                 LR chi2(91) =  10178.21
(Assumption: m1 nested in m2)                         Prob > chi2 =    0.0000
```

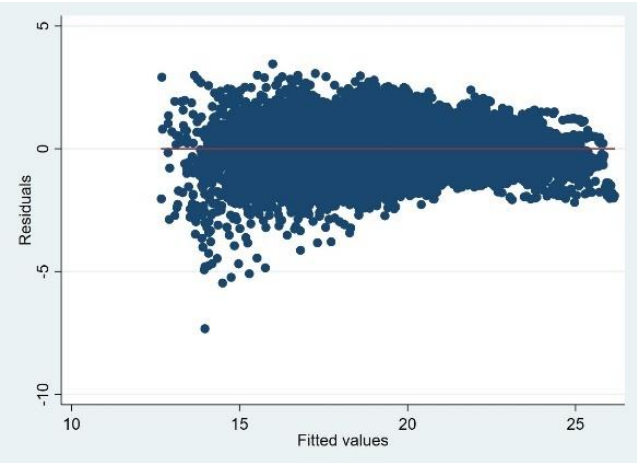
Likelihood-ratio test where m2 represents no fixed effects vs m3 with time and pair FE

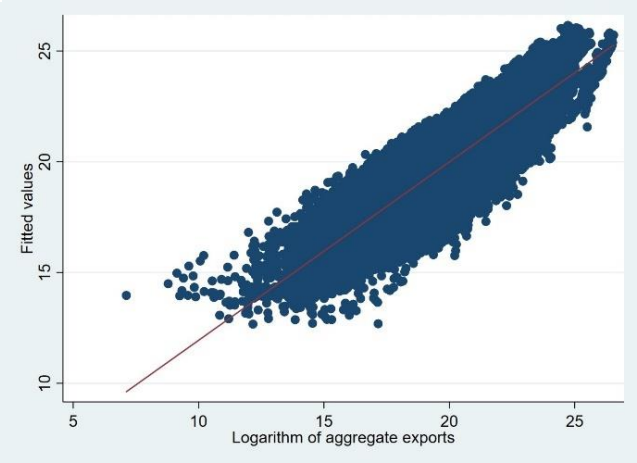
```
. lrtest  m2 m3

Likelihood-ratio test                                 LR chi2(1149)=  31956.75
(Assumption: m2 nested in m3)                         Prob > chi2 =    0.0000
```

C: RESIDUALS VS FITTED VALUES, FITTED VALUES VS THE DEPENDENT VARIABLE AND RESET TEST

MAIN TABLE:

Column 1

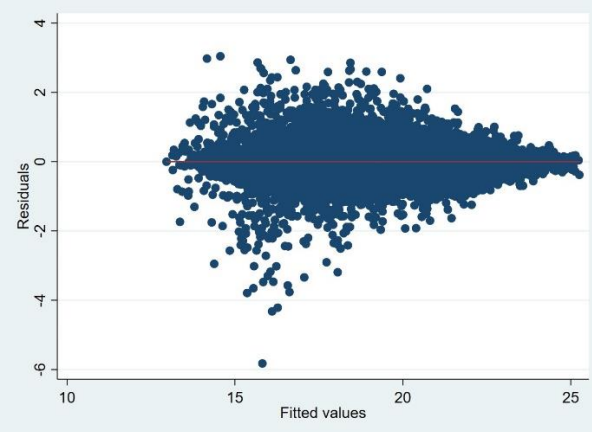


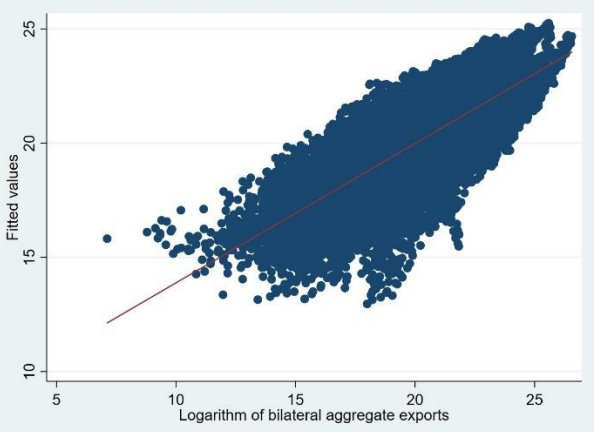


Reset test Column 1:

```
F(  1,  1224) =  138.86
      Prob > F =    0.0000
```

Column 2





Reset test Column 2:

