Trade Volume Effects of EU Membership: A Comparative Analysis of Gravity Estimators

by

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Abstract

This paper presents a comparative analysis of various gravity model specifications to estimate the effects of EU membership on trade volumes. In doing so, this paper expands on previous related literature by introducing theoretically-consistent models that have yet to be fully utilized in studying EU membership effects. Moreover, this paper comparatively analyzes differences in the effects presented by naïve and structural gravity models. Through the employment of a comprehensive dataset that includes trade flow data of all European country pairs from 1948 to 2006, this paper provides the following results. Using naïve and structural gravity models, my estimates of the gains to trade volumes when trading partners are both EU members range from an increase of 8.61 to 26.7-percent, and the losses to trade volumes when an EU member trades with a non-EU European country range from a 6.7-percent decrease to a 5.9-percent increase. More specifically, in the preferred specifications of the structural models, my estimates suggest the following. When trading partners are both EU members, trade flows increase by about 9-percent, and when an EU member trades with a non-EU European country, there are non-existent losses to trade volumes.

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I. Introduction

Over the last few decades, gravity models of trade have become the workhorse of applied international trade literature. The effect of free-trade agreements (FTAs) on trade flows has been studied since Tinbergen (1962) was published as the first econometric study on international trade flows using the gravity model of trade. Among the studies published on FTAs, the effect of FTAs on trade flows varies considerably in accordance with the data used and the econometric techniques employed. In addition, most FTAs vary on conditions regarding the trade of certain goods along with duties and tariff restrictions. Thus, it seems safe to say that there is no single FTA effect. For example, the effect of a major FTA such as the North American Free Trade Agreement (NAFTA) varies from no statistically significant effect on intra-NAFTA trade flows in Montenegro et al. (2006) to an increase of 118% in Caliendo and Parro (2015). Econometric methods as well as the comprehensiveness and availability of data are continually developed and enhanced by econometricians and data reporting agencies. As data and statistical methods improve, the employment and functionality of the gravity model of international trade flows has changed. With this in mind, this paper seeks to implement multiple econometric techniques that vary in complexity and theoretical consistency to study the effect of the European Union (EU) on trade flows within the EU and exports that leave the EU.

The EU is a politico-economic union of 28 member states that has developed into a single internal market that governs the movements of people, goods and services. Accordingly, as the EU is much more than just an FTA, it is more complex in its structure and policies than most FTAs. Evidently, studying the effect of the EU on trade flows is difficult, as members often practice different policies than other EU members. For example, only 19 out of the 28 EU members use the euro as their national currency. Differences such as these make it difficult to find a single effect of the EU on trade flows.

By using different proxies of EU membership and statistical methods of the gravity model, the results from previous studies on the effect of EU membership on intra-EU trade flows is mixed. Using a European Monetary Currency dummy as their proxy for EU membership, Serlenga and Sen (2007) estimate that when both European countries adopt the Euro as their national currency, trade between the countries increase by 8-percent. However, using an EU dummy variable to display EU membership, Lejour et al. (2009) provide evidence that joining the EU can increase intra-EU trade flows by up to 50-percent. Beyond these two papers, the variability of the estimates of the EU membership effect on trade flows is large and discussed in-depth later in this paper.

This paper seeks to study two important questions. First, what are the gains to intra-EU trade volumes due to EU membership? That is, upon joining the EU, by what proportion does trade between EU countries increase? Second, what are the losses to trade volumes with non-EU European countries due to EU membership? That is, upon joining the EU, by what proportion does trade between EU and non-EU European countries decrease? Thus, I seek to quantify the degree of trade creation and diversion due to the EU. In studying these two questions, this paper employs five econometric specifications of the gravity model of trade and conducts a comparative analysis of the results. The five different gravity models vary in complexity and theoretical consistency. Accordingly, the descriptions, issues and benefits of each of the models are discussed. Also, as gravity models of trade have advanced since Tinbergen (1962), this paper provides an analysis on the degrees of misspecification when employing the theoretically-inconsistent estimators, as oppose to modern and theoretically-grounded gravity estimators.

In studying the losses and gains to trade volumes upon signing the EU agreement, this paper proceeds in the following way. Section II presents a summary of the theory of the gravity model of trade. Section III provides a brief discussion of previous related literature. Section IV delivers a detailed description of the data employed. Section V describes the econometric techniques and models applied. Section VI presents the results of the summary statistics, econometric methods, and comparative analysis. Section VII provides an analysis on the limitations of the models and methods presented in this paper. Finally, Section VIII concludes the paper and presents direction for future research.

II. Gravity Model Theory

Starting with Tinbergen (1962), the gravity model has been used in hundreds of papers covering a variety of topics, time periods, and sectors. The gravity model links trade directly with economic size and inversely with trade costs. Often, proxies are used for economic size and trade costs, such as geographical distances and gross domestic product, respectively. The gravity model of trade captures deep regularities and findings in patterns of international trade. Accordingly, Leamer and Levinsohn (1995) argue that the gravity model has produced "some of the clearest and most robust findings in empirical economics" (Shepherd 2012, 11).

II.1 - Basis For The Gravity Model: Intuition and Theory

The gravity model was initially presented as an intuitive way of understanding trade flows. In its most basic form the gravity model can be written as follows:

(1) $$\ln x_{ij} = a_1 + a_2 lny_i + a_3 lny_j + a_4 lnd_{ij} + \varepsilon_{ij}$$

Where x_{ij} is exports from country i to j, y_i and y_j are GDP in countries i and j, and d_{ij} is the distance between countries i and j. The name "gravity" is derived from the fact that the nonlinear form of equation (1) resembles Newton's law of gravity: exports are directly proportional to the exporting and importing countries' economic "mass" (GDP), and inversely proportional to the distance between them. Similarly, gravity theory states that the larger the two countries are, the more they will trade, and the further apart two countries are, the less they will trade. As we will see later in this paper, GDP and distance are highly correlated, positively and negatively, respectively, with exports from country i to j. This specification is sometimes labeled as a naïve specification as it lacks theoretical grounding.

It is intuitive that bigger countries have more aggregate trade, and distant countries have less aggregate trade. However, it has been shown that this "intuitive" gravity model is problematic as evident from the theoretical microfoundations developed by Anderson and Van Wincoop (2003). Of the many potential issues with equation (1), an example is to consider the impact on trade between countries i and j due to a change in trade costs between countries i and k. For example, imagine that i and k enter an FTA. Standard economic theory suggests that this will impact the trade of country j, even though country j is not part of the trade agreement. Obviously, if country i trades with both j and k, then, when i enrolls in a trade agreement with k, i will trade more with k and less with j (Shepherd 2012, 13). Equation (1) does not account for this issue whatsoever.

Another issue with equation (1) is that it cannot account for decreases or increases in trade costs across all routes, including domestic trade (goods that a country sells internally). As an example, consider a fall in the price of oil, which will decrease transportation costs within and out of the country (Shepherd 2012, 13). Through equation (1), this move would result in proportional increases in trade across all bilateral routes, including internal trade. However, this result is counter-intuitive because despite the change in trade costs, relative prices should not have changed at all. Therefore, according to economic theory, in the absence of changes to relative prices, consumption patterns should remain constant for a given amount of production (GDP). Again, the basic gravity model provides results that are not consistent with economic theory.

Anderson (1979) provides a discussion of a theoretical grounding for the gravity model. Anderson (1979) provides that "after controlling for size, trade between two regions is decreasing in their bilateral trade barrier relative to the average barrier of the two regions to trade with all their partners" (Anderson and Van Wincoop 2003, 170). Intuitively, the more resistant to trade with all others a region is, the more it is pushed to trade with a given bilateral partner.

It was not until Anderson and Van Wincoop (2003) that empirical economists have focused on theoretically consistent gravity models. In their paper, Anderson and Van Wincoop provide a detailed derivation, intuition and application of the theoretically grounded gravity model. They argue that there are two important issues that arise due to a lack of theoretical foundation of empirical gravity equations. The first issue is that estimation results are biased due to omitted variables. The second issue is that "one cannot conduct comparative statics exercises, even though this is generally the purpose of estimating gravity equations" (Anderson and Van Wincoop 2003, 170). To complete a comparative statics exercise, such as asking what the effects are of removing or adding certain trade barriers or reliefs, one has to be able to solve the general-equilibrium model before and after the removal or addition of trade barriers and reliefs.

Simply put, the gravity model developed in Anderson and Van Wincoop (2003) is a demand function. The final form of the model is based largely on the constant elasticity of substitution utility function for consumer preferences (Shepherd 2012, 13). In this model, consumers prefer a variety of options. Therefore, utility increases from both consuming more of a particular variety, or from consuming a range of varieties.

The production side of the model follows standard assumptions that follow Krugman (1979). "Each firm produces a single, unique product variety under increasing returns to scale. By assuming a large number of firms, competitive interactions disappear and firms engage in constant markup pricing: in equilibrium, the difference between price and marginal cost is just enough to cover the fixed cost of market entry" (Shepherd 2012, 13).

Producers are able to sell goods both within the country where the goods are produced, and to other countries overseas. The model is simplified by involving no transportation costs to sell goods within the country, where the goods are produced. However, when goods are sold internationally, transportation costs are incurred. Accordingly, consumers can consume products from all countries, however, prices of non-domestically produced varieties are corrected upward to account for the cost of moving goods between countries (Shepherd 2012, 13).

Through the use of the key assumptions stated above, Anderson and Van Wincoop (2003) derive an equilibrium in which "firms both produce for the local market and engage in international trade", and accordingly, in which consumers consume from both markets (Shepherd 2012, 14). The model provides functions for the volume of exports by each firm that are then aggregated across firms within a country. This then makes it "possible to derive an expression for the total value of a country's exports, which is the dependent variable in the gravity model." (Shepherd 2012, 14)

Imposing macroeconomic identities leads to a theoretically consistent gravity model from the foundations stated above. The macroeconomic identities follow from "the fact that in a single sector economy, such as the one modeled in Anderson and Van Wincoop (2003), where there are no input-output relationships, the sum of all production must be equal to GDP" (Shepherd 2012, 14). Accordingly, the theoretically grounded gravity model derived in Anderson and Van Wincoop (2003) is provided and described below.

(2) $$\log X_{ij}^k = \log Y_i^k + \log E_j^k - \log Y^k + (1-\sigma_k)[\log \tau_{ij}^k - \pi_i^k - \log P_j^k]$$

(3) $$\pi_i^k = \sum_{j=1}^{C} \{\frac{\tau_{ij}^k}{P_j^k}\}^{1-\sigma_k} \frac{E_j^k}{Y^k}$$

(4) $$P_j^k = \sum_{i=1}^{C} \{\frac{\tau_{ij}^k}{\pi_i^k}\}^{1-\sigma_k} \frac{Y_i^k}{Y^k}$$

From the above equations, the variables represent the following. X is exports indexed over countries i and j, and sectors k. Y is GDP indexed by country i and sector k. E is expenditure indexed by country j and sector k. $Y^k = \sum_{i=1}^{C} Y_i^k$, or, equivalently equal to world GDP. σ_k is the intra-sectoral elasticity of substitution between varieties, and τ_{ij}^k represents trade costs.

