The Trade Potential in Manufacturing Sectors 84-89 for the EU countries.

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Abstract

Trade expansion is an important component of growth. EU countries have benefited from advantages of a monetary union and liberalization of trade, however there is room for further expansion fo trade. This thesis employs an augmented gravity model equation to analyze EU trade flows for important commodities 84-89. The coefficients obtained are used to predict trade potential for the 28 exporting European countries. Fixed effects with panel data for the years 2005-16 have been used for estimation. The results show that all of the effects that are traditionally observed in the "gravity" approach are reasonable and statistically significant. In addition, cultural similarities such as language, ethnicity or colonialism do not show a significant effect upon bilateral trade for the commodities considered in this analysis. The EU countries' trade potential results, which are illustrated through the use of maps, indicate that there is great potential with countries of the North America and the Asia-Pacific region, such as USA, China, Russia and Australia.

Keywords: Gravity Models, Trade Potential, Manufacturing, EU Countries

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1. Introduction

Trade is very essential and important for the expansion and the economic development of the countries. Naturally, the question of how much can a country trade is born and this is where the potential to trade of a country comes in to answer this question. Trade potential can show whether a country has any margin of increasing and exploiting more of its trade with others. So, the potential of a country immediately becomes a tool for policy formation, agreement expansion and development plans. Countries' trade potential has been examined from numerous studies in the past and the results show of how great importance it can be for policy explanations or growth (Wang and Winters (1991); Hamilton and Winters (1992); Baldwin (1994)). Countries' trade potential has been previously well examined and the literature has offered important insights as to how countries can conclude in trade agreements, improve trade conditions and thus enhance their trade flows with other economic partners. Following the development of gravity equation, a number of studies showed how various barriers such as distance or lack of agreements can reduce trade between countries. This is a very important step towards understanding why some countries could trade more, improving their bilateral trade relation and why others would observe reductions in exports and imports. Moreover, the gravity approach gave the opportunity to many researchers examine more precisely what kind of factors affect both negatively and positively trade relations creating thus a more clear image of the determinants of trade.

This thesis aims in examining the trade potential of 28 European Union (EU) countries with the rest of the world. A panel approach for a time interval of 12 years (2005-16) and a set of 2-digit HS classification commodities (84-89) from the industrial sector are used to derive the predicted value of trade of the 28 exporting countries. The commodities this thesis focuses on are the ones of 84 to 89; the codes that resemble the type of the commodities can be found on the table 16 of the appendix section. The choice of these categories is made because they hold the biggest percentage of trade. As a second step the potential to trade is calculated and the results are displayed using 6 maps, including all 237 countries of the world, which illustrate the volume of potential trade each EU country has. Our contribution lies in two parts. First, no previous study has examined the trade potential of manufacturing products of the European Union countries and secondly no previous analysis has presented the results in the form of mapping like this analysis does.

For our methodology we employ a traditional two-step analysis of the classic Gravity model. Besides the main variables the gravity equation dictates, our model includes various dummy variables which affect the trade between countries such as FTA agreements and common elements like language, ethnicity or borders. Our choice of these dummies strongly step upon previous studies which studied trade potential. In the section of methodology is thoroughly explained the nature of the model, the sources of the data, the reason the variables are included in the model and the way the equation is being estimated.

The estimated coefficients are then used to derive the predicted values of trade and thus the trade potential for each EU exporting country. The trade potential is then illustrated through the generation of 6 maps. The results are quite interesting, indicating that Europe can benefit and increase its trade flows with several countries of the Asia-Pacific and the North America region.

2. Literature

Trade potential traditionally reflects the difference between predicted and actual values of trade (Nilsson 2000; Baldwin 1994). Numerous studies in the past have estimated and interpreted the differences between the predicted values and the observed ones, through the use of the gravity approach and the OLS method and have provided results which are referred as the potential to trade between two countries.

Based on the notable studies that have led to today's Gravity approach and trade potential estimation we will divide the literature in 4 sections. The 1st section (2.1) refers to the definition, meaning and importance of the Trade Potential and the conventional 2-step method of estimation. The 2nd section presents a new approach of estimating the potential to trade of the countries that was developed by Kalirajan (2007), while the 3rd section expands on the Gravity Model, presents its history of evolution and discusses some key papers that formed today's Gravity approach. In the last and 4th section our focus turns to the empirical methods of estimation, specifically the Poisson Pseudo Maximum Likelihood Estimator (PPML) and base our analysis on the main study that introduced this estimator and changed the way Gravity Models are estimated today. In subsection 2.5 we present a quick summary of the literature review and a brief on the aspects that we will carry to the methodology and the application.

2.1. Trade Potential using the conventional method

Trade potential can be approached with different ways. One method very common and widely applied employs the conventional gravity model. During the past, all studies relating to the estimation of the trade potential, followed the traditional way of estimation using linearized gravity models. They estimated their models with the method of Ordinary Least Squares (OLS) and then compared the predicted values of the estimation results with the mean values of their trade dataset. This approach suffered from numerous issues and thus literature solved them with different methods. Examples include the zero trade flows, which was theoretically pointed out by Helpman (1987) or the heteroskedastic error terms which were later solved by Anderson van Wincoop (2003).

Only few of the studies that examined trade potentials focus on the European Union and especially on the sector of manufacturing. A worth-mentioning study is the one of Amita Batra (2006) which focuses on India's trade flows. For the estimation of the trade potential, Batra (2006) uses cross-section data for the year of 2000. Specifically, the analysis is based on data taken form the United Nations' Statistics Division and more particularly from PC TAS. The 20,531 observations dataset contains trade information for 146 countries (out of the 245 available ones) for the year 2000. Despite the the advantages of panel data that she acknowledges, she justifies the choice of cross-sectional data by stating that this research follows the classical way of gravity estimation and that previous panel approaches have shown that the aggregation of multiple time periods do not actually add any value to the estimations. The study follows the traditional two step approach of the gravity equation, where initially the gravity model is linearized and estimated using the OLS method and subsequently the predicted values of trade are compared to the actual trade ones, using mean values of the data. The model uses the total merchandise trade (exports plus imports in thousands of US dollars), in log form, between pairs of countries as the dependent variable while the control variables are the ones the gravity equation dictates such as the Gross Domestic Products of the countries and the distance between them. The trade pattern is approached using the augmented gravity equation and the estimates derived show that the magnitude of it's trade potential was at its highest level in the Asia-Pacific area followed by Western Europe and North America. Batra's conclusion, states that India can enhance the trade flows at highest with China, United Kingdom, Italy, and France. In addition, countries such as Georgia, Turkmenistan and Uzbekistan can increase India's trade 10 times than it's current level.