```
F(  1,  1224) =    1.53
      Prob > F =    0.2163
```

D: RESULTS AND DISCUSSION

FIGURE 4: KERNEL DENSITY FOR THE MAIN TABLE

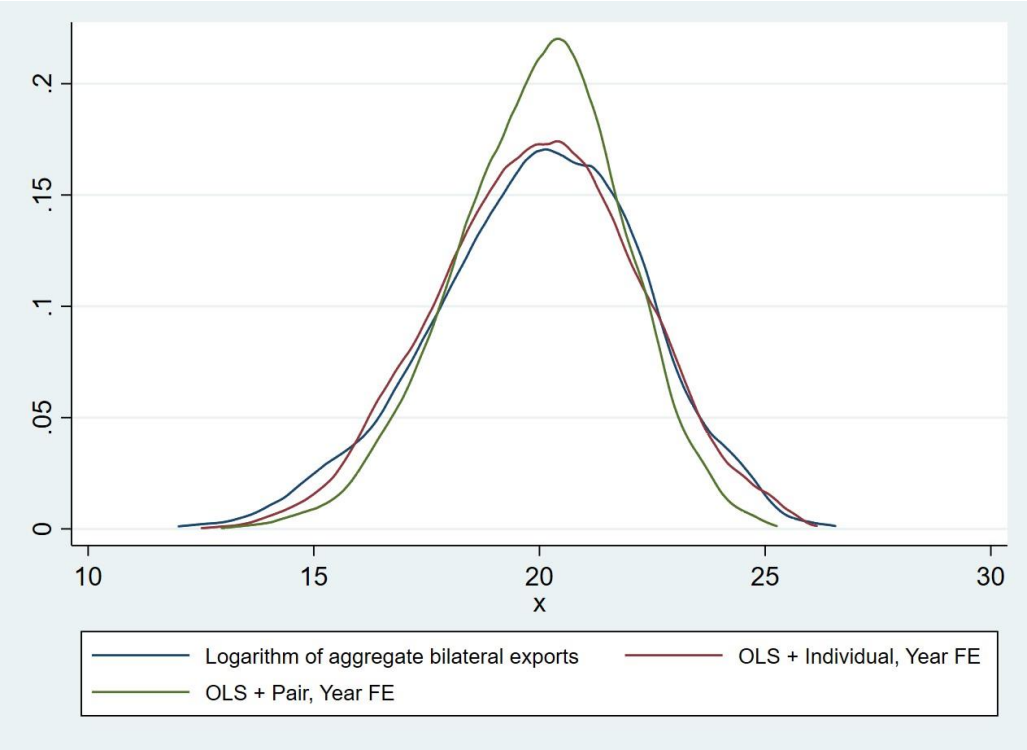


FIGURE 5: KERNEL DENSITY FOR THE ROBUSTNESS TABLE

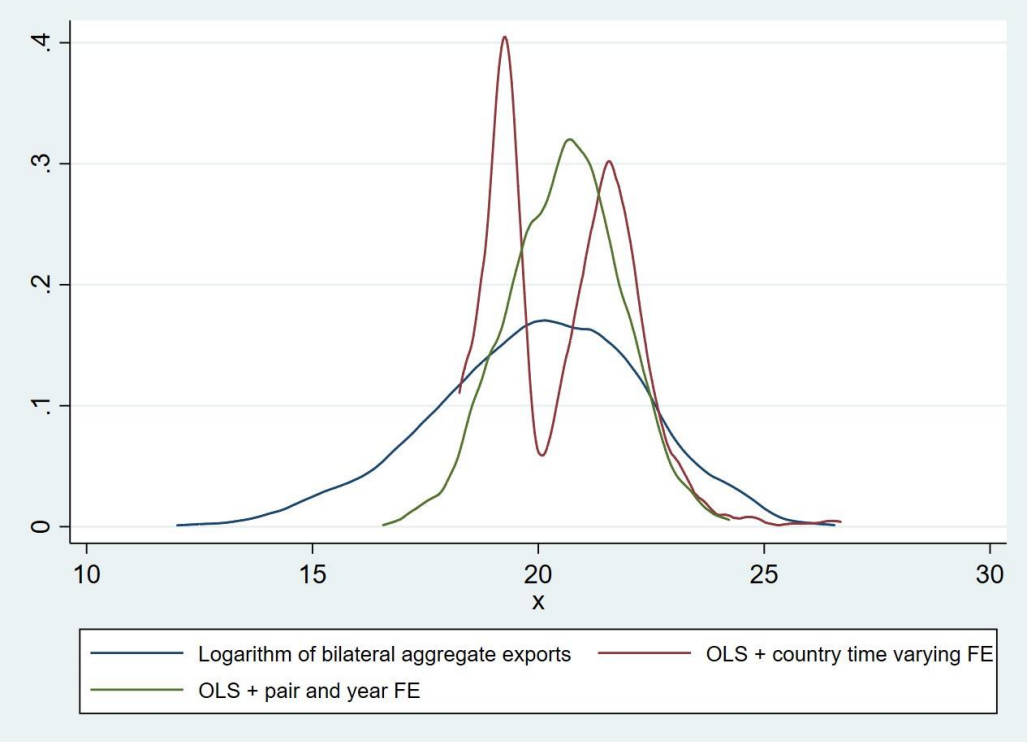


Table 7: Descriptive statistics for the robustness table

Variables	N	Mean	Standard Deviations	Minimum	Maximum	Skewness	Kurtosis
Investment freedom	31098	4.213	.527	0	4.554	-7.079	56.677
Trade freedom	31098	4.335	.522	0	4.5	-7.97	66.272
Financial freedom	31098	4.141	.542	0	4.5	-6.203	47.469
Economic globalization	29802	1.849	.078	1.531	1.963	-1.237	4.422
Political globalization	29802	1.928	.065	1.626	1.994	-1.622	5.612
Rule of law	31098	0	1	-7.347	.699	-5.531	40.62
Port infrastructure quality	16812	.693	.084	.418	.833	-.814	3.172
Road Infrastructure quality	16848	.684	.099	.281	.827	-1.031	3.946
Rail Infrastructure quality	12600	.621	.137	.146	.833	-.957	4.166
Air Infrastructure quality	16812	.729	.068	.502	.827	-1.106	3.649
Importer's tariffs (MFN)	30523	1.615	.331	.916	2.878	1.482	4.808
Fragile state index 1	15552	0	1	-3.113	2.307	-.195	3.589
Fragile state index 2	15552	0	1	-2.527	2.028	-.199	2.11
Innovation index	10332	1.698	.075	1.484	1.835	-.576	2.531

E: DIAGNOSTICS FOR ROBUSTNESS TABLE

HETEROSKEDASTICITY

Heteroskedasticity test by Cook-Weisberg / Breusch-Pagan of fitted values

Null Hypothesis: Variance that is constant
Variable: log of aggregate exports fitted values
Chi-square = 432.32
Prob > chi2 = 0.0000

Heteroskedasticity test by Cook-Weisberg / Breusch-Pagan of fitted values

Null Hypothesis: Variance that is constant
Variables: lEXP_gdp lIMP_gdp ldistw contig comlang_off colony comcol smctry rta eu comcur PCAGovSize lEXP_InvestFreedom lEXP_TradeFreedom lEXP_FinanFreedom EXP_EconGlobalization EXP_PoliticalGlobal PCARuleOfLaw lEXP_QualityofPortInfras lEXP_QualityofRoadInfras lEXP_QualityofRailInfras lEXP_QualityofAirInfras lIMP_TariffMFN EXP_FRAGILE1 EXP_FRAGILE2 lEXP_InnovationIndex
F(26 , 7960) = 39.01
Prob > F = 0.0000

Test developed by white, where the null hypothesis is Homoskedasticity

Alternative hypothesis: unrestricted heteroskedasticity
Chi-square (358) = 1990.10
Probability to have higher than Chi-square = 0.0000

Cameron & Trivedi's IM-test decomposition

Source	chi2	df	p
Heteroscedasticity	1990.100	358	0.000
Curve Skewness	143.680	26	0.000
Curve Kurtosis	26.090	1	0.000
The Total	2159.860	385	0.000