The main additional components of the gravity model developed by Anderson and Van Wincoop (2003) is the inclusion of multilateral resistance terms that are represented by π_i^k and P_j^k. The first variable is the outward multilateral resistance term, which captures the “fact that exports from country i to country j depend on trade costs across all possible export markets” (Shepherd 2012, 14). The second variable is the inward multilateral resistance term that captures the fact that imports into country i from country j depend on trade costs from all possible suppliers. Apart from the unitary sectoral elasticites, the multilateral resistance terms are the only additional variables from the naïve gravity model. However, these two variables are crucial as they resolve the issues with McCallum (1995) and non-theoretically grounded gravity models as a whole. It is evident that the multilateral resistance terms include trade costs across all bilateral trading routes, therefore, $\frac{\partial log x_{ij}}{\partial \tau_{ik}} \neq 0$. Accordingly, this model allows for changes in trade costs on one bilateral route to affect the trade flows on all other trading routes due to relative price effects. Given that the naïve specification provided in McCallum (1995) did not include these two multilateral resistance terms, even though they are correlated with trade costs, it leads to an omitted variable bias.

The gravity equation provides that bilateral trade, after controlling for size, depends on the bilateral trade barrier between i and j, relative to the product of their multilateral resistance indices. Therefore, the key implication of the theoretically grounded gravity equation is that trade between regions is determined by relative trade barriers. In other words, “trade between two regions depends on the bilateral barrier between them relative to average trade barriers that both regions face with all their trading partners” (Anderson and Van Wincoop 2003, 173).

Beyond correcting for omitted variable bias and providing a theoretically consistent model, the model derived by Anderson and Van Wincoop (2003) provides key implications on the set-up of the model and the types of data that should be used for gravity model estimation.

III. Related European Union Gravity Literature

Serlenga and Sen (2007) develop and apply a Hausman-Taylor estimation methodology to analyze the gravity equation of bilateral trade flows among the EU-15 countries for the years 1960 to 2001. In their paper, Serlenga and Sen study the intra-EU effect through the European Monetary Union (EMU), that is, whether both trading partners adopt the euro as their national currency. In doing so, they compare the EMU effect through two of the following methodologies. First, they use a two-way fixed effects methodology, that is, time-varying importer and exporter fixed effects. Second, they employ a Hausman-Taylor estimation in heterogeneous panels with time-specific common factors. Serlenga and Sen (2007) find that the two-way fixed effects methodology provides, that when both European countries adopt the Euro as their national currency, trade between the countries increase by 8-percent. However, through the Hausman-Taylor methodology, the authors find that there is no statistically significant EMU effect. Serlenga and Sen (2007) argue that the time period of EMU creation is too small to find a statistically significant effect. The Euro was created in 1999, and Serlenga and Sen (2007) study the period 1960 to 2001, which only leaves two years worth of observations to extrapolate an EMU effect. Accordingly, they argue that a re-examination of the EMU effect is required once the data over longer periods are available. Also, they argue that the insignificantly estimated impact of the EMU dummy is due to the shortage of observations in the utilized data set.

Lejour et al. (2009) study the effect of EU membership on economic growth, with a focus on the productivity gains of integrating national markets into the European internal market. Lejour et al. (2009) employ the following two-step procedure. First, they estimate the gravity equation to study the contributions to trade volumes EU membership provides among member states. Second, the effects of trade and better institutions are estimated to provide their effects on economic growth. Lejour et al. (2009) employ a dataset that spans from 1996 to 2000 and consists of 160 countries. The authors conduct an OLS regression that follows from a naïve gravity model that includes continuous variables such as GDP and GDP per capita, as well as discrete variables such as EU membership, common official language, common border, and distance. Lejour et al. (2009) include year fixed effects, but fail to include time-varying importer and export fixed effects (two-way fixed effects). Therefore, estimation results regarding the variable of interest, EU membership, likely suffer from severe bias. Nevertheless, Lejour et al. (2009) provide that joining the EU can increase trade flows from 27 to 50-percent. However, as mentioned earlier, given the lack of a theoretical foundation within the gravity model estimated in Lejour et al. (2009), the above results may be invalid. Appropriate inclusion of multilateral resistance terms is likely required to correctly study the EU membership effect.

Lapinska and Pietrzak (2015) study the gains to trade volumes due to EU membership for EU-15 and EU-12 countries. More specifically, Lapinska and Pietrzak (2015) focus on answering the question of whether enlarging the European Union has contributed to a significant increase in exports per capita from the new member states (EU-12) to the old member states (EU-15) and vice versa. In their paper, Lapinska and Pietrzak (2015) employ a dataset that spans from 1999 to 2010 and includes 27 countries that were EU members in 2010. The authors apply a Hausman-Taylor estimator with individual and time fixed effects to estimate the EU-12 and EU-15 dummy variables. In doing so, Lapinska and Pietrzak (2015) find that EU accession was followed by a significant increase in the level of exports of both the EU-12 and EU-15 countries. The results provide that trade volumes for EU-15 members increased by 98-percent due to accession, while trade volumes for EU-12 increased only by 12-percent. Interpretations of the regression output are not directly provided in Lapinska and Pietrzak (2015). In addition, a detailed guide and summary of the data used in this paper is not provided. Consequently, the validity in addition to the interpretation of the results of Lapinska and Pietrzak (2015) are uncertain.

Nardis and Vicarelli (2003) study the impact of the euro on trade by utilizing a country-pair fixed effects gravity model. In their paper, they employ a dataset that spans from 1980 to 2000 and includes the 11 Eurozone countries as well as 19 other countries. As Nardis and Vicarelli (2003) was introduced at around the same time Anderson and Van Wincoop (2003) was published, there are issues with the theoretical grounding in the gravity model used in Nardis and Vicarelli (2003). An issue with using country-pair fixed effects is that the errors may be correlated across country pairs, that is, the country-pair observations are not independent. This paper also suffers from a lack of observations, due to a relatively short dataset. The euro was introduced in 1999, while the dataset ends in 2000, this leaves only one year of observations in order to extrapolate a euro effect. Moving forward, Nardis and Vicarelli (2003) find that although the "early" euro effect is economically small, it is positive and significant. Nardis and Vicarelli (2003) provide that, other things being equal, the euro increases intra-EU (Eurozone members) trade by 2.6 to 6.3-percent.

Papazoglou et al. (2006) study the impact EU membership has on trade flows for the EU-15 and compute forecasts on the effect EU membership will have on trade flows for ten prospective EU members. The ten new EU countries consist of Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. In doing so, Papazoglou et al. (2006) estimate a gravity model to capture trade patterns of the EU-15 countries and their principal trading patterns. Subsequently, they use the model to forecast trade patterns of each of the ten new EU countries in two scenarios, accession and non-accession. The methodology assumes that by becoming member states of the EU, the ten new countries will have the same trading intensity with the rest of the world trade as well as intra-EU trade. The dataset spans from 1992 to 2003, and the authors forecast values of EU members' trade flows with EU and non-EU countries until 2006. Papazoglou et al. (2006) employ two econometric techniques to estimate the gravity equation. In specification A, they use a Random Effects GLS with Common AR(1). In specification B, they use Prais-Winsten with Panel-corrected Standard Errors and Country-specific AR(1). The results of Papazoglou et al. (2006) provide that the average rise in exports to the EU-15 is just over 12-percent, but the individual effects vary drastically. At large, proportional export growth is greater where the accession economy is initially less integrated with the EU countries. Furthermore, Papazoglou et al. (2006) predict that the new EU countries experience higher imports than exports with EU countries. In addition, Papazoglou et al. (2006) forecast that the new EU countries exhibit decreases of exports with North America and the Far East of 2.57 to 2.87-percent, post EU accession. Papazoglou et al. (2006) conclude that the effect of broadening EU membership is not only to generate additional trade flows, but also to lead to some redirection of trade flows.

IV. Data Description

The dataset used in this paper is titled “Gravity Dataset” and is gathered from CEPII, a French research center in international economics. CEPII provides a “square” gravity panel dataset for all world pairs of countries for the period 1948 to 2006. The term, world pairs of countries, should be understood as, the dataset provides annual data for each country’s geographic and economic relationship with every single other country, for each year during the specified time frame. The gravity dataset functions as a combination of multiple datasets to allow for estimation of a gravity model using international trade flows as a function of GDP, population and trade costs.

The dataset used in this paper was originally formed for the analysis of Head et al. (2010). However, although the data follows from that of the appendix in Head et al. (2010), the dataset employed in this paper is lighter in the sense that it is restricted to observations where trade flows are non-missing. In addition, although the dataset includes all world pairs of countries, for the purpose of this paper I omit all countries outside of Europe. This provides a dataset that consists of 48,733 observations.

The dataset provides trade costs data, which is essential to gravity estimation. The trade costs data is from Geodist, the CEPII distance dataset. Distance is measured in kilometers using the population-weighted distance, that is, the distance between the most populated cities of the two countries. In addition to distance, the Geodist dataset includes trade cost variables that are included in this paper such as whether the two countries share an official language, share a border, share colonial linkages or are in a state of war. The above four variables are intuitive as to why they would be in included as control variables in the model estimation. If two countries speak the same language one would expect higher trade flows, as language barriers to trade would be minimal. One might also expect two countries sharing a border to contribute to trade flows, as it entails that the two countries are geographically close and potentially have close political ties. Moreover, two countries sharing a colonial history may provide that the two countries remain politically close and function as a means to ease of trade. Finally, whether two countries are in a state of war or conflict is likely a strong indicator of trade flows, as countries exhibiting conflict or war are prone to have low aggregate trade flows.

Trade flow data is represented as exports between country pairs measured in millions of non-deflated US dollars. Trade flow data is restricted to a minimum of $10,000 worth of exports to ensure the omission of potential zero valued observations. Gross domestic product data is provided and measured in millions of non-deflated US dollars. In addition, population data is provided and measured in millions of people. Furthermore, data on common currencies are included as they are likely indicators of trade between countries. The importance of common currency data is that only 19 out of the 28 countries in the EU use the euro, so that including common currency data may provide further information on trade flow for countries outside of the EU as well as countries within the EU.

The key variable of interest is the intra-EU interaction variable. This variable consists of an interaction variable for whether the home country is an EU member and whether the partner country is an EU member. In addition, there is an interaction variable labelled EUtoROE that includes a dummy indicating if the home country is an EU member and a dummy indicating if the partner country is a non-EU member. Obviously, these interaction variables will be dependent on time to ensure that an EU member is only recognized as an EU member once they had signed the EU membership agreement. This will provide information on the gains to trade volumes to EU members due solely to EU membership, as we will see the differences in trade before and after they become EU members. Furthermore, the EU interaction variables will also be interacted with time, to study how changes in the EU impact trade flows throughout time. Through the use of the three interaction variables, the data allows for study on the gains to trade due to EU membership, the loss of trade volumes due to trade between EU and non-EU members, and how changes to EU agreements including the addition of new members impact trade flows throughout time.

To generate the two variables of interest, intra-EU and EUtoROE, data is created for each home and partner country at every time period. Accordingly, there are two dummy variables that are generated. First, a dummy variable for the home country that takes the value of one if the home country is an EU member at time t, and zero otherwise. Second, a dummy variable for the partner country that takes the value of one if the partner country is an EU member at time t, and zero otherwise. Therefore, as mentioned above, the intra-EU interaction variable takes the value of one if both countries are EU members, and zero otherwise. Whereas, the EUtoROE interaction variables takes the value of one if the home country is an EU member and the partner country is a non-EU member, and zero otherwise.