Western Europe has been a key partner in the discussions of trade flows. However Central and Eastern Europe (CEE) countries is a group that shows very interesting trade patterns. Wang and Winters (1991) calculate the trade potential of the Eastern countries following the traditional two step procedure of the gravity model. Their analysis uses data from the years 1984-86 - a three year interval to reduce the effects of temporary shocks - for 76 countries, 19 industrial and 57 developing, excluding the East European countries, all the oil exporting ones and China. As it is mentioned, trade flows can be measured either at the point of export or at the point of import but due to the time-lags between the recording of exports and imports the two measures are accounted as identical. Therefore they use import data, due to the fact that import data are more reliable, because countries tend to pay more attention to their import records, than to their export ones. It is important to state that their dataset treats very small trade flows as zero, according to the Department of International Trade (DIT) and the solution that they offer is to omit the 0 value trade flows. The equation they estimate uses the log of bilateral trade between two countries i and j while the independent variables of the equation are distance, population and incomes of the countries. They create country groupings and present their estimation results accordingly. Their estimates indicate a very large trade potential for several country groups. The results indicate that trade within Council of Mutual Economic Assistance (CMEA) countries matched its potential level in 1985. However as the analysis examines the trade potential of the developing countries, the European Free Trade Agreement countries (EFTA), the European Countries (EC) and of other industrial countries - mainly USA and Japan, it is clear that the potential to trade declines. These drops in trade potential reflect pre-liberalisation political biases. Thus, if the West wished to expand its exports then it should accept imports from the East.

Hamilton and Winters (1992) study is another example which describes the trade with Eastern Europe. In their analysis they focused on the relation of Soviet Union and Eastern Europe (SUEE) markets with the ones in the West. In order to examine trade patterns between these two groups they employed the traditional two step gravity model analysis. The equation estimated was the basic form of the gravity equation but "augmented" in the way of several dummies included in the model. As the dependent variable they considered the bilateral trade flows between the countries. Right hand side variables includeed GNP and the population of the countries plus the distance between them. The model also included 2 sets of dummies, one for each pair of countries that shared a border and one that stated the trade preferences of the countries. The data this study used were data only from market economies and this was to describe "normal" trade patterns. Data corresponded to the years 1984-86. The 2 year interval, however short, was used to reduce the effects of temporary distortions. The dataset included information for 76 countries - 19 industrial and 57 Least Developed Countries (LDCs) - which accounted for about 80% of total world trade during 1984. Trade data referred to the total imports ($US mn.) and were taken from the IMF Direction of International Trade. Continuing, they formed a table presenting the expected signs. As expected, estimations aligned with the coefficients except of two dummy variables. The basic gravity equation variables and various trade dummies showed a high statistical significance. After the regressions Hamilton and Winters used the estimated coefficients to derive the trade potential based on trade data from the mean year of 1985. As a third step they compared these potential trade results with the actual ones from 1985. What they found was that SUEE trade with market economies was quite below its potential. Specifically, Hungary and Romania seemed to have trade flows of about 30% of potential while other SUEE countries only about 20%. What is worth-mentioning is the impact of politics on SUEE trade volumes as the trade flow with LDCs was very close to the potential followed by trade with EFTA. The exact opposite was observed with the European and other industrial countries trade volume relations; they were much more restricted. Concluding, they discussed the benefits of international trade, to generate income, introduce new technologies and skills in the organization sector, stimulate competition and broaden horizons while they supported the openness of the countries. But in order for trade to lead to those changes, as they mentioned, it needed two sides. They made clear the fact that West was not as motivated and determined as the East to change towards the direction mentioned above. As their final remark, they derived the same conclusion as Wand and Winters (1991), that if West wished to change its trade regime it should allow for East to export towards the Western countries.

Baldwin (1994) predicted that the potential Central and Eastern Europe (CEE) exports to the EU were several times higher than their actual 1989 exports. He also employed a two step analysis of the gravity equation estimating his model through random effects with a maximum likelihood correction for first-order autocorrelation. He used data for Western European countries, as he aimed in showing how trade flows would be in Europe when the East became as united as the current West European nations were at the time. The findings of the previous mentioned studies indicated that, as imports from Eastern Europe increased rapidly, European Union (EU) trade policy would become more tense. So, as depicted above these researches predicted that after replacing the centralized trading regime with an East-West based market, trade would be anticipated to expand in the long-run.

Based on the previously cited studies, Gros and Gonciarz (1996) conducted their note on the trade potential of Central and Eastern Europe. Their empirical approach matched the approach of Baldwin (1994), as they used the same parameters and estimation method and concluded in the same results that he did. However, they described various sensitivity issues that in their opinion were neglected in Baldwin's (1994) study such as the fact that his trade projections used the pre-reform, purchasing power parity (PPP) based corrections for GDP in the CEE. They stated that, these PPP-converted GDP estimates seemed to suffer from upward biasness and could not be used to proxy the export-supply and import-demand potential of a country. Taking into consideration problems like the previously mentioned one they set 1992 as their base year to conduct a similar to Baldwin approach. Thus they aimed in estimating trade potential of the countries for the year of 1992, using 1992 actual data and then compare predicted values of trade with actual values of trade in 1992. Their whole methodology process required the combination of Baldwin's (1994) parameters with their own. Finally, they deducted 3 important findings. First, CEE countries achieved a high openness ratio, by 1994, through the Western European countries trade expansion. They achieved that without the expected impact of CEE transformation in terms of international trade. Second, as was already suggested by various 1992 studies, the reorientation of CEE trade towards the EU had already taken place by then. Finally, the European trade system had been characterized and marked by a "hub-and-spoke bilateralism", which should change and become a rather multilateral, from the Atlantic to the Ural, free trade area.

2.2. Trade Potential Using the Stochastic Frontier Analysis

So far, the articles we considered used the conventional two step approach of the gravity equation. The problem with this approach is that the second step does not align with the definition of "trade potential" as it examines the differences between mean values from predicted values rather than the maximum possible values of trade. Kalirajan (2007) acknowledged this problem and defined the Trade Potential Term as "the volume of trade that could be achieved, between two countries, at an optimum trade frontier with open and frictionless trade possible, given the current level of trade, transport and institutional technologies" (Miankhel, Thangavelu and Kalirajan 2009). Therefore he proposed a different way of approximating the benchmark, the Stochastic Frontier Analysis (SFA).

Kalirajan focuses on the relation between Indian Ocean Rim - Association for Regional Cooperation (IOR-ARC) and Australia and examines whether there is any decreasing of the impact of the existing socio-political-institutional restrictions on Australia's bilateral trade flows with IOR-ARC countries. Thus, he measures the trade potential of Australia with the IOR-ARC partners which is the difference between the actual volume of trade and the estimated (benchmark) one. For the estimation process this study uses the gravity model, initially introduced by Tinbergen (1962) and the distance between trading partners, GDP per capita of trading partners and Australia's are used to explain bilateral exports. This analysis is conducted for two different time periods, '92-'96 and '99-'02 and the stochastic frontier gravity models give the potential exports for the two time periods separately. The difference between the potential and the actual trades is stated as the impact of the socio-political-institutional restrictions that affect the trade between Australia and the IOR-ARC countries.