```
Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (1190)  =  1.7e+06
Prob>chi2 =      0.0000
```

Tests for the error component model:

Estimated results:

	Var	sd	=	sqrt(Var)
lTradeSimple	4.580		2.140	
e	0.053		0.231	
u	0.535		0.732	

Tests:

Random Effects, Two Sided:

ALM(Var(u)=0) =12512.27 Pr>chi2(1) = 0.0000

Random Effects, One Sided:

ALM(Var(u)=0) = 111.86 Pr>N(0,1) = 0.0000

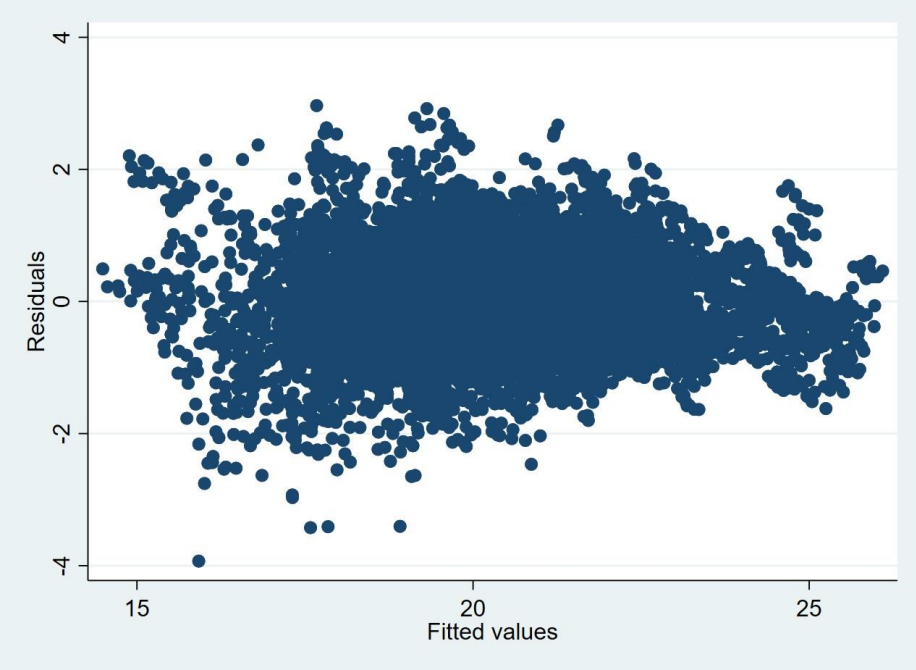
Serial Correlation:

ALM(lambda=0) = 7.94 Pr>chi2(1) = 0.0048

Joint Test:

LM(Var(u)=0,lambda=0) =18240.70 Pr>chi2(2) = 0.0000

Figure 6: Residuals plot



NORMALITY TESTS

Shapiro-Wilk W test for normal data

Shapiro-Francia W' test for normal data

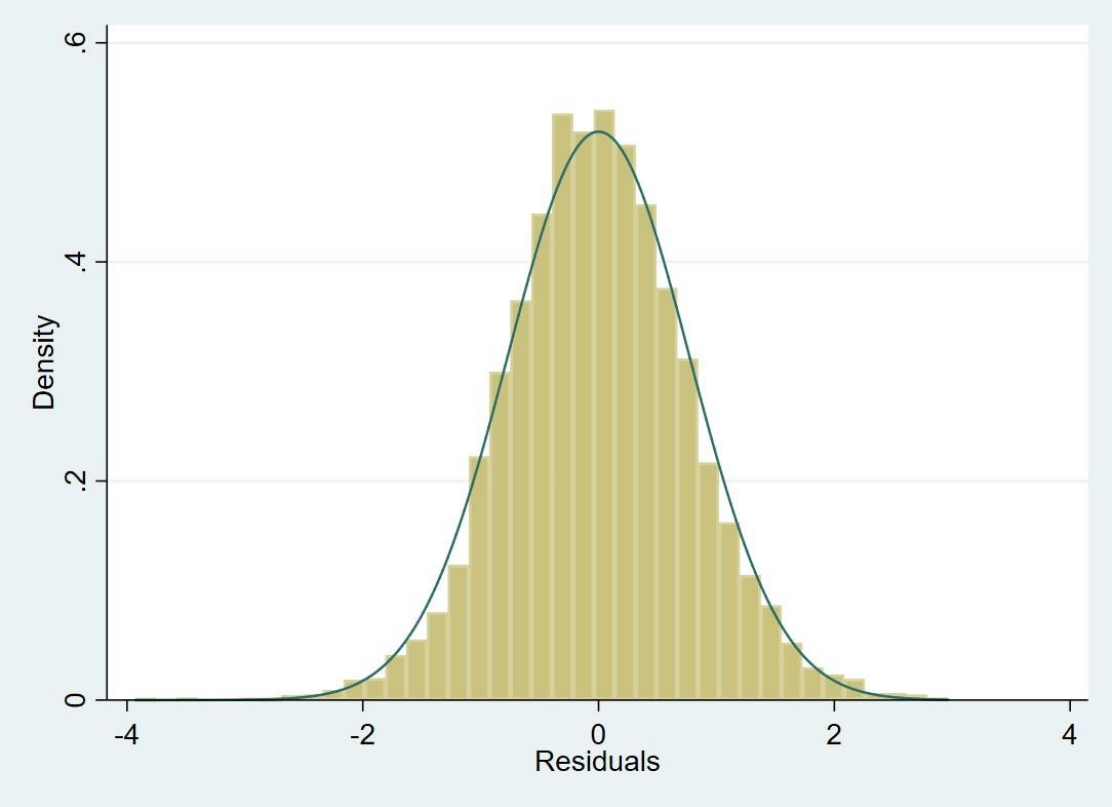
Variable	Obs	W'	V'	z	Prob>z
residual	7,987	0.997	14.496	6.968	0.000

Note: The normal approximation to the sampling distribution of W' is valid for 10<=n<=5000 under the log transformation.

Table 3 - tests for Normality shown by Kurtosis / Skewness

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
Log of aggregate exports	30,234	0	0	.	0
Exporter's GDP	30,234	0	0.0012	67.38	0
Importer's GDP	30,234	0	0.0014	68.34	0
Distance	30,234	0	0	.	.
Contiguity	30,234	0	0	.	.
Common lang.	30,234	0	0	.	.
Colonial link	30,234	0	0	.	.
Common col.	30,234	0	0	.	.
Same country	30,234	0	0	.	.
RTA	30,234	0	.	.	.
EU	30,234	0	0	.	.
Common Currency	30,234	0	0	.	.
Government size	28,309	0	0	.	.
Investment freedom	30,234	0	0	.	.
Trade freedom	30,234	0	0	.	.
Financial freedom	30,234	0	0	.	.
Economic globalization	28,974	0	0	.	.
Political globalization	28,974	0	0	.	.
Rule of law	30,234	0	0	.	.
Quality of port infrastructure	16,345	0	0	.	.
Quality of road infrastructure	16,380	0	0	.	.
Quality of rail infrastructure	12,250	0	0	.	.
Quality of air infrastructure	16,345	0	0	.	.
Importer's MFN tariffs	29,675	0	0	.	.
Fragile state index 1	15,120	0	0	.	0
Fragile state index 2	15,120	0	0	.	.
Innovation index	10,045	0	0	.	0

Figure 7: Histogram of the residuals with overlay normal curve



AUTOCORRELATION

Panel data: Autocorrelation test by Wooldridge

Null Hypothesis: No autocorrelation of the first order

F(1, 1218) = 81.499

Prob > F = 0.000

Test of Breusch Godfrey

Regression of the lagged residuals of first and second order on the residual indicates significant impact of the lagged residuals.

	(1)
	uhat
l1uhat	0.767***
	(0.029)
l2uhat	0.179***
	(0.028)
N	5512
R-squared	0.954
Standard errors in parentheses	
Note: only lagged residuals are displayed	

Chi square multiplier lagrange statistic calculation = 5512* 0.954=5258.44, the test rejects the null and we find that we do have significant autocorrelation.