The structure of the EU is quite complex given the range of agreements within the EU that some members abide by and others do not. For example, known as the Eurozone, only 19 out of the 28 EU member states use the euro as their official currency. In addition, there are treaties within the EU that affect the trading relationship between EU members differently. The complexities within the structure of the EU make it difficult to correctly model EU dummy variables that account for both, currencies and conditions. Therefore, for the purpose of this paper, the EU dummy variables will only focus on whether the country is indeed an EU member, and neglect any membership criteria differences amongst EU countries. Accordingly, the countries and dates of accession for the EU members used in this paper are as follows. The six founding EU members are France, Germany, Italy, Belgium, Netherlands and Luxembourg and their year of accession is identified as 1957. The first expansion includes Ireland, the United Kingdom, Denmark and Greenland, and their year of accession is identified as 1973. The second expansion includes Greece and their year of accession is identified as 1981. The third expansion includes Spain and Portugal and their year of accession is identified as 1986. The fourth expansion includes Austria, Sweden and Finland, and their year of accession is identified as 1996. Finally, the last expansion this paper includes consists of Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovakia and Slovenia, and their year of accession is identified as 2004.

The gravity dataset also includes two additional key variables of interest that are incorporated in this paper, including regional trade agreement (RTA) and General Agreement on Tariffs and Trade (GATT) and World Trade Organization (WTO) dummys. Regional trade agreement data is compiled from three data sources, including table 3 of Baier and Bergstrand (2007) supplemented with the WTO web site (http://www.wto.org/english/tratop_e/ region_e/summary_e.xls) and qualitative information contained in Frankel (1997). Obviously, whether two countries share an RTA is a strong indicator of large trade flows between them. Therefore, including RTA dummy variables will provide additional information on trade flows for trade between non-EU countries as well as trade between EU and non-EU countries. The inclusion of this variable is intuitive. For example, one would expect a non-EU country that trades with an EU country under an RTA to exhibit higher trade flows than the same two countries trading without an RTA. Finally, including dummy variables for WTO and GATT membership are significant as they are strong indicators of trade flow and provide information on whether countries can place certain tariffs, quotas, and other trading restrictions on other countries. One would expect GATT and WTO membership to allow for higher trade flows due to their limitations on trade restrictions.

V. Model and Estimation Methods

This paper compares various methods of estimation and a number of different specifications to ensure that an appropriate comparative analysis can be conducted. The comparative analysis will distinguish theoretically consistent structural models from naïve models. Initially, the paper presents summary statistics and correlation tests of the dependent variable, that is, exports, and multiple independent variables to check for evidence of a relationship between the variables. The second method of estimation is an OLS regression of the naïve specification, similar to that of McCallum (1995) but tailored toward the purpose of this paper. The third model involves an OLS regression that includes non-theoretically grounded multilateral resistance terms labeled remoteness variables. The naïve OLS regression and the OLS regression that includes the remoteness variables are crucial for the purpose of this paper, as they will be contrasted to the theoretically grounded structural gravity model. The portion of this paper that studies the differences between the naïve, remoteness, and structural models provides information on the degree of misspecification the first two models exhibit.

Similar to Anderson and Van Wincoop (2003), the difference between the models component of this paper will provide a figure on the misrepresentation of the contribution to trade EU membership provides, according to the naïve and remoteness model. Accordingly, the structural model is estimated through three different techniques including two-way fixed-effects estimation, pseudo-poisson maximum likelihood estimation, and a method proposed by Head and Mayer (2010) that uses a ratio of ratios, labeled as the Tetrad method. The inclusion of these three models provides information on the different effects each model presents, the statistical significance the independent variables present, and which model best fits the data.

I first provide summary statistics of key variables and correlation tests between exports and multiple independent variables. The summary statistics include studying the proportions of trade from EU countries to the EU as well as to the rest of Europe. Furthermore, a data analysis of the proportions of trade flows from EU countries to the EU before and after each country joins is conducted. This method will demonstrate evidence of a relationship between trade flows and joining the EU. In addition, correlation tests between exports and independent variables of interest are conducted to display their requirement to be present in regression analysis. Furthermore, correlation tests between independent variables are included to avoid the possibility of collinearity issues. After simple summary statistics and statistical tests, this paper proceeds to regression analysis.

The first method of regression analysis in this paper is an OLS regression that follows a naïve specification similar to McCallum (1995). As mentioned earlier, the naïve gravity model presents an intuitive way of understanding trade flows. Exports are directly proportional to the exporting and importing countries' economic "mass", that is GDP, and inversely proportional to the distance between them. A simple way to view the naïve specification is to think strictly on intuition. Richer countries trade more, and countries that are far apart trade less. The naïve specification excludes multilateral resistance terms, but includes multiple control variables in addition to distance. The additional independent variables that are included are mentioned in detail in the data segment of this paper. The list of additional independent variables include, GDP of the home and partner country, border, common official language, existence of a regional trade agreement, common currency, state of war, GATT/WTO membership and colonial history.

The independent variables of interest are two interaction variables, which consist of the following. The first interaction variable is labeled "intra-EU" which equals one if both the home and partner countries are EU members according to the period in which they joined, and zero otherwise. This provides information on the gains to trade from EU membership for EU countries before and after they joined. The second interaction variable is labeled "EU-to-ROE" which equals one if the home country is an EU member and the partner country in a non-EU European country in accordance to the period of time, and zero otherwise. Accordingly, this interaction variable represents exports from EU countries to non-EU countries. This interaction variable can be understood as similar as the "border effect" that is studied in McCallum (1995) as well as in Anderson and Van Wincoop (2003). It provides information on the decrease in trade volumes for a non-EU country when an EU country trades with a non-EU country. When two countries trade without complying with a free trade agreement it functions as a barrier to trade similar to that of a border. Furthermore, the countries that are included as part of the EU are as discussed in the "EU Structure" segment of this paper. Accordingly, the first method of estimation will follow the model below.

Model 1:

$$lnx_{ijt} = a_1 + a_2 lny_{it} + a_3 lny_{jt} + a_4 lnd_{ij} + a_5 intraeu + a_6 EUtoROE + a_7 Z_{ijt} + \varepsilon_{ijt}$$

Where lnx_{ijt} represents the log of exports from country i to j at time t. In addition, lny_{it} and lny_{jt} represents the log of GDP of country i and j, respectively, at time t. Furthermore, lnd_{ij} represents the log of distance from country i to j, $intraeu$ and $EUtoROE$ represent the interaction variables mentioned above. Finally, Z_{ijt} represents the set of covariates described. All of the continuous variables, including the dependent and independent variables, are logged so that the interpretation of the regressors are proportional changes in exports due to a one percentage change in the continuous independent variable. The independent variables that are non-continuous must be transformed in order to be interpreted as elasticities. The non-continuous variables follows the interpretation that, if the variable takes the value of one, then it will result in a $(e^x - 1)$ percent change in the dependent variable, where x is the estimated coefficient of the dummy variable. The dataset provides panel data, therefore, the estimation will be an OLS regression with a panel set to country pairs and years.

The second method of regression analysis is an OLS regression similar to Model One, except, with the inclusion of non-theoretically grounded multilateral resistance terms known as remoteness variables. Remoteness variables are frequently used as proxies to control for the multilateral resistance terms for exporting and importing countries. The remoteness variables measure a country's average weighted distance from its trading partners, where the weights are represented as the partner countries' shares of world GDP (Head, 2003). Accordingly, remoteness variables follow the following formula:

$$Equation\ 2: \qquad Rem_i = \sum_j \frac{dist_{ij}}{GDP_j/GDP_w}$$

To study the US-Canada border puzzle, Anderson and Van Wincoop (2003) include these remoteness variables as proxies to represent both the importer and exporter multilateral resistance terms and compare its results to the theoretically grounded structural gravity model. Accordingly, in this paper I include remoteness variables for both the home and partner country as proxies for the multilateral resistance terms. Later, as study of misspecification, I compare the results to the theoretically based structural gravity model. There are two main criticisms of using remoteness terms as proxies for the multilateral resistance terms, and they are as follows. The first criticism is that remoteness terms are not theoretically correct, since the only type of trade barrier it captures is distance (Anderson and Van Wincoop, 2003). The second criticism is in regards to an appropriate measure of internal distance, because the summation requires one to specify a country's distance to itself. Accordingly, the model including the remoteness variables is as follows.

Model 2:

$$lnx_{ijt} = a_1 + a_2 lny_{it} + a_3 lny_{jt} + a_4 lnd_{ij} + a_5 intraeu + a_6 EUtoROE + a_7 Z_{ijt} + a_8 Rem_i + a_9 Rem_j + \varepsilon_{ijt}$$

The dependent and independent variables are identical to those of Model 1, except that Rem_i and Rem_j represent the remoteness terms for the home and partner country, respectively.

The first method of applying a theoretically grounded gravity model to study the EU membership effect on trade flows is through two-way fixed-effects estimation using OLS. The panel data is described as, over time bilateral trade data, used in this paper it has "the advantage of mitigating the bias generated by heterogeneity across countries" (A Practical Guide to Trade Policy Analysis, 108). The fixed effects approach can be understood as accounting for all sources of unobserved heterogeneity that are constant for a given exporter across all importers, and constant for a given importer. Accordingly, as the dataset spans many years (58), the fixed effects method of estimation will allow the importer and exporter fixed effects to be time-varying as well. Although panels of trade flows with a large number of years may run into computational feasibility issues due to the large number of resulting dummies that must be estimated, this issue has been accounted for using a method proposed by Guimaraes and Portugal (2010). The fixed effects method presented in Guimaraes and Portugal (2010) is represented by the reg2hd command in Stata. Reg2hd solves the two-way fixed effect problem with unbalanced data and very large numbers of effects, and allows for clustered standard errors.

As mentioned in Head and Mayer (2014), using country fixed effects includes an additional advantage that has nothing to do with being consistent with economic theory. "There can be systematic tendencies of a country to export large amounts relative to its GDP and other observed trade determinants" (Head and Mayer, 2014). Head and Mayer (2014) consider the case of The Netherlands and Belgium, where much of Europe's trade flows through Rotterdam and Antwerp. They argue that the production location should be used as the exporting country and the consumption location as the importing country. However, this is not always the case, as use of warehouses and other reporting issues makes this difficult. Therefore, there is reason to believe that trade flows to and from these countries are overstated. “Fixed effects can control for this, since they will account for any unobservable that contributes to shift the overall level of exports or imports of a country” (Head and Mayer, 2014).

The fixed-effects estimation model takes the following form.

Model 3:

$$lnx_{ijt} = a_1 + a_2 lnd_{ij} + a_3 intraeu + a_4 EUtoROE + a_5 Z_{ijt} + a_6 F_{it} + a_7 F_{jt} + a_8 F_t + \varepsilon_{ijt}$$

The dependent and independent variables are identical to those of Model 1, except that F_{it}, F_{jt}, and F_t represent the fixed-effect dummy variables that allow for time-varying home country effects, time-varying partner country effects, and year fixed effects, respectively. In addition, due to reasons that will be explained later in the paper, time-varying continuous variables such as GDP are excluded.

The second method of applying a theoretically grounded gravity model to study the EU membership effect on trade flows is through fixed-effects estimation using the Poisson Pseudo-Maximum-Likelihood estimator. There has been a great deal of research on the various ways to specify and estimate a gravity equation. The specifications vary largely along two dimensions that include the error term and the degree of model structure that is imposed on the estimation (Fally, 2015). Silva and Tenreyro (2006) provide evidence that the Poisson Pseudo-Maximum-Likelihood estimator consistently estimates the gravity equation for trade as required by Anderson and Van Wincoop

(2003). In addition, Silva et al. (2006) illustrate that the Poisson PML estimator is robust to different patterns of heteroskedasticity and measurement error. Therefore, in many cases, the Poisson PML estimator is preferable to alternative gravity estimators such as OLS using the log of trade flows, or NLS in levels (Fally, 2014).