According to Kalirajan, the conventional gravity model does not take into account various latter constraints, i.e the country-specific constraints. These constraints can be present due to socio political-institutional factors, and their influence on trade flows can be minimized through several measures such as regional cooperation. Unfortunately, most of the empirical trade models do not employ these constraints ignoring the deficiency of these constraints. Thus, the model Kalirajan constructs for his estimation process is based on Kalirajan (1999) and can be depicted on equation (2.1).

$$lnX_{ij} = lnf(Z_i;\beta)exp(v_i - u_i) \quad (2.1)$$

the term X_{ij} represents the actual exports from country i to country j. The term $f(Zi;\beta)$ is a function of the potential bilateral trade determinants (Z_i) and β is a vector of unknown parameters . u_i is the single sided error term and illustrates the effect of the economic distance (Anderson and Roemer; 1979, 1977), which originates because of the different cross country socio-political institutional factors. This is the effect which is responsible for the actual-potential difference between countries. u takes values between 0 and 1 and it is usually assumed to follow a normal distribution. If and when this term takes the value 0, it means that the economic distance is of no importance and the actual and the potential exports are then the same. When its value is other than 0 - but still less or equal to 1 - it means that economic distance is important and thus actual exports are restrained from reaching the potential ones. This means that this term represents the influence and the importance of the economic distance, which is described from the socio-political-institutional factors that are in the control of the exporting or importing countries. Thus, by including such a term, this approach - unlike previous ones - does not exclude the influence of the distance or of those factors at all. v_i is the double-sided error term and it represents how the other variables affect trade flows.

Kalirajan's method of estimation has 3 major advantages compared to the previous gravity model approaches. Firstly, no loss of estimation efficiency is present.

Secondly, the influence of the economic distance term, which is the cause of heteroskedasticity and non-normality, is being estimated and isolated from the statistical error term. This isolation enables Kalirajan to examine how effective are is influence of economic distance as a trade constraint. Thirdly, this analysis derives trade potential estimates that are closer to frictionless trade estimates. Kalirajan determines potential trade by the upper limit of the data set and not by its mean as previous studies did. That is, by the economies who have minimized the existing restrictions in order to trade as much as possible. Thus, "potential trade can be defined as the maximum level of trade given the current level of the determinants of trade and the least level of restrictions within the system".

Kalirajan estimates the potential gains of Australia in terms of trade and finds that Australia should have more potential gains in exports due to the Indian Ocean Rim Association for Regional Corporation agreement. This means that due to the IOR-ARC existence Australia is in position of realizing more of its exports potential despite the fact that, due to restrictions, the exports are showing declining values among different countries members of IOR-ARC.

Due to the importance of trade in the economic growth, many studies have analyzed its potentials and impact on the countries' fundamental elements. Thus, a proper unbiased and consistent way of estimation was crucial in order to further elaborate on this topic. In the next session, we resolve the history and importance of the gravity model, present empirical findings from studies that implemented it while we depict the theoretical structure and form of this model.

2.3. Gravity Models

Several studies of the past that discussed trade potential estimation, employed the traditional two step approach on the gravity model. The first step would refer to the linearization and the estimating process of the gravity equation, assuming constant variation of the error term across observations or across country pairs in the case of a panel data study (homoskedastic error terms), while the second one would refer to the comparison of the predicted values of trade from the regression with the actual trade ones, using mean values from the data.

There has been great contribution on the development of the gravity model's theoretical background as well as on it's empirical application. This approach finds its routes in 1687 on the famous Newtonian law of gravitation, according to which, every particle attracts another one with a certain amount of force. Newton's law of universal gravitation explains that this force is directly proportional to the product of the two particles' masses and inversely proportional to the square of the distance between their centers. The mathematical form of this law is presented below,

$$F = G\frac{m_1 m_2}{r^2} \quad (3)$$

where F is the amount of the force, m_1 is the mass of of the 1st particle and m_2 the mass of the second one, r is the distance between their center and G is the gravitational constant.

2.3.1. The Theoretical Basis of the Gravity Model

Despite many economists' belief, the first appearance of the gravity equation in the world of economics was made in the nineteenth century by Ravenstein (1885) and then by Zipf (1946). However, the founding father of the formal usage of the gravity approach in international trade economics is considered the dutch Jan Tinbergen, who in 1962 used Newton's universal law of gravitation to approach and describe the trade flows between two countries i and j. Tinbergen's equation was

$$F_{ij} = G\frac{M_i^{\alpha} M_j^{\beta}}{D_{ij}^{\theta}} \quad (4)$$

where similarly to Newton's law the aggregate trade flow F between country i and country j is directly proportional to the the economic mass of these countries, which is usually measured by the Gross Domestic Products (GDP) M_i^{α} and M_j^{β} and inversely proportional to the distance between them D_{ij}^{θ}. It is important to notice that the magnitude of the countries is measured according to their GDP. Since Tinbergen's breakthrough this approach has become a very powerful tool to study and interpret various subjects in economics and their social interactions. The very effectiveness of the Gravity Model use can be observed in the recent study of Head (2013) on the relationship of tourism, immigration and foreign investments.

Penti Poyhonen (1963) was one of the first after Tinbergen's study to conduct an econometric study of trade flows based on the gravity equation his study though contained only intuitive justification for the usage of the gravity model. Later on, Linnemann (1966) experimented on the theoretical base of the Walrasian general equilibrium system adding more variables on the model. The problem he encountered was that in the Walrasian frame each trade flow would require a lot of explanatory variables in order for these flows to be introduced and included in the form of a gravity equation. During the 1970's, Leamer (1974), Leamer and Stearn (1970) and others had set solid foundations to the gravity model in economics; that it is based on fundamental laws and models of the economy. They stressed that the assumption of a vague similarity to Newton's Physics scientific approach should be avoided. In 1979, James E. Anderson set the very first strong foundations for the development of the theoretical gravity equation and his study became the starting point for many other researchers later on. In his study he formed a theoretical ground for the gravity equation, arguing that it can be used on a broad variety of goods and other determinants that refer to peripheral and national districts. The gravity equation can replace in short run the laws of demand and supply. Between 2 countries i and j, if we assume that i is the importer then M_i is the aggregate amount of product that the country is willing to offer and M_j depicts the aggregate amount of product that the country j demands. Distance between the two countries works as a "barrier", forming this way the transportation cost which leads to a lower trade flow. One of the first and basic characteristics of the gravity model is that imports and exports are formed according to the magnitude of the 2 trading countries. This means that exports grow depending on the gross domestic product (GDP) of the foreign country while imports grow depending on the gross domestic product of the home country. The GDP of each country is the main measure of the magnitude of the economy. The second vital characteristic of this equation is the negative relationship between the natural distance of the two countries and the trade flows. The mathematical form of the equation of gravity Anderson presents is

$$M_{ij\kappa} = a_k Y_i^{\beta\kappa} Y_j^{\gamma\kappa} N_i^{\xi\kappa} N_j^{\epsilon\kappa} d_{ij}^{\mu\kappa} U_{ij\kappa} \quad (5)$$

where $M_{ij\kappa}$ is the flow of imports, exports or aggregate trade of a good or production factor κ from country/region i to country/region j. Y_i and Y_j are the countries' incomes, N_i and N_j are the countries' populations while d_{ij} is the distance between the two countries. Finally $U_{ij\kappa}$ is the log of the disturbance term following the normal distribution with an expected value equal to 0, $E(lnU_{ij\kappa}) = 0$. Anderson uses a very simplistic approach through a rearranged Cobb-Douglas Expenditure System Model to set the very first basis for his theoretical form of the gravity system. Assuming that i) peoples' preferences are identical, ii) countries specialize in the production of only one good (it's own), iii) transportation costs and tariffs are equal to zero, iv) with cross-section analysis, in equilibrium point the prices are considered constant, he presents two equations (1) and (2) which combined end to the simplest form of a "gravity" model (3) which given the appropriate disregard of the error structure can be estimated with Ordinary Least Squares (OLS). The given mathematical forms of the above mentioned equations are,

$$M_{ij} = b_i Y_j \quad (6)$$

$$Y_i = b_i(\Sigma_j Y_j) \quad (7)$$

$$M_{ij} = Y_i Y_j / \Sigma Y_j \quad (8)$$

where b_i is the fraction of income spent on the product of country i, M_{ij} is consumption in value and quantity terms of good i in country j and Y_i, Y_j are the incomes of country i and j respectively. So, solving (7) for b_i and substituting into (6), the gravity equation (8) is derived. It is worth mentioning that in Anderson's 1979 gravity model, the share of aggregate spendings for international trade expenditures (openness to trade) is a logarithmic function of income and population.