```
Inoue and Solo (2006) LM-test on variables ue
Panelvar: pairid
Timevar: year
p (lags): 1
```

Variable	IS-stat	p-value	N	maxT	balance?
ue	269.11	0.000	1224	7	gaps

```
Notes: Under H0, LM ~ chi2(p*T-p(p+1)/2)
   H0: No auto-correlation of any order.
   Ha: Auto-correlation up to order 1.
```

MULTICOLLINEARITY TESTS

VIF

Table 9: Variance inflation factor for Robustness Table

	VIF
Rule of law	7.499
Exporter's innovation index	6.975
Exporter's economic globalization	6.167
Exporter's Fragile state index 2	5.428
Exporter's quality of railroad infrastructure	4.827
Exporter's GDP	4.823
Distance	4.141
Exporter's political globalization	3.947
Exporter's quality of road infrastructure	3.643
EU	3.38
Exporter's air transport infrastructure quality	2.998
Exporter's port infrastructure quality	2.977
Exporter's investment freedom	2.536
RTA	2.508
Exporter's Fragile state index 1	2.4
Exporter's Government size	2.282
Exporter's Trade freedom	2.146
Exporter's Financial freedom	1.992
Common Currency	1.695
Contiguity	1.628
Importer's MFN tariffs	1.416
Common official language	1.311
Same country in the past	1.305
Colonial link	1.216
Importer's GDP	1.158
Common colonizer post-1945	1.139
Mean VIF	**3.136**

Table 10: Correlation matrix for Robustness table

	Log of exports	Reporter GDP	Partner GDP	Bilat. Distance	Contiguity	Official language	Colonial relation	Shared Colonizer	Same country	RTA	EU	Common Cur.	Gov. size	Invest. Freed.
Log of exports	1.00													
Reporter GDP	0.47	1.00												
Partner GDP	0.54	-0.03	1.00											
Distance	-0.37	0.18	0.16	1.00										
Contiguity	0.34	0.02	0.04	-0.42	1.00									
Common lang.	0.20	0.12	0.14	0.02	0.24	1.00								
Colony	0.17	0.08	0.09	-0.05	0.20	0.36	1.00							
Common Col.	0.02	-0.14	-0.12	-0.15	0.18	-0.02	-0.01	1.00						
Same country	0.09	-0.09	-0.08	-0.26	0.40	0.02	0.16	-0.01	1.00					
RTA	0.10	-0.22	-0.21	-0.59	0.15	-0.07	-0.07	0.04	0.07	1.00				
EU	0.21	-0.21	-0.15	-0.71	0.20	-0.11	-0.02	0.09	0.16	0.44	1.00			
Common Cur.	0.11	-0.13	-0.08	-0.39	0.15	-0.04	-0.06	0.06	0.08	0.26	0.60	1.00		
Gov. size	-0.25	-0.20	0.01	0.24	-0.06	0.00	-0.02	0.08	0.01	-0.09	-0.25	-0.15	1.00	
Invest. Freed.	0.05	-0.18	0.00	-0.17	0.03	0.08	0.03	0.04	0.00	0.11	0.19	0.10	-0.20	1.00
Trade Freed.	0.07	-0.19	0.00	-0.31	0.08	0.04	0.00	0.03	0.05	0.03	0.25	0.13	-0.20	0.47
Finan. Freed.	0.06	0.04	0.00	0.02	-0.01	0.11	0.05	0.00	-0.01	-0.06	0.01	-0.09	-0.10	0.53
Econ. Glob.	0.11	-0.33	0.01	-0.40	0.09	0.00	-0.01	0.05	0.07	0.21	0.40	0.25	-0.40	0.57
Polit. Glob.	0.47	0.62	-0.02	-0.15	0.10	0.01	0.06	-0.13	0.01	0.05	0.11	0.07	-0.53	0.02
Rule of law	0.17	0.21	-0.01	0.00	0.01	0.12	0.04	-0.04	-0.04	-0.17	-0.02	-0.02	-0.41	0.46
Port quality	0.18	0.20	-0.01	-0.03	-0.02	0.05	0.03	0.01	-0.10	-0.08	0.08	0.09	-0.42	0.33
Road quality	0.29	0.42	-0.01	-0.01	0.03	0.08	0.04	-0.06	-0.03	-0.05	0.02	0.09	-0.41	0.21
Railroad qlty.	0.37	0.34	-0.01	-0.19	0.09	0.03	0.03	-0.01	0.01	-0.06	0.16	0.13	-0.34	0.22
Air trans. qlty.	0.26	0.44	-0.01	0.02	0.00	0.11	0.03	-0.07	-0.10	-0.09	-0.08	-0.04	-0.42	0.18
MFN tariffs	-0.06	0.00	0.07	0.22	-0.07	-0.03	-0.02	-0.03	-0.05	0.14	-0.29	-0.17	-0.01	0.03
Fragil. Index 1	0.01	0.23	-0.01	0.10	0.00	0.03	0.04	0.01	-0.03	0.01	-0.19	-0.11	0.21	-0.13
Fragil. Index 2	-0.28	-0.42	0.01	0.05	-0.07	-0.12	-0.05	0.06	0.02	0.17	0.03	0.02	0.50	-0.40
Innov. index	0.27	0.29	-0.01	-0.10	0.03	0.11	0.05	-0.04	-0.03	-0.11	0.03	0.00	-0.43	0.47

	Trade F.	Finan F.	Eco. Glo.	Pol. Glo.	Rule law	Port qlty	Road qlty	Rail qlty	Air qlty	MFN tarif	Frag. 1	Frag. 2	Inno. Ind.
Trade freed.	1.00												
Finan. freed.	0.19	1.00											
Econ. glob.	0.62	0.34	1.00										
Polit. glob.	0.13	0.17	0.13	1.00									
Rule of law	0.38	0.53	0.52	0.30	1.00								
Port quality	0.23	0.26	0.42	0.29	0.68	1.00							
Road quality	0.13	0.28	0.30	0.51	0.59	0.61	1.00						
Railroad qlty	0.29	0.29	0.53	0.47	0.54	0.54	0.71	1.00					
Air trans. qlty	0.14	0.23	0.26	0.41	0.64	0.70	0.62	0.53	1.00				
MFN tariffs	0.03	0.01	0.03	0.01	0.02	0.00	0.01	0.02	0.00	1.00			
Fragil. Index 1	-0.27	-0.18	-0.54	-0.09	-0.46	-0.40	-0.28	-0.37	-0.25	0.01	1.00		
Fragil. Index 2	-0.37	-0.44	-0.35	-0.51	-0.76	-0.49	-0.46	-0.51	-0.57	-0.05	0.10	1.00	
Innov. index	0.35	0.50	0.57	0.30	0.83	0.62	0.58	0.70	0.64	0.02	-0.38	-0.74	1.00

Random effects vs Fixed effects

Lagrangian multiplier test

```
Breusch and Pagan Lagrangian multiplier test for random effects

        lTradeSimple[pairid,t] = Xb + u[pairid] + e[pairid,t]

        Estimated results:
                         |       Var     sd = sqrt(Var)
                ---------+------------------------------
                lTradeS~e |     4.57996       2.140084
                        e |    .0528617       .2299167
                        u |    .3689784       .6074359

        Test:   Var(u) = 0
                                chibar2(01) = 17435.30
                            Prob > chibar2 =   0.0000
```

Sargan-Hansen – Overidentifying restrictions test

```
Test of overidentifying restrictions: fixed vs random effects
Cross-section time-series model: xtreg re  robust cluster(pairid)
Sargan-Hansen statistic 293.152  Chi-sq(20)    P-value = 0.0000
```

Likelihood-ratio test of no fixed-effects vs individual, and time fixed effects