Fally (2014) provides that estimating gravity equations with Poisson PML and fixed effects is consistent with equilibrium constraints imposed by more structural approaches such as Anderson and Van Wincoop (2003) and Anderson and Yotov (2010). Fally (2014) further argues that the "fixed effects in the Poisson PML specification are consistent with the definition of outward and inward multilateral resistance indexes and the equilibrium constraints that they need to satisfy" (Fally 2014, 2). Whereas, the fixed effects in NLS and OLS do not necessarily carry these attributes. Due to the above advantages, the gravity model of trade in this paper is also estimated using a Poisson PML method. Accordingly, the results, benefits and caveats, will be compared to all other models, including OLS with fixed effects, to ensure the degree of misspecification can be identified from all models relative to the correctly specified model. The Poisson PML model takes the following form.

Model 4:

$$X_{ij} = exp\left[a_1 + a_2 lnd_{ij} + a_3 intraeu + a_4 EUtoROE + a_5 Z_{ijt} + a_6 F_{it} + a_7 F_{jt} + a_8 F_t\right] \cdot \varepsilon_{ijt}$$

The dependent and independent variables are identical to those of Model 3, except that the model is in exponential form and is estimated through maximum likelihood. Interpretations of the results will be different than that of OLS, but they will be adjusted for.

The final method of estimating the structural gravity model to estimate the EU membership effect is through a method developed by Head and Mayer (2011) named the Tetrads method. The Tetrads method takes advantage of the multiplicative structure of the gravity equation and then takes a ratio of ratios to eliminate the monadic terms, that is, both the importers' and exporters' fixed effects (multilateral resistance terms). The Tetrads method requires a set of four trading partners and "can be seen as an extension of existing ratio approaches that take advantage of the multiplicative functional form of the gravity equation to eliminate either the exporters' or importers' fixed effects" (Head and Mayer, 2014). The Tetrad approach presents two issues. The first issue is the selection of appropriate reference countries to compute the Tetrad calculations, and the second issue involves concerns with the independence of the observations. These two limitations will be discussed later in this paper. Accordingly, the Tetrad method of estimation will take the following form.

Model 5:

$$\ln r_{\{il\}\{jk\}t} \equiv \delta \widetilde{D}_{ijt} + \tilde{u}_{ijt}$$

The dependent variable is ratio of ratios, defined as the ratio of the ratio of i's exports to j over its exports to importer k. $\widetilde{D}_{ijt}$ represents trade costs and is equal to, $\widetilde{D}_{ijt} \equiv D_{ijt} - D_{ikt} - D_{ljt} + D_{lkt}$ and $\tilde{u}_{ijt} = u_{ijt} - u_{ikt} - u_{ljt} + u_{lkt}$.

In addition to the above models presented, the estimation methods will include the following regression options to ensure violations of OLS and other estimators are not incurred. All of the regression analysis includes standard errors that are robust to arbitrary patterns of heteroskedasticity. This use of heteroskedasticity-consistent estimators aims to avoid violations of the second OLS assumption, that is, the errors must be independently drawn from a normal distribution with a given variance. Additionally, all estimations will be clustered by distance to allow for the correlation of error terms within groups defined by distance. “Failure to account for clustering in data with multiple levels of aggregation can result in greatly understated standard errors” (Shepherd 2012, 29). Distance is an appropriate variable to cluster as it is unique to each country pair but is also identical for both directions of trade.

VI. Results

In this section, I first provide the summary statistics and charts as described in the “Model and Estimation Methods” section of this paper. Moving forward, I provide the estimate results of several specifications of the naive gravity model referred to as Model One. Subsequently, I provide the estimate results of several specifications of the Remoteness gravity model referred to as Model Two. Later, I provide the estimation results of several specifications of the Two-Way Fixed Effects estimation, Pseudo Poisson Maximum Likelihood (PPML) estimation and the Tetrad method, referred to as Model Three, Model Four and Model Five, respectively. Finally, to pursue the key purpose of this paper, a comparative analysis amongst all models is presented to contrast all models and provide an estimate on the degree of misspecification that non-structural gravity models provide. This paper then goes on to study the differences between three of the most commonly used structural models in empirical gravity literature.

VI.I Summary Statistics

In the “Summary Statistics” section of this paper, I conduct a brief analysis of European countries before and after they join the EU. In this analysis, I provide the following charts, tables, and manipulations of the data. First, in accordance to the dates at which each country joined the EU, I compare the proportion of trade from EU countries to EU countries before and after each country joined the EU. In addition, I provide the average proportion of trade to EU countries before and after joining as well as the proportional difference in trade flows to EU countries after joining. Second, I provide a comparison of the proportion of trade flows from EU countries to EU countries as well as to the rest of Europe. The above two data manipulations will allow for this paper to identify the change to trade flows after a country joins the EU, as well as determining tendencies of trade for EU countries before they join. For example, it will provide evidence as to EU countries already exhibiting a tendency to trade a lot with EU countries even before they join. In addition, this will provide evidence for issues such as a simultaneity bias of the EU effect.

First, this paper examines the proportions of exports from EU countries to the EU before and after joining the EU. From Table One, there is strong evidence of EU countries exporting largely to the EU even before joining. The average proportion of exports from EU countries to the EU before joining is about 85-percent, and ranges from 73-percent to 99-percent. Therefore, it is evident that EU countries have a strong tendency to trade with other EU countries even before they join the EU. One can argue that joining the EU is not what leads to higher intra-EU trade. Rather, it is large trade with EU countries that is what leads to countries reaching the logical conclusion of joining the EU. This issue is understood as the simultaneity bias of the EU effect and will be discussed in detail later in this paper. In addition, from Table One, there is strong evidence of EU countries continually exporting primarily to the EU after joining. The average proportion of exports from EU countries to the EU after joining is about 88-percent, and ranges from 73-percent to 96-percent. Moreover, the average proportional change in intra-EU trade is an additional 3.3-percent of intra-EU trade after a country joins the EU. The proportional change in intra-EU trade after joining varies by a great deal, it ranges from a decrease of 7-percent to an increase of 18-percent. Figures One and Two illustrate the data presented in Table One. Figure One illustrates the proportion of exports from each EU country to the EU before and after joining, and displays evidence of increased exports to the EU after joining. Figure Two illustrates the proportional change of exports from each EU country to the EU after joining, and displays an indication of increased proportional exports to the EU after countries join.

Table One – Proportional Trade Flows to EU Before and After Joining

EU Countries	EU Entry Year	Proportion of Trade to EU Before Joining	Proportion of Trade to EU After Joining	Proportional Change After Joining EU
France	1957	0.850	0.897	0.047
Germany	1957	0.844	0.861	0.017
Italy	1957	0.791	0.869	0.078
Belgium	1957	0.897	0.949	0.052
Netherlands	1957	0.913	0.947	0.034
Ireland	1973	0.992	0.952	-0.040
U.K	1973	0.854	0.909	0.056
Denmark	1973	0.881	0.870	-0.011
Greece	1981	0.891	0.814	-0.077
Spain	1986	0.918	0.948	0.030
Portugal	1986	0.920	0.960	0.040
Austria	1995	0.839	0.874	0.036
Sweden	1995	0.818	0.822	0.004
Finland	1995	0.752	0.824	0.072
Czech Rep.	2004	0.922	0.924	0.002
Estonia	2004	0.794	0.847	0.053
Cyprus	2004	0.863	0.943	0.080
Latvia	2004	0.802	0.831	0.028
Lithuania	2004	0.702	0.730	0.028
Hungary	2004	0.702	0.881	0.179
Malta	2004	0.951	0.919	-0.032
Poland	2004	0.731	0.847	0.115
Slovakia	2004	0.919	0.930	0.011
Slovenia	2004	0.774	0.755	-0.018
Average		0.847	0.879	0.033