In 1985, Helpman and Krugman offer a slightly different aspect on the theoretical basis of Anderson's model. Keeping the assumptions of the identical and homothetic preferences and the cypher transportation costs of the goods that can function as means of transaction constant, they add the factor that all industries produce differentiated products. Thus the value of exports from a country j to a country k can mathematically be depicted as

$$T_{jk} = \tau \frac{Y_j Y_k}{Y_w} \quad (9)$$

where Y_j is the GDP of country j, Y_w is the Gross World Product and τ is the share of trade of the aggregate expenditures. This equation can be directly related and compared to the previous gravity equation but what is worth mentioning is that the factor of distance observed in the previous relations is missing and is now depicted through cost, the term τ. The above equation uses different terms than the one of Anderson's 1979 and is still considered scientific evidence that the gravity approach is based solidly on economic assumptions. This means that the gravity model aligns with the arguments about the economy and the international trade and is not a vague assumption just coming form the physics law of gravitation.

Alan V. Deardorff offered a quite interesting approach on his publications in 1984 and 1998 on the theoretical base of the gravity equation in economics. He changed the way of approaching the model by using a bilateral trade flow on a two case study of the Heckscher-Ohlin formula. On his first case study he assumes no barriers and identical products, which is the outcome of indifferent consumers and producers. On his second approach he uses a Cobb-Douglas form as well as a CES preferences equation form while adding trade barriers and finds that the gravity equation depends on the elasticity of substitution between two goods. This means that the higher the substitution the higher the elasticity is. Finally, the mathematical form of the so called standard gravity equation, a simple version of the gravity model is presented,

$$T_{ij} = A\frac{Y_i Y_j}{D_{ij}} \quad (10)$$

where T, is the value of exports from country i to country j, Y_i and Y_j are the national incomes of country i and country j respectively, the denominator D_{ij} measures the distance between the two countries while A is a constant.

Deardorff (1998) mentions in his study the work of Bergstrand (1985, 1989,1990). Jeffrey H. Bergstrand's recurrent findings are a notable addition to the further development of the theoretical basis of the Gravity Model. In his paper, he assumes perfect substitution of international products and he creates a worldwide general equilibrium of goods model in which a certain form of gravity equation is formed. He strongly supports the the generalized equation can become a gravity model through the addition of an exogenously defined income, while he makes the deduction of the prices affecting strongly the trade flows (a vital connection to the gravity structure).

Finally, starting from Anderson's (1979) first approach on the Gravity equation, along with all the other contributions and further variations on the initial theoretical model mentioned above, we conclude to the simple stochastic form of the gravity equation

$$T_{ij} = \alpha_0 Y_i^{\alpha_1} Y_j^{\alpha_2} D_{ij}^{\alpha_3} \eta_{ij} \quad (11)$$

where $\alpha_0, \alpha_1, \alpha_2$ and α_3 are unknown parameters and in order to estimate the above equation we use it's logarithmic form

$$lnT_{ij} = ln\alpha_0 + \alpha_1 lnY_i + \alpha_2 lnY_j + \alpha_3 lnD_{ij} + ln\eta_{ij} \quad (12)$$

All of the above studies are found vital and significant for the development of the theoretical gravity model, but the one study which is responsible for the final form of the gravity equation is the one of Anderson and van Wincoop (2003). Their research became a workhorse for further studies equally important, as the ones of Silva and Tenreyro (2006) and Fally (2015), on the foundation and estimation of other gravity models. The innovation of this paper was that Anderson and van Wincoop (2003) argued that the gravity equation presented by then was not defined correctly and its estimation did not correspond to the theory behind it, since that model did not consider the theoretically appropriate average barriers or as they called them, multilateral resistance terms. Initially, in their study, they assume the existence of bilateral trade and monopolistic competition between regions/countries. Therefore, they develop a model based on previous studies but they add a new term; an average barrier/resistance a country faces when it wishes to perform any trade activities. This is what they call multilateral resistance terms. In example the different prices consumers may face when two countries begin trading is a term of multilateral resistance. The solution offered in their research, is the induction of two dummies d_i and d_j, in the gravity equation, representing the fixed effects so of the exporters as of the importers and the form they present is the following

$$T_{ij} = \alpha_0 Y_i^{\alpha_1} Y_j^{\alpha_2} D_{ij}^{\alpha_3} e^{\theta_i d_i + \theta_j d_j} \quad (13)$$

Anderson and van Wincoop (2003) estimate the above equation and they compare their findings with previous and other studies. Since the beginning of the development of the gravity model, each study aimed in the better explanation and foundation of the equation and the non biased estimation and interpretation of the model's results. In this section we presented and explained the theoretical basis and approach of the gravity model through the use of the existing literature.

2.3.2. The Empirical Approach of the Gravity Model

In this section we aim to elaborate on the literature that has contributed to the empirical estimation and findings of the gravity equation. For estimation an interpretation purposes it is important to state that the gravity model is defined by certain characteristics.[1] Given its form and structure, the empirical evidence of several studies for the gravity equation in international economics is strong. One of the first empirical and worth mentioning studies on the estimation of the gravity equation is the one of Aitken (1973). He structured a model with dummies in a Free Trade Agreement zone. His study aligns with the basic form of the gravity approach connecting the volume of trade between two countries with their incomes and populations and is based on the cross-sectional trade flow model developed by Linnemann and J. Tinbergen (1962). His effort focuses on empirically isolating the major forces that shaped European trade flows of 1951-67. Initially he adds in his model two dummies which included data for the two following cases i) whether a country is a member of European Economic Community (EEC) or ii) if the country belongs in the European Free Trade Association (EFTA). In this way he created a frame with countries belonging only in the European Union and thus he estimated these isolated trade flows between them. He finds that the EU participation was a positive factor for increasing it's members' trade volume and emphasizes on the positive correlation of trade with GDP and the negative one with distance and the population. After Aitken many studies have tried to embed various variables to the gravity equation such as the common language between countries, the potential colonialism linkages, the income per capita or whether the countries share common borders and if these borders affect the trade flows. Such study was conducted by McCallum (1995) on the importance of existing (or not) barriers between USA and Canada, who finds a large negative effect of the US-Canada border existence, which later on is characterized as seemingly implausible by Anderson and van Wincoop (2003) claiming that the large difference in the size of the US and Canada might be an explanation to this effect. Trade barriers and

[1] 1. The logarithmic form of the Gravity Equation can be estimated, 2. The magnitudes of the countries M_i and M_j are usually measured according to their GDP, 3. Distance is defined between the capitals or the economic centers of the countries and the latitude and longitude are required for the measurement of distance. Distance also serves as a measurement of the transportation cost and the time passed for a good to reach its destination. Estimations must show that distance is a barrier that reduces trade.

national borders factors occupied for long many later studies and gradually the liberalization of trade started gaining scientific ground with Free Trade Agreements starting to exist across Europe and America. The argument that these agreements would increase by a lot the trade flows did not take long to appear and on 2002 Frankel and Rose showed that a potential FTA between countries could triple the amount of trade volume. Of course other factors that were previously examined such common language or currency were also taken in mind. In advance, they showed that countries who shared same currency would trade more, sustaining this way the argument of EU countries strengthening their trade bonds made in previous studies.