```
. lrtest m1 m2

Likelihood-ratio test                                 LR chi2(74) =    3121.19
(Assumption: m1 nested in m2)                         Prob > chi2 =     0.0000
```

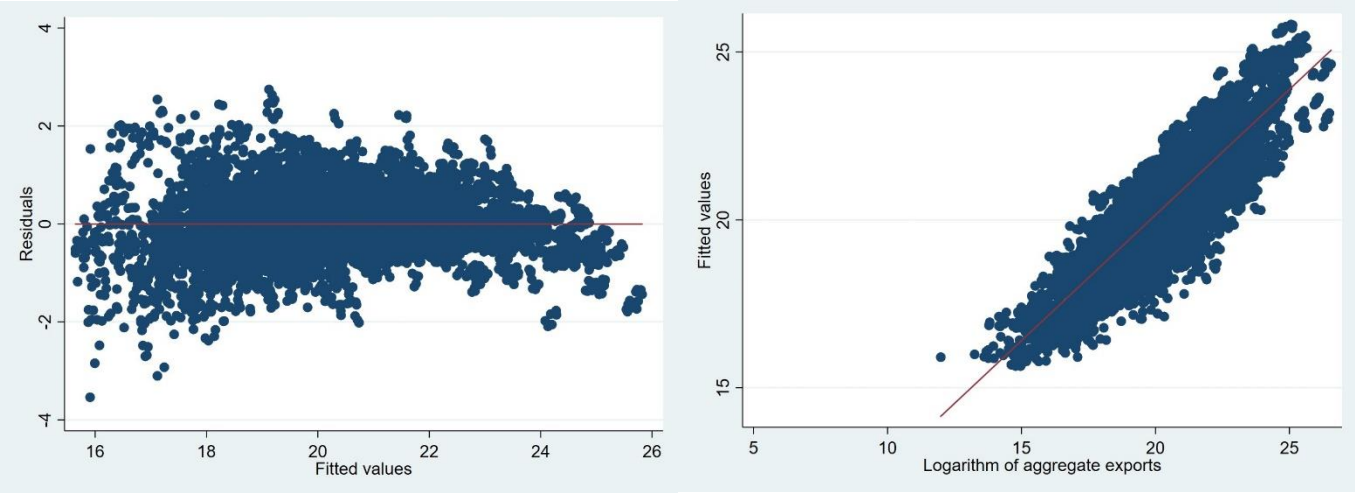
Likelihood-ratio test where m2 represents no fixed effects vs m3 with time and pair FE

```
Likelihood-ratio test                                 LR chi2(1188)=  20600.21
(Assumption: m1 nested in m3)                         Prob > chi2 =     0.0000
```

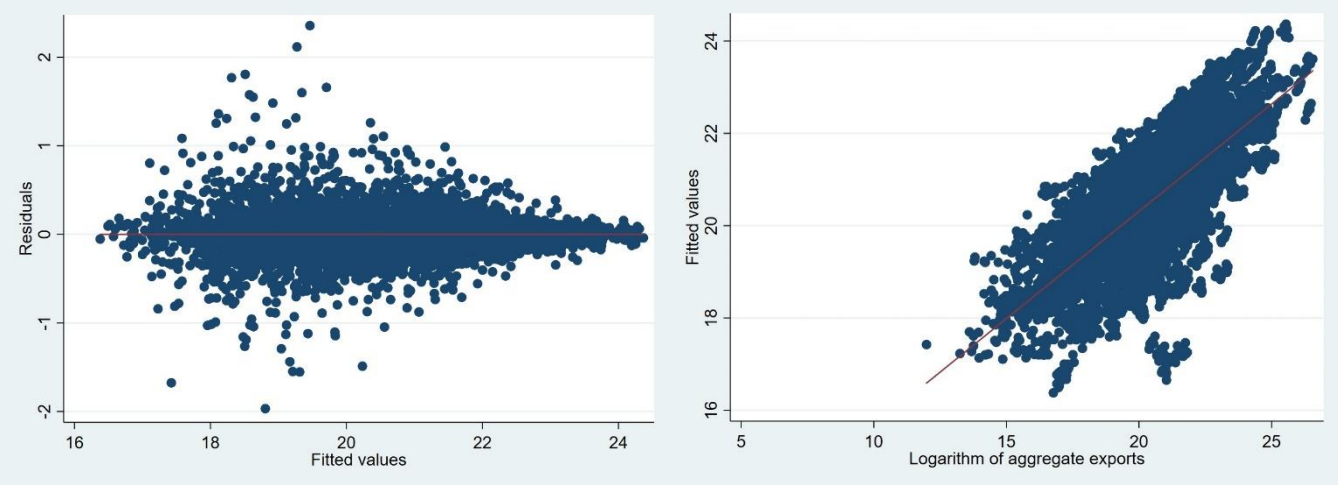
F: RESIDUALS VS FITTED VALUES

ROBUSTNESS TABLE

Column 1

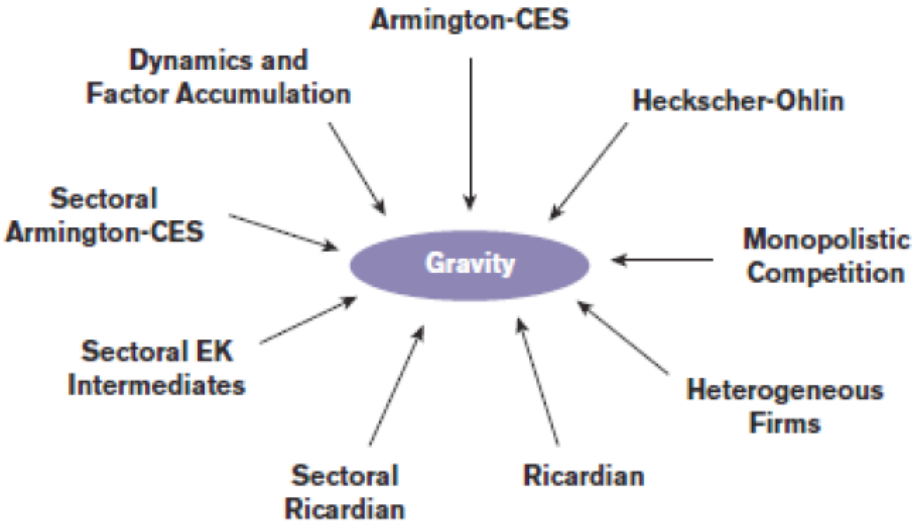


Column 2



G: THEORETICAL FOUNDATIONS OF GRAVITY MODEL

Figure 8



Source: adapted from Yotov et al. (2016: 12).

H: TRADITIONAL SPECIFICATIONS

<u>The econometric theory lays down three sufficient and necessary conditions for OLS</u>

1. The error ε_{ijt} must be uncorrelated with each of the independent variables and have mean equal to zero.
2. The disturbances ε_{ijt} ought to be drawn independently from a distribution that is normal with a given variance.
3. The explanatory variables must not be a linear combination of other independent variables

The basic gravity model of internation trade flows

Table 11:

	(1) Log of AVG Trade	(2) Average of Logs of trade	(3) Log of SUM of trade	(4) Sum of logs of trade
Exp_GDP	0.368***	0.316***	0.883***	5773.3***
	(0.003)	(0.002)	(0.003)	(26.049)
Imp_GDP	0.570***	0.323***	0.850***	3105.2***
	(0.003)	(0.002)	(0.003)	(26.038)
Distance	-0.377***	-0.359***	-1.001***	-6398.7***
	(0.004)	(0.003)	(0.005)	(42.274)
contiguity	0.638***	0.826***	0.360***	10663.8***
	(0.021)	(0.015)	(0.026)	(208.868)
Language	0.237***	0.208***	0.521***	4267.4***
	(0.019)	(0.013)	(0.023)	(186.691)
colony	-0.0268	-0.0617***	0.209***	2369.7***
	(0.025)	(0.018)	(0.031)	(252.015)
comcol	0.661***	0.196***	2.558***	10642.2***
	(0.063)	(0.045)	(0.077)	(629.865)
_cons	-8.641***	-3.554***	-17.84***	-167210.0***
	(0.098)	(0.070)	(0.120)	(971.547)
N	30234	30234	30234	30234
R-sq	0.723	0.733	0.857	0.767

In parentheses standard errors are displayed
* p-value<0.1, ** p-value <0.05, *** p-value<0.01

The regression with the logarithms of the average trade is shown in Column 1. Column 2 depicts the regression (the theoretically correct method) with the average of the logarithms. The regression of the aggregated bilateral trade flows is shown in Column 3. Column 4 is the regression with the aggregated logs of bilateral trade flows.

Theory suggests that GDP coefficients should be close to unity, we can test if that is the scenario for the average goods and services trade flow logs.

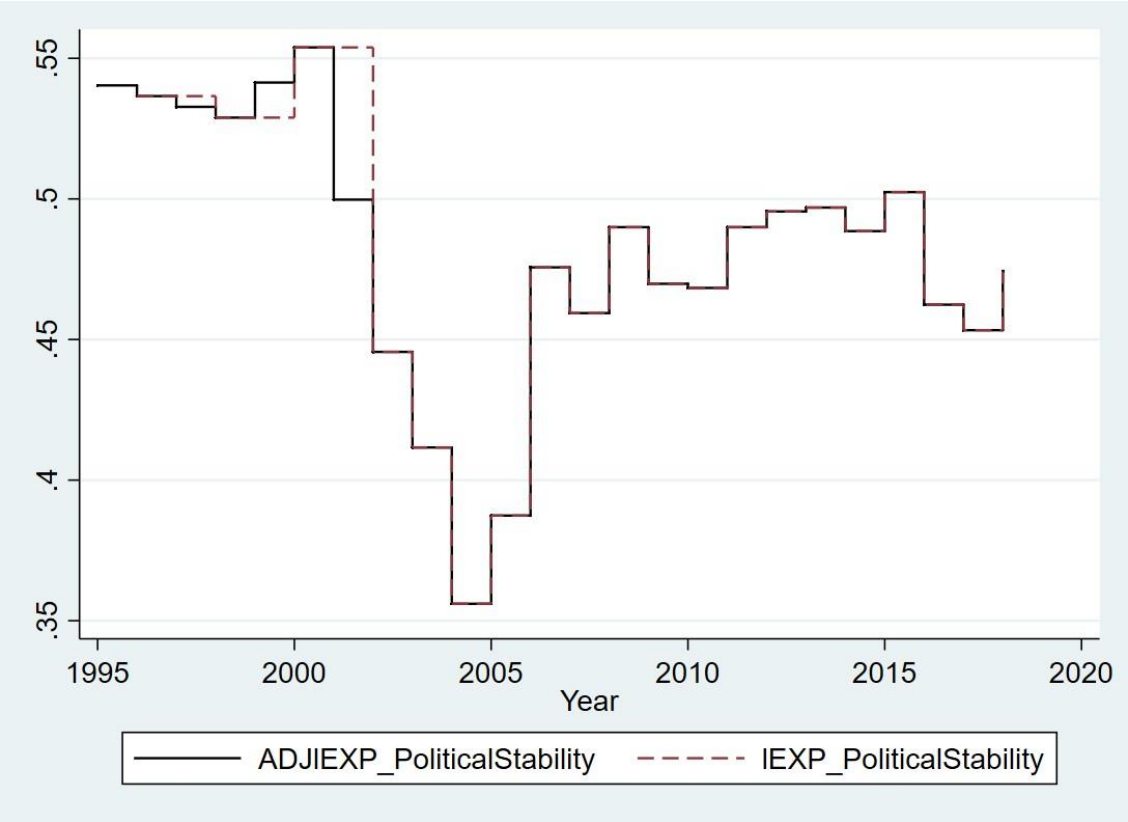
```
. test (lEXP_gdp = lIMP_gdp = 1)