Figure One – EU Exports to EU Countries Before and After Joining

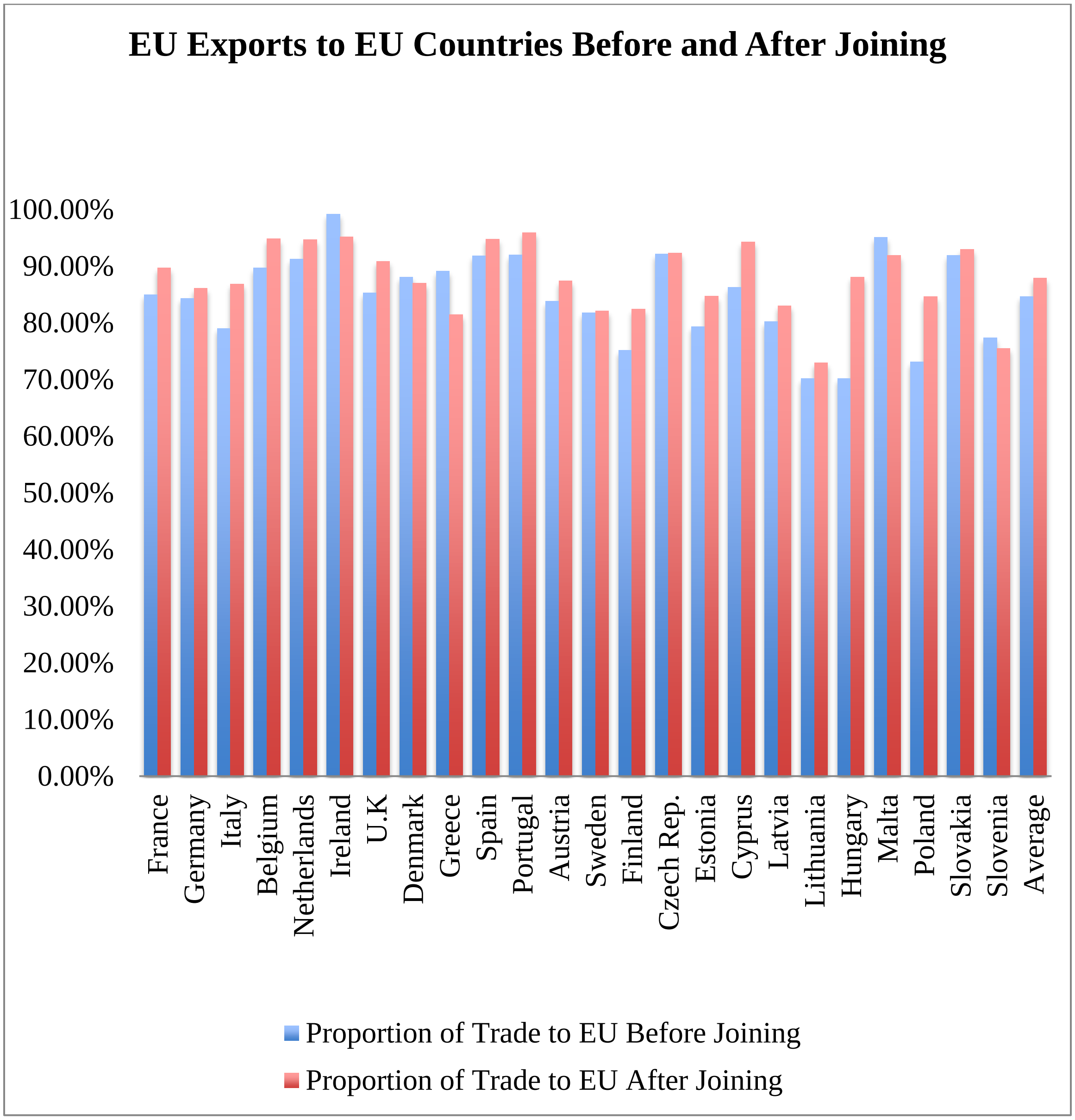
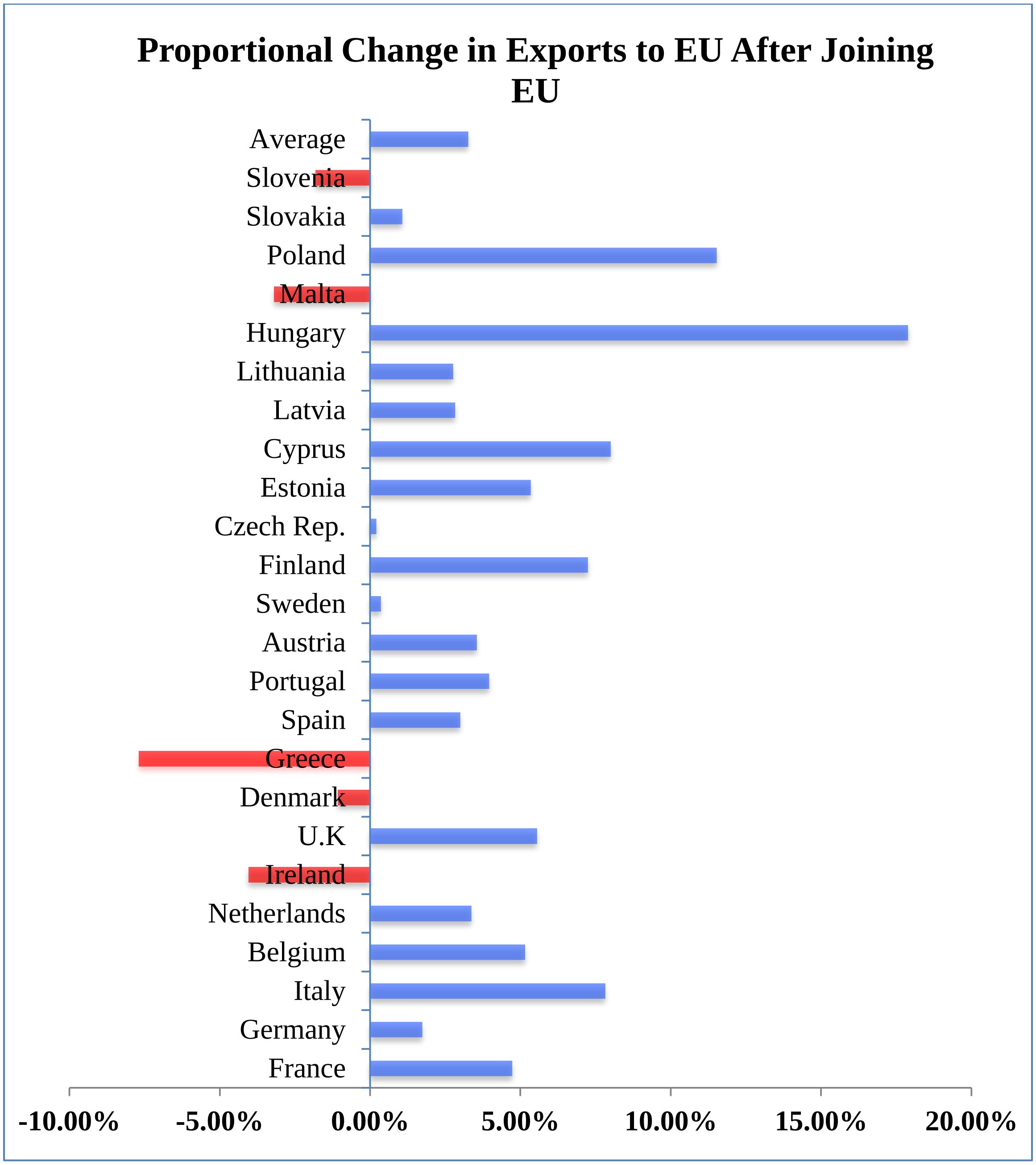


Figure Two – Proportional Change in Exports to EU After Joining EU

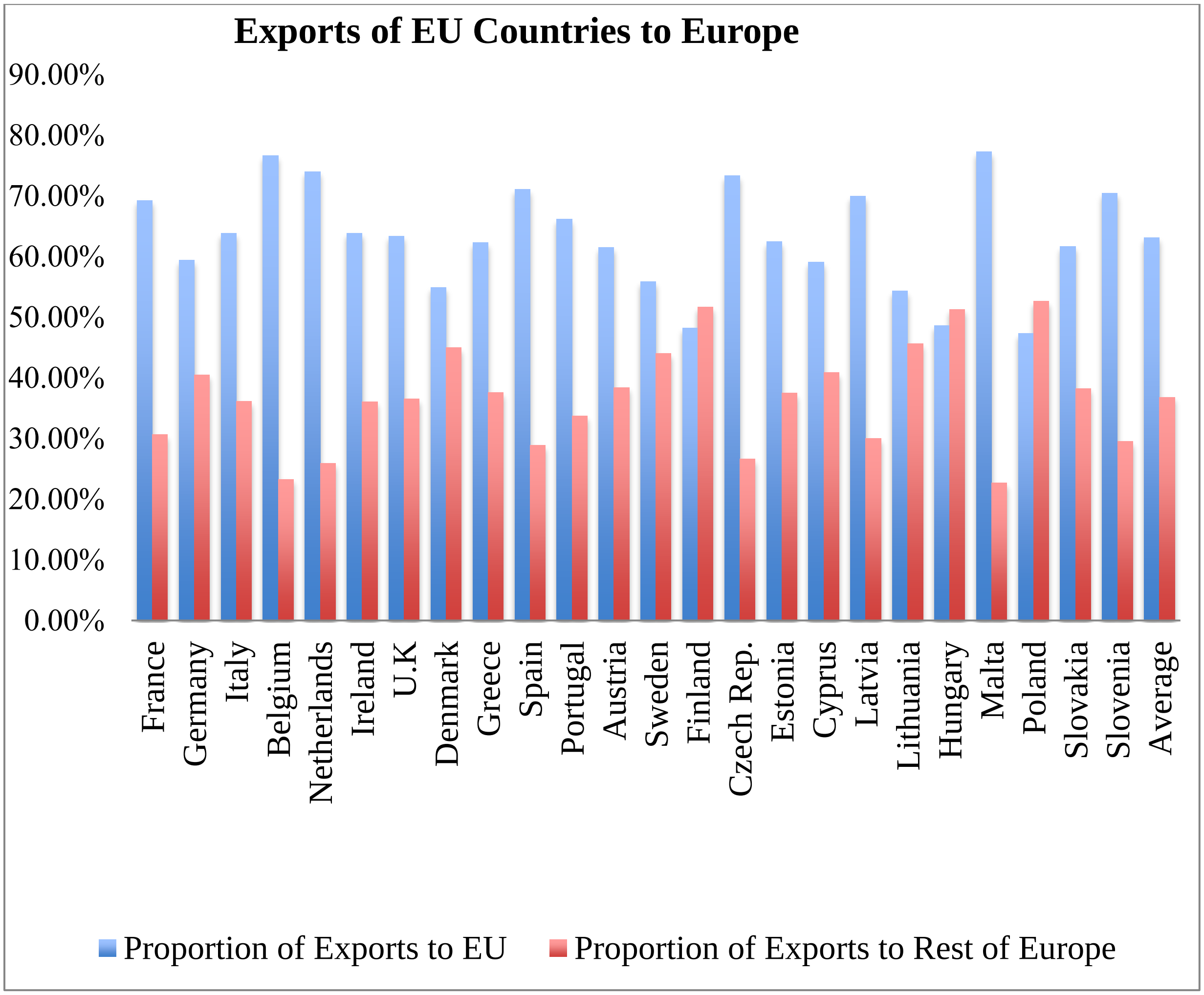


Next, this paper examines the proportions of exports from EU countries to the EU as well as to the rest of Europe. From Table Two, it is evident that when limiting the exports just to Europe, a majority of the exports from EU countries are sent to the EU. The average proportion of exports from EU countries to the EU is 63.1-percent, and the average proportion of exports from EU countries to the ROE is 36.9-percent. The proportion of exports from EU countries to the EU ranges from 48-percent to 77-percent. Figure Two illustrates the proportions of exports from each EU country, and projects a strong representation of intra-EU trade. The strong evidence of intra-EU trade from the data paves the way for regression analysis.

Table Two – Proportion of Exports to EU and ROE

EU Countries	Proportion of Exports to EU	Proportion of Exports to Rest of Europe
France	0.693	0.307
Germany	0.594	0.406
Italy	0.638	0.362
Belgium	0.767	0.233
Netherlands	0.740	0.260
Ireland	0.639	0.361
U.K	0.634	0.366
Denmark	0.550	0.450
Greece	0.624	0.376
Spain	0.711	0.289
Portugal	0.662	0.338
Austria	0.615	0.385
Sweden	0.559	0.441
Finland	0.482	0.518
Czech Rep.	0.733	0.267
Estonia	0.625	0.375
Cyprus	0.591	0.409
Latvia	0.700	0.300
Lithuania	0.543	0.457
Hungary	0.487	0.513
Malta	0.773	0.227
Poland	0.473	0.527
Slovakia	0.617	0.383
Slovenia	0.705	0.295
Average	0.632	0.368

Figure Three - Proportion of Exports to EU and ROE



VI.II - Results – Regression Analysis

Model One – Naïve OLS Estimation

In Specification One of Model One, one notices very statistically significant results for all independent variables. Unless stated otherwise, all results are significant at the one-percent significance level. Again, non-continuous variables follow the interpretation that, if the variable takes the value of one, then it will result in a $(e^x - 1)$ percent change in the dependent variable, where x is the estimated coefficient of the dummy variable. The variable of interest, understood as the intra-EU effect, provides that when the two trading partners are both EU member countries, they exhibit 21.18-percent more trade than when both trading partners are non-EU European countries. Also, EUtoROE provides that when the home country is an EU member and the partner country is a non-EU European country there is 6-percent additional trade than when both countries are non-EU. Additionally, a one-percent increase in the home or partner country's GDP leads to over a 0.57-percent increase in the home country's exports. Furthermore, a one-percent increase in either country's population leads to about a 0.3-percent increase in trade flows. In addition, a one-percent increase in distance between trading partners is associated with a 1.45 percent decrease in the home country's exports. Accordingly, European countries that share a border exhibit 93-percent more trade than countries that do not. Additionally, trading partners that share a common official language incur 127-percent more trade than trading partners that do not. Moreover, countries that share a regional trade agreement (RTA) independent of EU membership exhibit 74.7-percent more trade.