A. C. Disdier and K. Head (2008) stated at the beginning of their study, one of the best-established empirical results in international economics is the negative effect of distance on bilateral trade. This is something that had not been thoroughly analyzed before, so they collected a sample of 1,467 estimates of the distance coefficient in 103 papers and conducted a meta-analysis of these estimates. Despite the average dispersion in the estimated distance coefficient, ζ remains stable, taking values around 1. This result holds when their model is tested with a large amount of different data across time. They empirically find and state that distance plays indeed a negative role on the volume of trade between two countries-regions. Disdier and Head (2008) showed that, after controlling with many different samples and methods, the distance coefficient started to show a slightly increasing course by the 1950's and has remained high since then.

Summing up in this section we presented the findings of empirical estimations from a numerous of studies and emphasized on the potential variations of the Gravity Model through the adding of new factors-variables.

2.4. Estimation Methods of the Gravity Model

Since the establishment of the gravity equation there have been many attempts to find the appropriate way of estimating such a model. Initially the model's logarithmic form would be estimated through the use of Ordinary Least Squares (OLS) with cross-sectional data. However, this method had many disadvantages one of which was dealing with large amounts of datasets, especially on panel data forms. In example, the potential enormous existence of dummy variables would set a limit on the number of parameters than could be estimated. In some cases, fixed effects seemed helpful[2], however this did not change the fact that they were still not appropriate for massive data control. In the presence of heteroskedasticity, OLS estimation results were found biased and inconsistent. The most important and crucial problem with this estimation method though, was when the trade flow model contained countries with volume of imports-exports close or equal to zero. The logarithmic value of the volume then could not be estimated and omitted observations occurred, which led to a biased result. The solution to this hurdle was offered from Silva and Tenreyro (2006), who acknowledged the above problem that occurred in international economics and claimed that generally non-linear equations, such as the gravity model, suffered from biased results, due to the presence of heteroskedasticity, when estimated with fixed effects. This is how the pseudo-maximum likelihood estimator (PML) was introduced. Silva and Tenreyro (2006) using cross-sectional data proved that their estimator (PML) solves the problem of heteroskedasticity and the cypher trade flows in the logarithmic equation. In extension, the Poisson Pseudo-Maximum Likelihood estimator (PPML) was presented and its similarity with the PML was well defined. [3] After the use of various simulations on the logarithmic form of the gravity equation, they compared the PPML estimator performance with the one of OLS and concluded that when heteroskedasticity was present, the estimation results from the use of log linear models were extremely biased and led to a misinterpretation of the model. The estimation results derived from the traditional log linear gravity equation, as well as from the Anderson-van Wincoop (2003) one were quite different and offered an unlike approach on the international trade defining parameters.[4] For the traditional model, the

[2]Fixed may seem helpful due to the fact that they represent the unobserved parameters that are crucial in shifting or altering the aggregate volume of imports and exports of a country

[3]Part taken from Silva and Tenreyro (2006) paper for the clarification of PML and PPML: "The estimator defined by equation (9) is numerically equal to the Poisson pseudo-maximum-likelihood (PPML) estimator, which is often used for count data. The form of equation (9) makes clear that all that is needed for this estimator to be consistent is the correct specification of the conditional mean, that is, $E[y_i|x] = \exp(x_i\beta)$. Therefore, the data do not have to be Poisson at all, and what is more important, y_i does not even have to be an integer, for the estimator based on the Poisson likelihood function to be consistent. Equation (9): $\sum_{i=1}^{n}[y_i - \exp(x_i\beta)]x_i = 0$

[4]The estimators used for this simulation were i) Ordinary Least Squares (OLS), ii) Non Linear Squares (NLS) & iii) Poisson Pseudo-Maximum Likelihood (PPML).

Poisson estimates revealed, that the level of coefficients of the importer's and exporter's GDPs are not close to 1 as generally believed. According to the trade-GDP ratio odds, this can be interpreted as the smaller the economic magnitude of a country is (lower GDP) the more open to international trade this country is. OLS results, as expected, were biased by omitting the zero trade flows between countries who do not commit to trade and by overestimating the distance and the colonial-tie dummy in comparison to the PPML estimator who finds this parameter statistically insignificant. Moving to the Anderson-van Wincoop model, it is stated, that even with the use of fixed effects, heteroskedasticity problems may still occur in the log linear form of the equation and provide completely different results. On the other hand PPML is found robust and provides a way to deal with the trade flows who are equal to zero. It is important to underline the use of Ramsey's test RESET, which showed the fitness of the Poisson Pseudo Maximum Likelihood estimator.

Besides Silva and Tenreyro (2006), other studies have offered great insight to the estimation of gravity type models. Honorable mentions are the ones of Helpman, Melitz and Rubinstein (2008) and Eaton, Kortum and Sotelo (2011) who - within the context of the structural gravity model of Anderson and Van Wincoop - demonstrated how to handle zeros in the matrix of bilateral trade flows to estimate gravity equations.

Equally important is the contribution of Fally (2015) who emphasizes on the impact of the any additional restrictions that may occur during the process of forming a gravity model structure. Such restrictions can be the multilateral error terms, for which he claims, that despite their existence, the estimation results using PPML with fixed effects on the importer and exporter are still consistent. This finding immediately makes the Anderson-van Wincoop (2003) model consistent during its estimation with PPML even if fixed effects are present. The same does not happen when this model is estimated using different estimators, so Fally states that the results produced from the Gamma-PML and the OLS estimators are quite unlike. The size of the trade market as well as the constant effects in the multilateral resistance terms of the importers and exporters are some effects that produce biased results when the estimators of OLS or Gamma-PML are used. Thus, they are considered unfit in comparison with the Poisson-PML estimator who is proven to be the most trustworthy and consistent estimator for the gravity type equations.

In this section we provided a thorough analysis of the Trade Potential topic and its estimation process, through a literature review. Initially, the trade potential topic is presented with examples of various studies that engaged with this subject and its importance can be reflected on these studies findings and policy making decisions. Continuing, the history and evolution of the most recent way of estimation, the gravity model, is analyzed. We separate our literature analysis on the theoretical and empirical approach while we mention our key papers (Anderson-van Wincoop 2003, Silva and Tenreyro 2006 etc). In the last subsection of this sector we present the best and most widely today accepted way of estimation, the Poisson-PML estimator and we mention the studies responsible of the development of this estimator. At this part, it is important to clarify that this research will employ the gravity approach and among others the PPML estimation method.

3. Methodology

Our empirical approach consists of 2 stages which are equally important and essential in order to derive the trade potential term for the country pairs our data includes. Several studies of the past have examined trade potential and, as mentioned in section 2, have employed a two-step analysis using Gravity Models. Our approach aligns more with the augmented form of the gravity equation, since besides the solid terms the gravity model dictates, we implement several dummy variables that are important to the trade potential study.