 ( 1)  lEXP_gdp - lIMP_gdp = 0
 ( 2)  lEXP_gdp = 1

       F(  2, 30226) = 1.3e+05
            Prob > F =    0.0000
```

We can reject the null hypothesis that the coefficients of GDP are equal to one. We can also test whether traditional historical and cultural ties matter, i.e. contiguity, common language, colony or common colony, for trade in goods and services, using the same approach.

```
. test (contig = comlang_off = colony  = comcol = 0)

 ( 1)  contig - comlang_off = 0
 ( 2)  contig - colony = 0
 ( 3)  contig - comcol = 0
 ( 4)  contig = 0

       F(  4, 30226) = 1031.39
            Prob > F =    0.0000
```

Once more, we can reject the null hypothesis and infer that the fundamental determinants of trade in goods and services are historical and cultural links.

Figure 9: Interpolation of political stability for years 1997, 1999 and 2001



PRINCIPAL COMPONENT ANALYSIS FOR INSTITUTIONS, GLOBALIZATION AND INFRASTRUCTURE

Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Property rights	1.000										
(2) Freedom from Corr.	0.841	1.000									
(3) Tax burden	-0.342	-0.356	1.000								
(4) Gov. spending	-0.211	-0.314	0.639	1.000							
(5) Fiscal freedom	-0.349	-0.363	0.990	0.618	1.000						
(6) Trade freedom	0.250	0.331	0.046	-0.108	0.055	1.000					
(7) Investment freedom	0.360	0.266	-0.035	-0.102	-0.020	0.408	1.000				
(8) Financial freedom	0.396	0.367	-0.017	-0.042	0.013	0.223	0.422	1.000			
(9) Economic global.	0.442	0.500	-0.250	-0.363	-0.221	0.576	0.499	0.403	1.000		
(10) Political global.	0.351	0.347	-0.428	-0.327	-0.438	0.303	0.064	0.143	0.281	1.000	
(11) Social global.	0.563	0.674	-0.187	-0.316	-0.185	0.646	0.359	0.386	0.744	0.386	1.000

PCARuleOfLaw: This index incorporates the property rights index with freedom from corruption index

```
. factor $xlist, pcf  blanks(0.3)
(obs=31,098)

Factor analysis/correlation                    Number of obs    =     31,098
    Method: principal-component factors        Retained factors =          1
    Rotation: (unrotated)                      Number of params =          1
```

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	1.92848	1.85696	0.9642	0.9642
Factor2	0.07152	.	0.0358	1.0000

```
    LR test: independent vs. saturated:  chi2(1)  = 6.2e+04 Prob>chi2 = 0.0000