In Specification Two of Model One, two variables are added. These include a variable for whether the two countries were engaged in war at time t, and whether the two countries share a common currency. Including these two variables changes the estimates of most of the variables that are presented in Specification One. A likely factor causing this issue is that the number of observations drops from 44,744 to 1,560 due to missing conflict data. Accordingly, the intra-EU and EUtoROE variables are no longer significant. In addition, the border effect is completely eliminated. These strange results are likely due to the inclusion of too many independent variables with the consequence of multicollinearity. In this specification, significant at the 10 percent level, trading partners that are currently at war incur 78-percent less trade than countries that are not at war. Also, countries that share a common currency incur 145-percent more trade than countries that do not.

In Specification Three of Model One, the conflict variable is omitted and GATT/WTO membership dummies for both the home and partner countries are added. The effects of most variables revert back to that of Specification One, which provides that including the conflict dummy caused multicollinearity issues in the model. In addition, when either trading partner is a GATT/WTO member, the trading partners exhibit 24-percent more trade than if neither of the countries are GATT/WTO members. As GATT/WTO membership requires member countries to follow certain laws relieving trade restrictions such as tariffs and quotas, one would expect that GATT/WTO membership have a positive and more economically significant effect on trade volumes.

Model Two – Remoteness Variable Estimation

Moving forward, this paper proceeds by comparing the results of several specifications of Model Two understood as the Remoteness gravity model that follows from Head (2003). In Specification One of Model Two, two additional variables are included than that of Specification One of Model One, and they are the importer and exporter remoteness variables. The results are quite similar to that of Model One. The two variables of interest provide the following. The intra-EU membership effects provides that, when the two trading partners are both EU member countries, they exhibit 17.87 percent more trade than when both trading partners are non-EU European countries. In addition, there are non-existent decreases to trade volumes for when an EU country trades with a non-EU European country. Also, a one-percent increase in the home or partner country's GDP leads to over a 0.54-percent increase in the home country's exports. Furthermore, a one-percent increase in either country's population leads to about a 0.3-percent increase in trade flows. In addition, a one-percent increase in distance between trading partners is associated with a 1.51-percent decrease in the home country's exports. Countries that share a border incur 81.1-percent more trade than countries that do not. Also, countries that share a common official language possess 144.4-percent more trade than countries that do not. Additionally, countries that share an RTA independent of EU membership exhibit 21.2-percent more trade than countries that do not.

Specification Two of Model Two follows Specification Three of Model One with the exception of the importer and exporter remoteness variables. The results prove very similar to the above specification. However, the intra-EU membership effect increases from 17.87-percent to about 20-percent for when the two trading partners are both EU members. Also, countries that share a common currency possess 18.34-percent more trade than countries that do not. This is a large decrease to the estimate provided in Model One that displayed an increase of 145-percent due to countries sharing a common currency. In addition, when either trading partner is a GATT/WTO member, the trading partners exhibit 23-percent more trade than if neither of the countries are GATT/WTO members.

Specification Three of Model Two replaces home and partner populations with home and partner GDP per capita. GDP per capita is included as it indicates the purchase power of importing and exporting countries. Two countries with considerably different populations may have similar GDPs but very different levels of economic development.

According to Bergstrand (1985), GDP per capita serves as a proxy for the capital-endowment ratio. Also, in combining economic geography and factor proportions theory, Bergstrand (1989) derives the gravity equation at the industry level, which predicts that, the exports of a good in bilateral trade is dependent on income and per capita income as well. Therefore, to avoid specification issues, GDP per capita in included in this model.

The effects for home and partner GDPs increase in comparison to the above specifications. A one-percent increase in home GDP leads to a 0.94-percent increase in trade flows between the pair. Surprisingly, GDP per capita have negative effects on trade flows. A one-percent increase in home and partner GDP per capita lead to a 0.37 and 0.32-percent decrease in trade flows, respectively. This entails that as per capita economic well-being rises in either country, trade between the countries decrease. An explanation for this result could be that per capita increases in GDP are attributed to a rise in productivity within either country. This then leads to a decrease in overall trade as either country specializes in producing more products. Accordingly, consumers in the countries facing rising per capita GDP will consume more products produced in their country which then further decreases overall trade. Again, this is strictly speculation. A much more in-depth analysis is required to understand the true effect of GDP per capita on trade flows and why it may be negative.

Model Three - Fixed Effects Estimations

In 2016, Sergio Correia released a Stata package labeled reghdfe. Reghdfe builds on the iterative method presented in Guimaraes and Portugal (2010) but is not subject to the arbitrary limits presented with the least square dummy variable method. Reghdfe runs linear regressions with multiple fixed effects and can include combinations of fixed effects. For the purpose of this paper this is a very important feature, as studying the gravity model of the intra-EU and EUtoROE effect requires time-varying importer and exporter fixed effects. According to Head and Mayer (2014), for gravity estimations that employ datasets that spans several years, time-varying country fixed effects should be used. This is because characteristics of the importer and exporter are not constant throughout time, and time-varying fixed effects capture time-varying features of the importer and exporter (Benedictis and Salatici, 2011). Failing to incorporate time-varying fixed effects will leads to non-theoretically based multilateral resistance terms. However, there is one issue with incorporating time-varying fixed effects. It is that time-varying fixed effects are perfectly collinear with time-varying country-specific variables. Therefore, they render estimation of the impact of country-specific variables such as GDP impossible. Accordingly, the estimation of all structural gravity models employed in this paper will exclude country-specific continuous variables such as GDP, population and GDP per capita.

To display the econometric issues of incorporating time-varying country-specific effects in a structural gravity model, Specification One of Model Three uses the same explanatory variables as in Specification One of Models One and Two. However, with the exception that this specification includes time-varying importer and exporter fixed effects as well as year fixed effects as the theoretically based multilateral resistance terms. As mentioned earlier, time-varying fixed effects are perfectly collinear with time-varying country-specific variables. Therefore, the results in this specification are biased due to the inclusion of home and partner GDP and populations. The two following specifications will exclude all time-varying country-specific effects, and will instead focus on time-invariant dyadic variables.

In Specification Two of Model Three, GDP and population of home and partner countries are omitted. In addition, the RTA and EUtoROE dummy variables are omitted due to collinearity issues with the variable of interest, intra-EU. Note that RTAs vary throughout time, therefore, their inclusion leads to perfect collinearity with time-varying fixed effects. This issue leads to a limited but theoretically grounded analysis of the intra-EU membership effect. In Specification Two, the model finds that a one-percent increase in distance between trading partners leads to a 1.76-percent decrease in trade flows. Also, using time-varying country fixed effects, I find that the effects of a sharing a border and a common official language have statistically insignificant effects. The intra-EU membership effect provides that, when the two trading partners are both EU member countries, they exhibit 20.8-percent more trade than when both trading partners are non-EU European countries.

In Specification Three of Model Three, intra-EU is replaced with EUtoROE. Although several biases arise due to the exclusion of the intra-EU variable, it is still interesting to see the direction of the effect EUtoROE has on trade flows in a time-varying country fixed effects model. Accordingly, Specification Three provides that when the home country is an EU member and the partner country is a non-EU European country there is 9-percent less trade than when both countries are non-EU. This result provides mild evidence of a decrease in trade volumes when an EU country trades with a non-EU European country. Earlier in this paper, this effect was argued to share a similar interpretation to the border effect in McCallum (1995). Obviously, the results in this specification and in McCallum (1995) differ drastically.

Model Four – Pseudo Poisson Maximum Likelihood Estimation

Continuing forward, this paper studies and compares multiple specifications of the fixed effects Pseudo Poisson Maximum Likelihood (PPML) estimator. As discussed in the "Model and Estimation Methods" section of this paper, the PPML estimator presents many attributes that often allow the estimator to function superior to the fixed-effects estimation presented in Model Three. These attributes include robustness to different patterns of heteroskedasticity and measurement error, as well as consistency under fixed effects. In addition, the interpretation of the coefficients from a Poisson model is straightforward, and follows exactly from those of OLS. However, in the Poisson regression the dependent variable is exports presented in levels. Nevertheless, if the independent variable is entered in logarithms, the interpretation is still conveniently presented as simple elasticities. For example, a one-percent increase in the independent variables is associated with an x-percent increase in exports. Moreover, large values of the dependent variable are difficult to estimate, therefore, as the estimator is scale-invariant, the dependent variable is estimated in millions of dollars.

In presenting the results for Model Four, we learned that including time-varying fixed effects leads to the issue of perfect collinearity with any continuous variable that varies over time. Therefore, estimation of key variables such as GDP, GDP per capita and population could not be included. Accordingly, for the purpose of PPML estimation these continuous, time-varying variables are also excluded from the PPML model. However, due to the computational limitations of employing a PPML model, importer and exporter fixed effects are included that do not vary over time, as well as separate year fixed effects. This allows for estimation of independent variables that are discrete and vary over time, as well as estimation of the intra-EU and EUtoROE effect.

In Specification One of Model Four, the same explanatory variables as in Specification One of Model Three are used. In regards to the key variables of interest, intra-EU and EUtoROE, only EUtoROE is statistically significant. Accordingly, the results present that when the home country is an EU member and the partner country is a non-EU European country there is a decrease in trade by 16.64-percent than when both countries are non-EU. This result provides another example of mild evidence of a decrease to trade volumes when an EU country trades with a non-EU European country, relative to two non-EU European countries trading. Also, the results provide that a one-percent increase in distance between trading partners leads to a 1.036-percent decrease in exports. Also, sharing borders, common official languages and RTAs are all statistically significant and positively associated with exports.

In Specification Two of Model Four, RTAs are replaced with common currency and GATT/WTO membership dummys to prevent collinearity issues. The effects of distance, borders and common official language are very similar to that of Specification One. Also, the effects of GATT/WTO membership for both the importer and exporter are statistically significant and positively associated with exports. The intra-EU membership effect provides that, when the two trading partners are both EU member countries, they exhibit a 25.107-percent increase in trade than when both trading partners are non-EU European countries. In addition, when the home country is an EU member and the partner country is a non-EU European country there is no statistically significant effect.

However, the direction and magnitude of the effect is consistent with economic theory. That is, there is a loss to trade volumes when one trading partner engages in an FTA and the other does not. The results of the EU membership variables are of economic significance, as one would expect EU membership to increase trade between countries substantially as evident above. Also, the results do present statistically significant effects that move in a direction that follow from economic intuition. There are gains to trade volumes when trading partners are both EU members, and there are decreases to trade volumes when one trading partner is an EU member and the other is not.

In Specification Three of Model Four, distance is kept, in addition to border, common official language, common currency, an interaction variable for both trading partners being GATT/WTO members, as well as intra-EU and EUtoROE. The results presented are very similar to those of Specification Two. However, the effect of the intra-EU variable increases to 26.74-percent of additional trade, and the effect of the EUtoROE variable is still statistically insignificant. In addition, both trading partners engaging in GATT/WTO membership is associated with an additional 126% of trade volumes than when both partners are non-EU European countries. Again, the results of the PPML estimation likely suffer from biases and misspecification due to the omission of time-varying fixed effects. However, the omission of time-varying fixed effects is necessary to allow for a computationally feasible PPML estimation.

Model 5 – Tetrad Method

The final method of estimation is the Tetrad method presented in Head et al. (2011). Head et al. (2011) developed a Stata program that applies the Tetrad method to run gravity regression on large panels of trade flows, when simple least-square dummy variable regressions are not computationally feasible. In a Monte-Carlo study of gravity model of trade estimators, Mayer finds that the Tetrad method of estimation presents similar results to that of two-way fixed effects (Model Three). Accordingly, I make the same comparison to investigate whether Mayer's result holds true when focusing strictly on Europe. The Tetrad method requires exporter and importer reference countries. For the purpose of this study, I choose the United Kingdom as the reference exporter and Germany as the reference importer. This combination of importer and exporter reference countries is chosen because Germany and the United Kingdom are the largest European economies in the world (IMF, 2016), and Germany is the United Kingdom's largest importer after the US. Head et al. (2011) find that the choice of reference countries has some effect on results. However, the basic shape and magnitude of independent effects are robust.