The first step focuses on forming the "augmented" Gravity Model with our dummies of preference and finding the best way of estimation. This allows us to retrieve the predicted values of trade that are essential in order to compare them with the actual ones and form the trade potential. Our approach takes into consideration the basic form of the gravity equation, but our main model of study includes the dummies that affect the trade between two countries. After the appropriate tests and the right choice of the estimation method for our model, we estimate the value of the coefficients and form a table comparing them among different regressing methods.

In the second stage we use the estimated coefficients to find the predicted values we need for the calculation of the trade potential. We then form the fraction of predicted to real values and find the potential to trade for each exporting country by code of our data set. As a last step, we create maps showing the volume of trade potential each exporting country has. All these are described in detail once information for the data employed is presented.

3.1. Data

Our analysis is based on a 4 dimensional panel data set which includes exporting countries, importing countries, years and commodity codes. In order to be able to create a 2 dimensional panel data set we had to create a cross-section group containing the importers, the exporters and the commodity-code of the products. Then, it was feasible to set this group as our cross-section variable (i) and maintain the years as our time variable (t). Due to the magnitude of the dataset and the calculations issues, we decided to divide our data in smaller parts. Since our focus turns only on the manufacturing products that are being traded, a table showing the highest percentages of traded industry goods for the 28 EC for the year of 2016 is presented below.

Table 1: The percentage of trade by commodity groups (9-21)

Commodity group	**Total of Exports (Value)**	**Percentage (%)**
Section XVI (16)	2,367,678,800,000	36.2
Section XVII (17)	1,588,971,100,000	24.3
Section XV (15)	789,987,560,618	12.1
Section XVIII (18)	399,998,119,114	6.1
Section XI (11)	357,857,169,634	5.4
Section XX (20)	238,569,804,507	3.6
Section XIV (14)	223,975,011,623	3.4
Section X (10)	207,724,934,872	3.1
Section XIII (13)	127,071,811,923	1.9
Section IX (9)	95,769,118,399	1.46
Section XII (12)	91,630,807,397	1.4
Section XXI (21)	25,621,484,812	0.39
Section XIX (19)	11,948,375,065	0.18
Aggregate (9-21)	**6,526,754,097,964**	

Table 1[5] illustrates the percentage of the commodity categories that are traded mostly. The first column represents the number of the category in which commodity codes are included, the second column resembles the total

[5]Section Definitions can be found in the appendix of this thesis

sum of trading commodities by each category and the third column depicts the percentage of the commodity categories that are traded between partners. Thus, it is clear that the two largest commodity groups that are being traded are the group 16 and 17 which correspond to the following products. Group 16 refers to products of nuclear reactors, boilers, machinery and mechanical appliances, electrical equipment, television image and sound recorders and group 17 includes vehicles, aircraft, spacecraft, ships, boats and other floating structures, vessels and associated transport equipment. Sections 16 and 17 hold the 36% and the 27% of trade respectively. Thus, our empirical frame includes the commodities by code that correspond to these categories. Specifically these codes are 84 to 89 and they correspond to the products cited previously. [6]

Our dataset includes 28 countries-members of European Union (EU)[7] as exporting countries while the importers are the rest of the world. The commodities we employ belong to the industrial sector; 2-digit HS codes are used. Our analysis takes into consideration the years 2005-16. In order to create the basic form of the gravity model we needed the exports, the distance between the countries' capitals and the Gross Domestic Products (GDP) of both the exporters and the importers. For our "augmented" approach we also include the per capita incomes of the countries as well as dummies for common language and ethnicity, common colony, contiguity, the openness of the countries and whether a Free Trade Agreement (FTA) of any kind exists[8].

The exports of the 2-digit commodity codes of the countries were downloaded form the UN Commtrade database, the world development indicators were provided by the World Bank and the distance between capitals were taken from CEPII.

[6] All manufacturing commodity groups with the codes included in each sector can be found in the appendix on table 16.

[7] The names of the countries both exporters and importers are presented in the appendix

[8] All the variables of the model are being presented in table 2 of the section "Data"

Table 2: The gravity model of exports from country i to country j

Variable	Expected Sign	Reason
GDP of i	+	Export Supply because of available various products
GDP of j	+	Import Demand for Product Variety
GDPPC of i	+	
GDPPC of j	+	
CPI of i	+	European Currency stronger than other currencies
CPI of j	−	Weaker currencies affect negatively imports
Contiguity	+	Common borders reduce costs
Common Language	+	Common language help transactions
FTA	+	Trade Agreements help trade flows
Openness of i	+	More opened Economies trade more
Openness of j	+	More opened Economies trade more
Distance between i and j	−	Transaction costs

Note: All variables except dummies are in their logarithmic form

Table 2 presents the variables our model includes. On the "Variable" column we state the name of the variable, on the "Sign" column we show what sign we expect for the variable to have prior to the regressions and the "Reason" column briefly explains why we chose to include the variables illustrated. All variables except the Consumer Price Index (CPI) of the importing countries and the distance between partners are expected to have a positive relation with the bilateral trade flows. Distance is expected to affect negatively the trade relations between countries as the longer the distance between them is the lower the value of trade is expected to be. The inversely proportional relation between distance and trade volume is one of the fundamental elements of the gravity model and a resulting outcome of various studies.

3.2. The model

The model we employ is based on the basic gravity equation but at the same time it is "augmented" in that, several conditioning dummy variables that may affect trade have been included. Based on Batra (2006) we draw our model's structure. We include several of the dummies that Batra does too, but we also include other dummy variables that literature acknowledges they affect bilateral trade flows between trading partners. The traditional model along with the one we use are presented in equations (14) and (15) respectively.

Basic Gravity Model

$$Log(T_{ij}) = \alpha + \beta_1 log(GDP_i) + \beta_2 log(GDP_j) + \beta_3 log(D_{ij}) + U_{ij} \quad (14)$$

where $log(T_{ij})$ represents the logarithm of the trade flows - these flows represent the annual exports measured in nominal terms - between two countries i and j; $log(GDP_i)$ and $log(GDP_j)$ account for the logarithmic forms of the the GDP's of countries i and j respectively and $log(D_{ij})$ stands for the distance between the capitals of the two countries.

As stated in section 2, the gravity model explains bilateral trade flows (T_{ij}) being proportional to the product of GDP_i and GDP_j and inversely related to the distance between them.

In order to account for other factors that may influence trade levels, our model employs several dummy variables that the basic gravity equation does not. The augmented gravity equation is thus expressed as follows:

Augmented Gravity Model

$$\begin{gathered} Log(T_{ijkt}) = \\ \alpha + \beta_1 log(GDP_{ikt}) + \beta_2 log(GDP_{jkt}) + \beta_3 log(GDPPC_{ikt}) + \beta_4 log(GDPPC_{jkt}) \\ + \beta_5 log(CPI_{ikt}) + \beta_6 log(CPI_{jkt}) + \beta_7 (CON)_{ij} + \beta_8 (CLE)_{ij} + \beta_9 (COL)_{ij} \\ + \beta_{10} (CC)_{ij} + \beta_{11} (FTA)_{ijt} + \beta_{12} log(OP_{it}) + \beta_{13} log(OP_{jt}) \\ + \beta_{14} log(D_{ij}) + d_{ij} + d_{it} + d_{jt} + u_{ij} \qquad (15) \end{gathered}$$

3.2.1. The variables included in the Augmented Gravity Model

All of the variables the main model includes have been transformed into their logarithmic form; when the original model is logarithmed the basic gravity equation is derived.