Factor loadings (pattern matrix) and unique variances
```

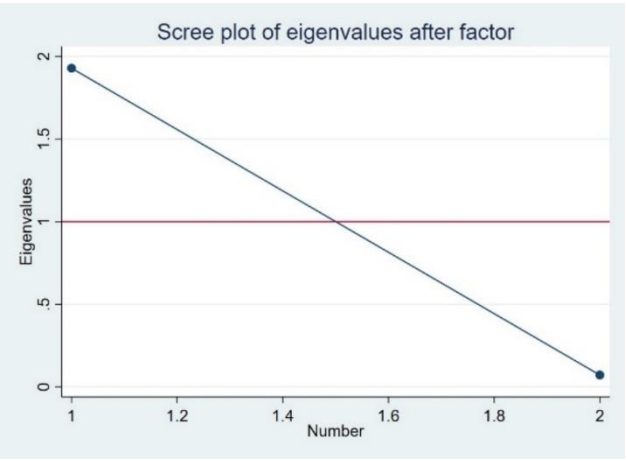
Variable	Factor1	Uniqueness
lEXP_Prope~s	0.9820	0.0358
lEXP_FreeF~p	0.9820	0.0358

```
    (blanks represent abs(loading)<.3)

Scoring coefficients (method = regression; based on varimax rotated factors)
```

Variable	Factor1
lEXP_Prope~s	0.50919
lEXP_FreeF~p	0.50919

```
 Raw residuals of correlations (observed-fitted)

. estat kmo

 Kaiser-Meyer-Olkin measure of sampling adequacy
```

Variable	kmo
lEXP_Prope~s	0.5000
lEXP_FreeF~p	0.5000
Overall	0.5000



PCAGovSize: Represents the government size index, composed of the tax burden, government spending and fiscal freedom indexes.

```
. factor $xlist2, pcf  blanks(0.3)
(obs=29,098)

Factor analysis/correlation                    Number of obs    =     29,098
    Method: principal-component factors        Retained factors =          1
    Rotation: (unrotated)                      Number of params =          3
```

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	1.94220	1.23619	0.6474	0.6474
Factor2	0.70601	0.35423	0.2353	0.8827
Factor3	0.35178	.	0.1173	1.0000

```
    LR test: independent vs. saturated:  chi2(3)  = 2.1e+04 Prob>chi2 = 0.0000

Factor loadings (pattern matrix) and unique variances
```

Variable	Factor1	Uniqueness
lEXP_Taxbu~n	0.8794	0.2267
lEXP_Govsp~g	0.8292	0.3124
lEXP_Fisca~m	0.6938	0.5187

```
    (blanks represent abs(loading)<.3)
. predict f1 f2 f3, regression

Scoring coefficients (method = regression; based on varimax rotated factors)
```

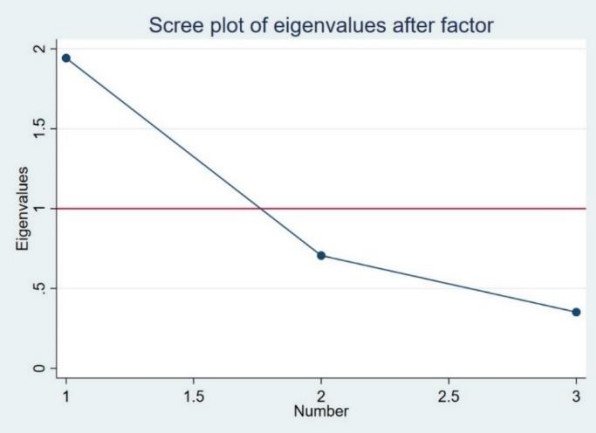
Variable	Factor1
lEXP_Taxbu~n	0.45276
lEXP_Govsp~g	0.42696
lEXP_Fisca~m	0.35721

```
Raw residuals of correlations (observed-fitted)
```

Variable	lEXP~en	lEXP_~g	lEXP_..
lEXP_Taxbu~n	0.0000		
lEXP_Govsp~g	-0.0963	0.0000	
lEXP_Fisca~m	-0.1723	-0.2513	0.0000

```
  Kaiser-Meyer-Olkin measure of sampling adequacy
```

Variable	kmo
lEXP_Taxbu~n	0.5770
lEXP_Govsp~g	0.5994
lEXP_Fisca~m	0.7377
Overall	0.6138



PCAMarketOpeness: stands for the market openness index composed of trade, financial and investment freedom.

```
. factor $xlist4, pcf  blanks(0.3)
(obs=31,098)

Factor analysis/correlation                    Number of obs    =     31,098
    Method: principal-component factors        Retained factors =          1
    Rotation: (unrotated)                      Number of params =          3
```

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	2.85494	2.75406	0.9516	0.9516
Factor2	0.10089	0.05672	0.0336	0.9853
Factor3	0.04417	.	0.0147	1.0000

LR test: independent vs. saturated: chi2(3) = 1.4e+05 Prob>chi2 = 0.0000

Factor loadings (pattern matrix) and unique variances

Variable	Factor1	Uniqueness
lEXP_Trade~m	0.9796	0.0403
lEXP_Finan~m	0.9655	0.0678
lEXP_Inves~m	0.9814	0.0369

(blanks represent abs(loading)<.3)

Scoring coefficients (method = regression; based on varimax rotated factors)

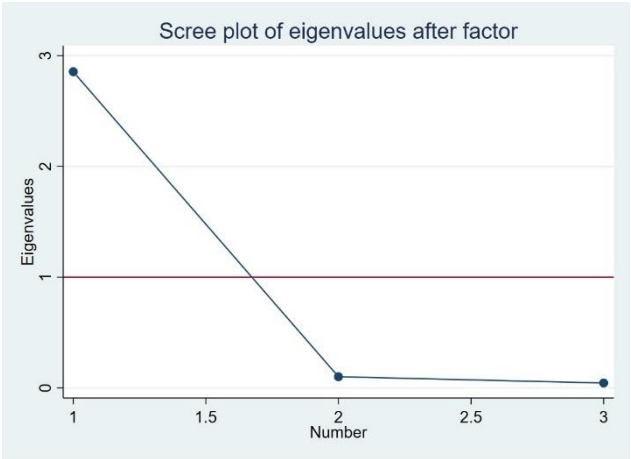
Variable	Factor1
lEXP_Trade~m	0.34314
lEXP_Finan~m	0.33818
lEXP_Inves~m	0.34374

Raw residuals of correlations (observed-fitted)

Variable	lEXP_..	lEXP_..	lEXP_..
lEXP_Trade~m	0.0000		
lEXP_Finan~m	-0.0351	0.0000	
lEXP_Inves~m	-0.0057	-0.0317	0.0000

Kaiser-Meyer-Olkin measure of sampling adequacy

Variable	kmo
lEXP_Trade~m	0.7351
lEXP_Finan~m	0.8789
lEXP_Inves~m	0.7213
Overall	0.7708



PCAGlobalization: Globalization index is composed of economic, political and social globalization indexes

```
. factor $xlist5, pcf  blanks(0.3)
(obs=29,802)