In using the Tetrad method presented in Head et al. (2011) the coefficients of only time-varying dyadic variables can be estimated. These include dummy variables that vary over time, such as sharing an RTA, common currency, EU membership and GATT/WTO membership. Therefore, time-fixed dyadic variables such as shared border, shared language, and distance cannot be included. Also, monadic variables such as GDP, GDP per capita and population cannot be included. In Specification One of Model Five, the independent variables that are included are RTA, common currency, EUtoROE, both countries GATT/WTO members, and the log of distance. The intra-EU variable is omitted due to collinearity with the EUtoROE variable. Proceeding, the results provide that when two countries share a RTA, trade flows increase by 14-percent. Also, two countries sharing a common currency is associated with a 31.65-percent increase in trade flows. Furthermore, when both countries are GATT/WTO members, trade flows increase by about 51-percent than when both countries are not GATT/WTO members. In this specification, the EUtoROE variable is only statistically significant at the 11% level, however, the direction of the effect is negative as expected. The EUtoROE effect can be interpreted as the following. When the home country is an EU member and the partner country is a non-EU European country there is a 4.3-percent decrease in trade than when both countries are non-EU.

In Specification Two of Model Five, the log of distance and EUtoROE is dropped in order to study the intra-EU membership effect. The results are very similar to that of Specification One. In regards to the variable of interest, intra-EU, the results provide the following. At a statistical significance of 11%, when the two trading partners are both EU member countries, they exhibit 8.76 percent more trade than when both trading partners are non-EU European countries. Obviously, the Tetrad method of estimation presents limitations for comparative analysis with other gravity estimators due to its focus on time-varying dyadic variables. However, the Tetrad method does present economically and statistically significantly different estimates of our key variables of interest, which are the intra-EU and EUtoROE variables. Therefore, its inclusion in this paper is vital for the purpose of comparison between structural and non-structural gravity models in studying the EU membership effect.

Comparative Analysis

In the comparative analysis section of this paper, I compare and contrast the results of the five models of estimation presented in this paper. The comparative analysis section focuses on key variables of interest such as intra-EU and EUtoROE among others. Variables that are continuous and time-varying such as GDP, Population and GDP per capita are excluded, as theoretically grounded estimation of these variables through the gravity model of trade is not possible. Accordingly, some specifications do not allow for both intra-EU and EUtoROE to be present due to collinearity issues. Therefore, some specifications will exclude the intra-EU or EUtoROE variable and then include the omitted variable in the next specification.

Using five different models of gravity estimation the effects of the variables of interest differ as follows. The intra-EU variable, which measures the proportional change in exports when trading partners are both EU members, ranges from an 8.61-percent increase to a 26.74-percent increase. The Naïve specification, similar to McCallum (1995), provides that when trading partners are both EU members, exports increase by 22.5-percent, than when both trading partners are non-EU European countries. The Remoteness specification, as presented in Head (2003), provides that the intra-EU membership effect is 19.96-percent. However, using the two-way fixed effects method with time-varying importer and exporter fixed effects, the intra-EU membership effect drops to 8.61-percent. Although the effect is only statistically significant at the 11% level, the drop in the magnitude of the effect suggests that the two non-structural models (Naïve and Remoteness) are misspecified.

In comparing the three structural models (Two-Fixed Effects, PPML, and Tetrad), the intra-EU membership effect ranges from 8.61-percent to 26.74-percent. The Tetrad method, presented in Head et al. (2011), suggests that the intra-EU membership effect is 9.15-percent. However, the PPML estimation provides that the intra-EU membership effect is 26.74-percent. This finding suggests that even amongst structural gravity models, the effects of the same variables may differ drastically depending on the model used. Furthermore, given that the PPML model used importer and exporter fixed effects that do not vary over time, it is likely that it suffers from severe bias. As the two most theoretically consistent estimators used in this paper are Two-Way Fixed Effects and the Tetrads method, the intra-EU membership effect is likely to fall between 8 and 10-percent.

The EUtoROE variable, which measures the proportional change in exports when only one trading partner is an EU member, ranges from a 6.8-percent decrease to a 5.9-percent increase. The Naïve specification, provides that when strictly one trading partner is an EU member, exports increase by 5.74-percent than when both trading partners are non-EU European countries. The Remoteness specification provides that the EUtoROE membership effect is not statistically significant. However, using the two-way fixed effects method with time-varying importer and exporter fixed effects, the EUtoROE membership effect drops to negative 4.04-percent. Although the effect is only statistically significant at the 11% level, the drop in the magnitude of the effect suggests that the two non-structural models (Naïve and Remoteness) are severely misspecified.

In comparing the three structural models (Two-Fixed Effects, PPML, and Tetrad), the EUtoROE membership effect ranges from a decrease of 6.8-percent to 4.04-percent. However, all of these effects are statistically insignificant at the 10% level. Focusing strictly on directions of effect and magnitudes, the Tetrad method suggests that the EUtoROE membership effect is a decrease in exports of 4.28-percent. However, the PPML estimation provides that the EUtoROE effect is negative 6.8-percent. Similar to the case for the intra-EU variable, this finding suggests that even amongst structural gravity models, the effects of the same variables may differ depending on the model used. Accordingly, the estimates of the two theoretically consistent estimators are very similar, ranging from a decrease of 4.04-percent to 4.28-percent. However, considering the statistical insignificance of EUtoROE in the structural models employed in this paper, it is possible that there is no EUtoROE effect.

Beyond the EU membership and barrier effects, there are several significant differences among the five models with regard to variables that have large impacts on trade flows between countries. When both trading partners are GATT/WTO members, according to the five models, the gains to trade volumes range from 32.4-percent to 186-percent. A noticeable feature of these results are that the non-structural estimators predict the GATT/WTO effect increase trade by under 30-percent, while the structural estimators predict dual GATT/WTO membership to increase trade by over 100-percent. Moving forward, the border effect between countries range from no statistically significant effect to a 97.5-percent increase in trade when the trading partners share a border. In addition, the effect of trading partners sharing a common currency ranges from an 18.64-percent to 73-percent increase in exports than when the partners do not share a common currency. It is difficult to argue which model has a more accurate estimate of the common currency effect, as evident by the lack of similarity between the estimates within all five models. The effect of trading partners sharing a common official language is quite high within the non-structural models, ranging from an increase in exports by 109-percent to 126-percent. Whereas, there is no evidence of a common official language effect within the structural models presented in this paper. Finally, the effect of trading partners sharing a

RTA seems quite consistent between structural and non-structural models, suggesting an increase in exports by about 15-percent.

VI. Limitations

A major limitation in panel-data empirical work is the possibility of endogenous independent variables. If any of the right-hand side variables in the equations presented in the "Model and Estimation Methods" section of this paper are correlated with the error term, ϵ_{ijt}, those variables are considered econometrically endogenous. Accordingly, OLS, PPML as well as the Tetrad method may yield biased and inconsistent coefficient estimates (Baier and Bergstand, 2007). The three possible sources of endogeneity bias include the following: omitted variables, simultaneity, and measurement error. For the purpose of studying the "EU effect", only the limitations of omitted variables and simultaneity are discussed.

In this paper, the explanatory variables of interest are the intra-EU and EUtoROE variables. Accordingly, to determine the possibility of a correlation of ϵ_{ijt} with intra-EU and EUtoROE, one must first consider what determines a pair of countries to join the EU in the first place (Baier and Bergstand, 2007). Baier and Bergstand (2007) present strong evidence that pairs of countries that share free-trade agreements (FTA) tend to share economic characteristics such that joining the FTA will enhance the economic welfare of each country's consumers. As an example, "two countries tend to have an FTA the larger and more similar their GDPs, the closer they are to each other but the more remote the pair is from the rest of the world" (Baier and Bergstand 2007, 6). However, these same factors are what determine large trade flows. Therefore, countries that share FTAs have chosen well, because most country pairs with FTAs tend to have economic characteristics that are associated with large trade and with welfare enhancing net trade creation (Baier and Bergstand, 2007). Yet, there is still a considerable amount of unobserved heterogeneity in trade flow determinants associated with the decision of whether or not to join or form an FTA.

The error term, ϵ_{ijt}, may represent unobservable policy-related barriers that may reduce trade between pairs and also may not be captured by the independent variables in the gravity equation. For example, two countries may have immeasurable regulations such as internal shipping regulations that decrease trade such that ϵ_{ijt} is negative. In addition, the probability of two countries' governments selecting to join an FTA is high if there are large expected welfare gains from "potential bilateral trade creation if the FTA deepens liberalization beyond tariff barrier into domestic regulations" (Baier and Bergstand 2007, 7). Accordingly, FTA and the intensity of domestic regulations may be positively correlated, and because domestic regulations and ϵ_{ijt} are negatively correlated, this leaves FTA and ϵ_{ijt} to be negatively correlated. Ultimately, if policy regulations that inhibit trade are existent between the countries, the intra-EU and EUtoROE variables will be underestimated. Obviously, it is very unlikely to find variables that capture all unobserved heterogeneity in the gravity equations used in this paper. However, the above example is used to illustrate the consequence and possibility of omitted variables in gravity equations studying FTAs such as the EU.

Simultaneity is also a potential issue in studying the effect of FTAs. As an example, holding right-hand side variables constant, two countries that trade more than their expected level, as predicted by the typical gravity equation, may be induced to form an FTA. This is because there might potentially be less "trade diversion" due to their existing extensive trading relationship. This suggests a positive simultaneity bias, countries that already share an extensive trading relationship join an FTA as it will further ease trade restrictions. Then, it is not the FTA that is causing the high trade flows, rather, it is the already high trade flows that are causing the countries to form an FTA. As evident in the “Summary Statistics” section of this paper, countries that join the EU already exhibit high trade flows with the EU. Therefore, there is reason to believe there exists a positive simultaneity bias with the intra-EU variable in this paper. A method to correct for this issue is to estimate a system of simultaneous equations treating bilateral trade and intra-EU as endogenous variables using two-stage least squares (2SLS). This paper failed to implement this method, but encourages further research on the “EU effect” through use of 2SLS and the Heckmen Selection estimator.

VII. Conclusion

This paper presented a comparative analysis of various gravity model specifications to estimate the effects of EU membership on trade volumes. In doing so, this paper expanded on previous related literature by introducing theoretically-consistent models that have yet to be utilized in studying the EU membership effects. In studying the intra-EU and EUtoROE effects, this paper presented the following results.

The intra-EU variable, which measures the proportional change in exports when trading partners are both EU members, ranges from an 8.61-percent increase to a 26.7-percent increase. However, this paper found that the two of the three theoretically consistent estimators used in this paper, Two-Way Fixed Effects and the Tetrads method, presented very similar estimates. The intra-EU membership effects of these estimators fall between 8.61 and 9.15-percent. In addition, these estimates are quite similar to

Serlenga and Sen (2007). Furthermore, the EUtoROE variable, which measures the proportional change in exports when only one trading partner is an EU member, ranges from a 6.7-percent decrease to a 5.9-percent increase. However, in comparing the three structural models, two of three structural models, Two-Way Fixed Effects and the Tetrads method, presented very similar estimates. The EUtoROE membership effects of these estimators are all statistically insignificant, but, range from a decrease of 4.28-percent to 4.04-percent. As described earlier, the Two-Way Fixed Effects estimator and the Tetrads method are among the most consistent estimators employed in modern empirical gravity work and share very similar results. Therefore, there is good reason to believe that the most consistent intra-EU and EUtoROE effects presented in this paper are within the ranges presented above.