GDPPC

The per capita incomes of both the exporters and the importers are included in the model and are depicted as $GDPPCi$ and $GDPPCj$. Literature includes the per capita incomes of countries for various reasons. One is that it can be a measure of exploring the relation between a country's trade and its development stage. Frankel (1997) offered another explanation for the per capita Gross National Product as an independent variable; that exotic foreign varieties of goods are superior in consumption. Thus, the per capita income of both the exporters and the importers are expected to have a positive sign.

Consumer Price Index (CPI)

Consumer Price Index for both importers and exporters, $CPIi$ and $CPIj$, are variables included in our model. They are indexes that can affect trade due to a possible difference in the currencies between partners. Since the exporting countries are the 28 members of EU, it means that most of them have as an official currency the Euro (€). This means that the rest of the countries hold a currency weaker than the Euro and thus the CPI of the importers is expected to affect negatively the trade flows. Partners with a weaker currency means that products may seem more expensive to them and this is why the trade flows may be lower than expected.

Openness

OP_i and OP_j indicate the openness of country i and j respectively. It is widely accepted and in previous studies mentioned that international openness plays an important role in the economic development of a country (Livingstone 1976). The more open a country is into importing and exporting the less barriers exist and therefore the easier the trade becomes. Thus, we expect a positive sign.

Distance

Distance is a major factor that affects trade flows between countries. The greater the distance is the less the countries trade. Gravity model explains that distance between the trading partners is inversely related to the bilateral trade flows. Distance one of the fundamental factors of the gravity equation and it is thus included in our model and illustrated as D_{ij}.

In order for us to capture the impact of various geographical factors between countries that may affect bilateral trade, we include dummy variables.

Contiguity: Border Adjacency or Contiguity implies that 2 countries share a common border and it is depicted in the model through the variable CON_{ij}. When it is equal to 1 it means that two countries are neighbors and can thus can engage in a potentially large trade volume. Since common borders tend to reduce transportation friction we expect a positive sign.

Colonies (Common): COL_{ij} is equal to 1 if country i colonized country j and vice versa, while $(CC)_{ij}$ is equal to 1 if i and j where colonized from the same colonizer. According to Livingstone (1976) common elements tend to reduce transaction costs and thus a positive sign is to be expected.

Common Language or Ethnicity: $(CLE)_{ij}$, is equal to one if two countries share the same language or ethnicity. Common language, as literature argues, is expected to reduce transaction costs as it helps in negotiations. For the same reason as for colonies, this dummy is also expected to present a positive sign.

FTA: $(FTA)_{ij}$ is equal to 1 when any kind of Free Trade Agreement between two partners i and j exists. FTAs are expected to increase the trade volume between countries as they improve trade terms and thus we expect a positive sign.

3.2.2. Estimation Steps

The model described in equation 15 is our main model, which we use to derive our results. First we employ some statistical tests in order to check our model for various problems such as heteroskedasticity and autocorrelation and in order to choose the right estimation method.

The first test we employ is the Hausman test; we perform this test first to find the right estimation method for every regression and choose between random and fixed effects. The Hausman's test null hypothesis indicates that the preferred model is random effects while the alternative hypothesis implies that the fixed effects model should be employed. The results form the tests are depicted on the appendix section[9]. For each test we perform for the 6 groupings of commodities (84-89) the value of the probability is equal or very close to 0 and therefore lower than 0.05 and thus it is clear that the fixed effects model must be employed. Below, it is briefly presented the outcome of the Hausman test for the commodity group 84.

b = consistent under H_0 and H_1; obtained from xtreg
B = inconsistent under H_1, efficient under H_0; obtained from xtreg
Test: H_0: difference in coefficients not systematic
$chi2(20) = (b-B)'[(V_b - V_B)^(-1)](b-B) = 54.26$
$Prob > chi2 = 0.0001$

In order to test for heteroskedasticity in fixed effects we perform a modified Wald test (xttest3). The null hypothesis of the Wald test implies homoskedasticity, or constant variance, while the alternative hypothesis indicates presence of heteroskedasticity. The test results for every Wald test performed show that the probability is 0 and thus we reject the null hypothesis and conclude in heteroskedasticity presence; we employ robust standard errors to solve the heteroskedasticity problem.

Next, we estimate our main model in equation 15, using 5 different methods and illustrate the results in the following tables. We do that to compare the benchmarks of each estimation and point out the difference in the coefficients. The 5 methods shown are Pooled OLS, Fixed Effects, Random effects, Least Square Dummy Variable (LSDV) and Poisson Pseudo Maximum Likelihood (PPML). The six commodity groups include the codes 84 to 89. As mentioned earlier in this section considering how big the cross section variable of importers, exporters and commodity codes is and due to the difficulty of the program to calculate and estimate such a large coefficient, our analysis procedure is divided into smaller steps. We estimate equation (15) 6 times separately for each commodity code individually - 84 to 89 - "forcing" this way the cross section variable to include only importers and exporters. This allows us to speed up the estimation process and not face any technical issues during the procedure.

After the comparison of the models we choose the fixed effects as our main

[9] Tables of the appendix show the results from the Hausman Test for each regression according to the commodity groups

method of estimation in order to derive the trade potential. However, due to the amount of time-invariant dummies and important independent variables such as distance that are being omitted in the Fixed Effects model, we also employ the LSDV method in order to comment upon them. As shown in the table of the results we can actually observe, that the fixed effects method derives the same magnitude and sign for all coefficients as the LSDV model does.

The coefficients estimated from the fixed effects model, are then used to find the predicted values of trade. In the last step, we use the predicted values to find the Trade Potential for all 28 EU countries. The trade potential is calculated as shown on formula (16), by comparing the predicted values of trade to the real ones.

$$TP = \frac{\hat{Y}_{ijkt}}{Y_{ijkt}} \quad (16)$$

As mentioned in the introductory part, our contribution lies in 2 ways. The first is that no previous study employed this kind of dataset on EU countries and specifically on the sector of Industry in order to examine the trade potential of these countries. The second one is the way our findings are being presented. We employ 6 maps for the 6 commodity code groupings (84-89)[10] in which we illustrate by color the trade potential of each exporting country with the rest of the world.

[10]The 2-digit commodities for the manufacturing sector are grouped according to the UN International Trade Statistics HS 2002 Classifications and are depicted in table 16 of the Appendix.

4. Estimation Results

Tables 3 to 8 present the estimation results from 5 different methods, Pooled OLS, OLS (Fixed Effects), Random Effects, LSDV and PPML. The estimations were made upon the log form of both the dependent and the independent variables.

Overall, the estimation results are not falling far from our expectations. The coefficients' signs for each commodity group (84-89) illustrate that distance does indeed affect negatively the exports, while the GDP's of the countries and the openness of both the exporter and the importer affect positively the trade volume. For text length purposes, we choose to comment on some of the results depicted on the tables 4 to 8 while we offer a thorough explanation for every coefficient of the regression results of table 3. Our choice of commentary stands upon the importance both statistical and conceptual of the variables.