Factor analysis/correlation                    Number of obs    =     29,802
    Method: principal-component factors        Retained factors =          1
    Rotation: (unrotated)                      Number of params =          3
```

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	1.98142	1.22051	0.6605	0.6605
Factor2	0.76090	0.50322	0.2536	0.9141
Factor3	0.25768	.	0.0859	1.0000

LR test: independent vs. saturated: chi2(3) = 2.8e+04 Prob>chi2 = 0.0000

Factor loadings (pattern matrix) and unique variances

Variable	Factor1	Uniqueness
EXP_EconGl~n	0.8758	0.2330
EXP_Politi~l	0.6290	0.6043
EXP_Social~n	0.9048	0.1813

(blanks represent abs(loading)<.3)

Scoring coefficients (method = regression; based on varimax rotated factors)

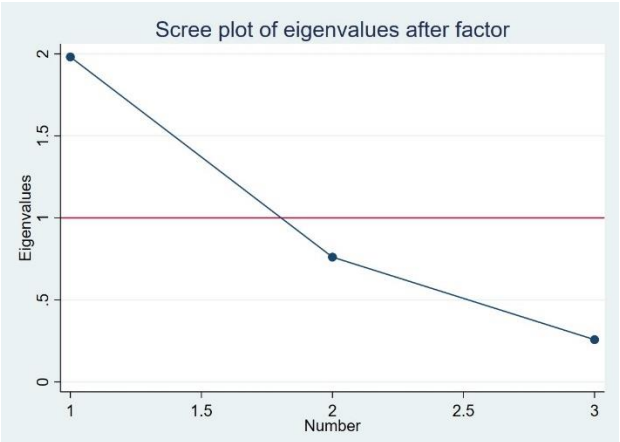
Variable	Factor1
EXP_EconGl~n	0.44201
EXP_Politi~l	0.31747
EXP_Social~n	0.45665

Raw residuals of correlations (observed-fitted)

Variable	EXP_E~n	EXP_P~l	EXP_S~n
EXP_EconGl~n	0.0000		
EXP_Politi~l	-0.2445	0.0000	
EXP_Social~n	-0.0555	-0.1835	0.0000

Kaiser-Meyer-Olkin measure of sampling adequacy

Variable	kmo
EXP_EconGl~n	0.5614
EXP_Politi~l	0.7939
EXP_Social~n	0.5535
Overall	0.5842



PCAInternetMobileSubs: Represents an index of internet and mobile subscriptions

```
. factor $xlist6, pcf  blanks(0.3)
(obs=30,684)

Factor analysis/correlation                    Number of obs    =     30,684
    Method: principal-component factors        Retained factors =         1
    Rotation: (unrotated)                      Number of params =         1
```

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	1.92758	1.85516	0.9638	0.9638
Factor2	0.07242	.	0.0362	1.0000

LR test: independent vs. saturated: chi2(1) = 6.0e+04 Prob>chi2 = 0.0000

Factor loadings (pattern matrix) and unique variances

Variable	Factor1	Uniqueness
lEXP_Inter~s	0.9817	0.0362
lEXP_Mobil~s	0.9817	0.0362

(blanks represent abs(loading)<.3)

Scoring coefficients (method = regression; based on varimax rotated factors)

Variable	Factor1
lEXP_Inter~s	0.50931
lEXP_Mobil~s	0.50931

```
. estat kmo
```

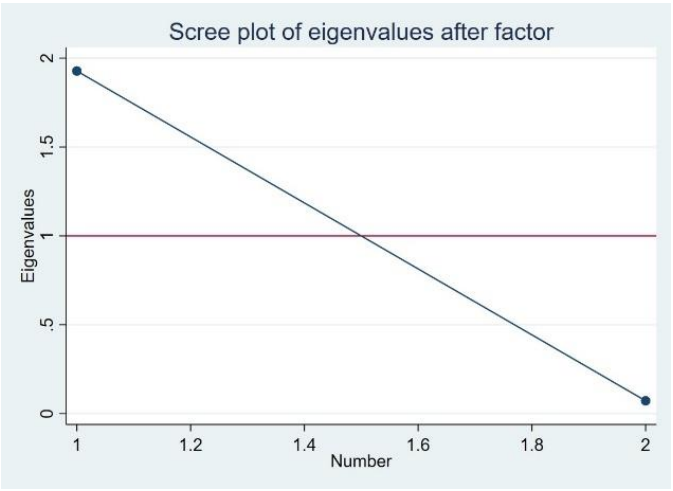
Kaiser-Meyer-Olkin measure of sampling adequacy

Variable	kmo
lEXP_Inter~s	0.5000
lEXP_Mobil~s	0.5000
Overall	0.5000

```
. estat residuals
```

Raw residuals of correlations (observed-fitted)

Variable	lEXP~rs	lEXP_..
lEXP_Inter~s	0.0000	
lEXP_Mobil~s	-0.0362	0.0000



PCA construction for Fragile State Index:

Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Security threats	1.000										
(2) Factionalized elites	0.750	1.000									
(3) Group grievance	0.680	0.700	1.000								
(4) Economic decline	0.507	0.509	0.355	1.000							
(5) Uneven econ. dev.	0.607	0.609	0.637	0.448	1.000						
(6) Brain drain	0.542	0.523	0.338	0.552	0.489	1.000					
(7) State legitimacy	0.698	0.788	0.570	0.641	0.744	0.726	1.000				
(8) Public services	0.738	0.672	0.513	0.658	0.751	0.712	0.835	1.000			
(9) Human rights	0.695	0.641	0.577	0.459	0.767	0.603	0.815	0.827	1.000		
(10)Demograp. pressure	0.622	0.538	0.552	0.336	0.705	0.542	0.657	0.755	0.781	1.000	
(11) Refugees	0.632	0.666	0.594	0.226	0.481	0.410	0.587	0.507	0.570	0.571	1.000

Factor correlation/analysis — Number of obser. = 15,552
Method: principal-component factors — Retained factors = 2
Rotation: (unrotated) — Number of params = 21

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	7.153	6.106	0.650	0.650
Factor2	1.047	0.313	0.095	0.745
Factor3	0.733	0.173	0.067	0.812
Factor4	0.561	0.225	0.051	0.863
Factor5	0.335	0.019	0.030	0.893
Factor6	0.316	0.039	0.029	0.922
Factor7	0.278	0.075	0.025	0.948
Factor8	0.203	0.021	0.018	0.966
Factor9	0.182	0.077	0.017	0.983
Factor10	0.105	0.018	0.010	0.992
Factor11	0.087	.	0.008	1.000

Factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Uniqueness
Security threats	0.847	-0.138	0.264
Factionalized elites	0.838	-0.168	0.270
Group grievance	0.734	-0.434	0.273
Economic decline	0.635	0.558	0.285
Uneven econ. dev	0.825	-0.047	0.317
Brain drain	0.726	0.418	0.298
State legitimacy	0.916	0.166	0.133
Public services	0.907	0.246	0.118
Human rights	0.884	0.004	0.219
Demograph. pressure	0.804	-0.113	0.340
Refugees	0.703	-0.471	0.284

Variable	kmo
EXP_Securi~t	0.9323
EXP_Factio~s	0.8919
EXP_GroupG~e	0.8713
EXP_Econom~e	0.8615
EXP_Uneven~v	0.9156
EXP_BrainD~n	0.9248
EXP_StateL~y	0.8795
EXP_Public~e	0.8909
EXP_HumanR~w	0.9247
EXP_DemogP~e	0.9165
EXP_Refugees	0.9247
Overall	0.9032