Beyond focusing on the Two-Way Fixed Effects estimator and the Tetrads method, this paper still presents large variability and ambiguity. The ambiguity and variability are present in the results of intra-EU and EUtoROE variables as well as key gravity variables such as RTA, common currency, sharing borders and official languages. Future research should employ a Heckmen Selection Estimator and 2SLS Instrumental Variable regression in addition to the Two-Way Fixed Effects estimator and the Tetrads method used in this paper. Accordingly, utilizing a Heckmen Selection Estimator and 2SLS will tackle the issue of simultaneity, and comparing the results to that of this paper will provide a better estimate of the true intra-EU and EUtoROE effects. Finally, future research should focus on measuring the EU membership effect by accounting for the policies and agreements held within the EU structure. As EU members abide by different policies and regulations they are categorized differently within the EU structure. For example, Eurozone members are EU members that adopt the euro as their national currency. The EU membership effects will vary depending on members' categorization within the EU structure. This paper fails to make distinctions between EU members, but encourages future research to do so, while employing the structural models and comprehensive data delivered in this paper.

Section IX – Regression Output
Model One – Naïve OLS Model

VARIABLES	(1) ln_TradeFlow	(2) ln_TradeFlow	(3) ln_TradeFlow
ln_GDP_Home	0.616***	0.660***	0.594***
	(0.0327)	(0.110)	(0.0326)
ln_GDP_Partner	0.571***	0.595***	0.548***
	(0.0345)	(0.120)	(0.0344)
ln_Pop_Home	0.321***	0.281*	0.354***
	(0.0459)	(0.158)	(0.0458)
ln_Pop_Partner	0.269***	0.169	0.302***
	(0.0481)	(0.199)	(0.0477)
ln_Distance	-1.447***	-1.127**	-1.422***
	(0.0665)	(0.528)	(0.0664)
Border	0.658***	0.0216	0.693***
	(0.161)	(0.438)	(0.164)
Common Lang.	0.822***	1.369***	0.745***
	(0.223)	(0.269)	(0.226)
RTA	0.213***	0.558***	0.176***
	(0.0321)	(0.166)	(0.0321)
intra_EU	0.192***	-0.136	0.206***
	(0.0495)	(0.162)	(0.0476)
EUtoROE	0.0628*	0.152	0.0589*
	(0.0326)	(0.183)	(0.0327)
Common Curr.		0.898***	0.236***
		(0.185)	(0.0446)
GATT – Home			0.221***
			(0.0421)
GATT – Partner			0.210***
			(0.0368)
State of Conflict		-1.533*	
		(0.833)	
Constant	0.0427	-1.134	-0.104
	(0.500)	(4.327)	(0.500)
Observations	44,744	1,560	44,744
Number of id	1,636	58	1,636

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Model Two – Remoteness Variables OLS Regression

	(1)	(2)	(3)
VARIABLES	ln_TradeFlow	ln_TradeFlow	ln_TradeFlow
ln_GDP_Home	0.589***	0.567***	0.938***
	(0.0310)	(0.0310)	(0.0387)
ln_GDP_Partner	0.547***	0.523***	0.844***
	(0.0311)	(0.0309)	(0.0375)
ln_Pop_Home	0.337***	0.371***	
	(0.0453)	(0.0455)	
ln_Pop_Partner	0.286***	0.321***	
	(0.0466)	(0.0463)	
ln_Distance	-1.514***	-1.495***	-1.495***
	(0.0710)	(0.0709)	(0.0709)
Border	0.594***	0.626***	0.626***
	(0.163)	(0.166)	(0.166)
Common Lang.	0.894***	0.824***	0.824***
	(0.224)	(0.227)	(0.227)
RTA	0.193***	0.152***	0.152***
	(0.0323)	(0.0325)	(0.0325)
intra_EU	0.164***	0.186***	0.186***
	(0.0492)	(0.0478)	(0.0478)
EUtoROE	0.0516	0.0439	0.0439
	(0.0320)	(0.0321)	(0.0321)
Exporter-Remotenesss	6.52e-07***	6.02e-07***	6.02e-07***
	(1.29e-07)	(1.30e-07)	(1.30e-07)
Importer-Remoteness	-5.49e-07***	-4.91e-07***	-4.91e-07***
	(1.32e-07)	(1.34e-07)	(1.34e-07)
Common Currency		0.168***	0.168***
		(0.0493)	(0.0493)
GATT – Home		0.213***	0.213***
		(0.0425)	(0.0425)
GATT – Partner		0.235***	0.235***
		(0.0367)	(0.0367)
ln_GDPperCapita_Home			-0.371***
			(0.0455)
ln_GDPperCapita_Partner			-0.321***
			(0.0463)
Constant	0.759	0.646	0.646
	(0.524)	(0.522)	(0.522)
Observations	44,744	44,744	44,744
Number of id	1,636	1,636	1,636

Robust standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Model Three – Two-Way Time-Varying Fixed Effects Estimation

VARIABLES	(1) ln_TradeFlow	(2) ln_TradeFlow	(3) ln_TradeFlow
ln_GDP_Home	-30,460		
	(3.217e+08)		
ln_Pop_Home	-32,740		
	(5.563e+08)		
ln_Distance	-1.686***	-1.764***	-1.764***
	(0.0849)	(0.0907)	(0.0907)
Border	0.0878	0.0969	0.0969
	(0.132)	(0.142)	(0.142)
Common Off. Language	-0.148	-0.227	-0.227
	(0.227)	(0.234)	(0.234)
RTA	0.674***		
	(0.0617)		
EUtoROE	0.0152		-0.0947***
	(0.0351)		(0.0358)
Common Currency		0.533***	0.533***
		(0.130)	(0.130)
intra_EU		0.189***	
		(0.0716)	
Observations	44,739	46,702	46,702
R-squared	0.875	0.872	0.872
Time-Varying Importer FE	YES	YES	YES
Time-Varying Exporter FE	YES	YES	YES
Year FE	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Model Four - Pseudo-Poisson Maximum Likelihood Estimation

VARIABLES	(1) TradeFlow	(2) TradeFlow	(3) TradeFlow
ln_Distance	-1.036***	-1.076***	-1.057***
	(0.0652)	(0.0667)	(0.0658)
Border	0.221***	0.223***	0.219***
	(0.0592)	(0.0610)	(0.0597)
Common Lang.	0.222**	0.225**	0.224**
	(0.0954)	(0.0962)	(0.0951)
intra_EU	-0.0253	0.224***	0.237***
	(0.0574)	(0.0717)	(0.0705)
EUtoROE	-0.154**	-0.106	-0.0711
	(0.0604)	(0.0676)	(0.0657)
Common Curr.		0.0365	0.0486
		(0.0502)	(0.0495)
GATT - Home		0.260***	
		(0.0593)	
GATT - Partner		0.268***	
		(0.0525)	
RTA	0.661***		
	(0.0464)		
Both - GATT			0.814***
			(0.128)
Constant	8.340***	8.524***	8.893***
	(0.665)	(0.560)	(0.658)
Observations	48,733	48,733	48,733
R-squared	0.944	0.939	0.941
Importer FE	YES	YES	YES
Exporter FE	YES	YES	YES
Year FE	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Model Five – Tetrad Method of Estimation

VARIABLES	(1) ln_TradeFlowr_d	(2) ln_TradeFlowr_d
Tetraded RTA	0.129**	0.129**
	(0.0521)	(0.0521)
Tetraded Common Curr.	0.274***	0.274***
	(0.106)	(0.106)
Tetraded EUtoROE	-0.0438	
	(0.0272)	
Tetraded Both-GATT	0.412***	0.412***
	(0.104)	(0.104)
Tetraded Intra-EU		0.0876
		(0.0544)
Constant	-4.13e-09	-4.13e-09
	(0.0145)	(0.0145)
Observations	40,030	40,030
R-squared	0.142	0.142

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

Comparative Analysis Table 1

VARIABLES	(1) Naive OLS	(2) Remoteness OLS	(3) TwoWay FE
intra_EU	0.203***	0.182***	0.0826
	(0.0477)	(0.0479)	(0.0693)
EUtoROE	0.0574*	0.0421	
	(0.0330)	(0.0323)	
both_GATT	0.281***	0.295***	1.051***
	(0.0321)	(0.0318)	(0.0928)
ln_GDP_Home	0.595***	0.567***	
	(0.0326)	(0.0310)	
ln_GDP_Partner	0.548***	0.524***	
	(0.0348)	(0.0313)	
ln_Pop_Home	0.351***	0.369***	
	(0.0452)	(0.0450)	
ln_Pop_Partner	0.300***	0.318***	
	(0.0477)	(0.0463)	
ln_Distance	-1.417***	-1.489***	-1.718***
	(0.0660)	(0.0705)	(0.0896)
Border	0.681***	0.614***	0.0983
	(0.162)	(0.164)	(0.139)
Common Official Language	0.740***	0.819***	-0.210
	(0.223)	(0.224)	(0.229)
RTA	0.160***	0.135***	
	(0.0321)	(0.0325)	
Common Currency	0.238***	0.171***	0.548***
	(0.0450)	(0.0498)	(0.130)
Constant	0.0238	0.774	
	(0.498)	(0.519)	
Observations	44,744	44,744	46,702
R-squared			0.875
Number of id	1,636	1,636	
Time-Varying Importer FE	NO	NO	YES
Time-Varying Exporter FE	NO	NO	YES
Importer FE	NO	NO	NO
Exporter FE	NO	NO	NO
Year FE	NO	NO	YES
Remoteness Terms	NO	YES	NO

Comparative Analysis Table 2

VARIABLES	(1) TwoWay FE	(2) PPML	(3) Tetrad
intra_EU		0.237***	
		(0.0705)	
EUtoROE	-0.0413	-0.0711	
	(0.0347)	(0.0657)	
both_GATT	1.051***	0.814***	
	(0.0928)	(0.128)	
ln_GDP_Home			
ln_GDP_Partner			
ln_Distance	-1.718***	-1.057***	
	(0.0896)	(0.0658)	
Border	0.0983	0.219***	
	(0.139)	(0.0597)	
Common Official Language	-0.210	0.224**	
	(0.229)	(0.0951)	
Common Currency	0.548***	0.0486	
	(0.130)	(0.0495)	
Tetraded intra-EU			0.0876
			(0.0544)
Tetraded both_GATT			0.412***
			(0.104)
Tetraded RTA			0.129**
			(0.0521)
Tetraded Common Currency			0.274***
			(0.106)
Constant		8.893***	-4.13e-09
		(0.658)	(0.0145)
Observations	46,702	48,733	40,030
R-squared	0.875	0.941	0.142
Time-Varying Importer FE	YES	NO	NO
Time-Varying Exporter FE	YES	NO	NO
Importer FE	NO	YES	NO
Exporter FE	NO	YES	NO
Year FE	YES	YES	NO
Remoteness Terms	NO	NO	NO

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