Table 3 presents the model's estimations for the commodities of the code 84 which includes products such as nuclear reactors, boilers and machinery. The countries incomes, both per capita and total show in most of the models a strong statistical significance. Moreover, in all 3 estimations - Fixed Effects, Random Effects and LSDV - GDPs (per capita and total) maintain their signs. For example, table 3 Fixed Effects and LSDV models indicate that if the exporter's income increases by one percent then the exports decrease by 1.57 percent. On the other hand, if the GDP of the importer increases by 1 percent then the overall exports increase by 1.66 percent. Furthermore, distance maintains a negative relation with the overall exports. This aligns with both the existing literature as well as with the fundamental laws of the gravity model, that distance shows an inverse relation with trade flows. Distance is a time invariant variable - it does not change over time - and thus it is omitted form the fixed effects estimation. Additionally, its statistical significance seems strong only in the case of the random effects model. The Consumer Price Index (CPI) of both the importers and the exporters present a high and strong statistical significance while maintain their signs through all regression models. They hold exactly opposite signs, meaning that if the weighted average of prices of the exporters' consumer goods and services increase by 1 percent then the overall exports increase by 1.67 percent, as depicted by the fixed effects Model. On the other hand if the Consumer Price Index of the importers increase by 1 percent then the overall exports decrease by 0.32 percent. In addition, the dummy variables of contiguity and common elements due to their time invariant nature are omitted in the fixed effects model. However, in the random effects model colonies present a strong statistical significance and a positive sign, thus aligning with literature and supporting the fact that common elements tend to reduce transaction costs and improve trade flows (Livingstone 1976). FTA, is also a variable of great importance. On an average level, literature has shown that Free Trade Agreements tend to increase the volume of trade (Bartra 2006; Frankel and Rose 2002). As it becomes clear form table 3 the variable indicating the existence of any kind of FTA agreements, does not align with the existing bibliography as it presents an unstable and not significant relation with the overall exports. This however does not happen with the openness of the countries as they present a strong statistical significance and maintain a positive sign across all estimations. Wang and Winters (1992) showed that higher openness ratios of countries increase trade potential and thus table 3 estimates do align with the bibliography.

Regarding the estimates for the commodity groups of code 85 are presented in table 4. Commodities of this group refer to machinery and mechanical appliances. As depicted, most of the signs agree with the ones of table 3. The importing countries GDP's show a strong statistical significance while the exporting countries GDP's seem less significant. The importers' GDP maintains a negative sign across estimations in contrast to the positive one of the importers'. This means that if the GDP of an EU exporting country increases by 1 percent the exports decrease by 4.9 percent. Additionally, the variable of distance holds a negative and statistically significant relation with the trade flows. Openness also seems to affect positively trade flows, which agrees both with our previous results as with the bibliography too. Of great importance are also the dummy variables of colony and common colony. They present a positive and statistically significant relation with the dependent variable and thus proving right our expectations. Common elements between countries reduce transaction costs, improve the trade environment and help countries engage more (Livingstone 1976).

Table 5 presents the model's estimations for the commodities of the code 86 which refers to products of electrical and electronic equipment. Relating to the previous tables, the main variables of interest maintain the same significance and the same sign aligning with both our expectations and the existing literature. Excluding the variable FTA, the remaining variables present a strong relation with the overall exports. A very important variable is the Consumer Price Index of the importers. As shown form the results it holds a significant and negative relation with trade. This means that if the CPI of the importing countries increases by 1 percent then the exports decrease by 0.9 percent and this can be an effect of many factors. The Consumer Price Index is practically a measure of inflation. Countries can be affected by it, because of different production costs in labor, or because their trade is linked with weaker economies. Additionally, previous studies have shown that price elasticities for consumption goods can have a strong effect upon exports both outside and inside the eurozone (Thorbecke, Atsuyuki (2012)).

The estimations for the commodities of the code 87 which refer to vehicles other than railway are presented in table 6. The results do not differ from the other commodities. It is important though to comment on the variable of contiguity. As explained on section 3.2.1 contiguity is a dummy variable that indicates whether two trading partners share a common border or not. Adjacency is a geographical factor that affects trade (McCallum 1995; Bartra 2006; Wang and Winters 1992).Table 6 shows that the variable of contiguity shows a positive sign but not a significant relation but this is not something to worry about since the literature has shown that contiguity can derive unstable results in terms of signs and significance.

Table 7 illustrates the model's estimations for the commodities of the code 88 which include aircraft, spacecraft, and parts thereof. Following the previous results, distance shows the significant and negative relation we expected and can be seen in the random effects model. The Consumer Price Index of the importers still holds a negative sign across estimations and shows that a potential percentage increase of the index, the exports decrease by 0.54 percent. Interesting seems the level of significance and the sign of the variable contiguity which in this set of commodities seems to have a positive sign and a strong affect upon trade. This difference can be a sign of the above sentence stating that literature finds contiguity to have a fluctuating course in terms of signs and significance. Either way, for the commodities of aircraft and spacecraft the border sharing appears to be a significant factor for trade increases.

In the last table we present the estimates for the commodities of the code 89 which refer to ships, boats and other floating structures. As seen from the table results, the GDP's retain the same positive and significant relation with the exports, distance appears as a negative factor upon trade, meaning that the greater the distance is the less the countries trade, the CPI of the importers maintain the same negative and significant relation while the openness ratios follow the previous results.

Most of these conclusions align with the so far existing literature (Livingstone 1976; Wang and Winters 1992; Bartra 2006) and are also confirmed from the gravity model theory and application. Some key variables and dummies such as FTA and common language respectively do not present a statistical significance. In the context of this thesis, we can interpret it by stating that the variables who do not present the optimal level of significance do not affect the dependent variable of our model. In this case, it can be said that Free Trade Agreements do not improve any trade conditions for the commodities this analysis framework takes into account.

Table 3: Determinants of Two-way Trade for the Code **84** of the Industrial Sector for 28 EU Exporting Countries, 2005–2016

	Pooled OLS	**Fixed Effects**	**Random Effects**	**LSDV**	**PPML**
GDP_i	1.616***	-1.571***	-1.535***	-1.571***	
	(171.64)	(-4.18)	(-4.10)	(-5.58)	
GDP_j	1.053***	1.668***	1.651***	1.668***	
	(203.15)	(11.14)	(11.02)	(17.42)	
$GDPPC_i$	0.0272	1.888***	1.839***	1.888***	
	(1.57)	(5.06)	(4.94)	(6.79)	
$GDPPC_j$	-0.0572***	-0.700***	-0.689***	-0.700***	
	(-7.31)	(-4.41)	(-4.34)	(-6.73)	
Distance	-1.024***		-1.399***	-0.0893	
	(-81.88)		(-14.14)		
CPI_i	-0.802***	1.679***	1.683***	1.679***	
	(-5.10)	(5.92)	(5.93)	(7.79)	
CPI_j	-0.559***	-0.326***	-0.329***	-0.326***	
	(-10.45)	(-5.08)	(-5.11)	(-7.04)	
Not Common Language	-0.161**		0.381**	6.970	
	(-2.80)		(2.71)	(0.00)	
Contiguity	0.484***		-0.0662	-2.929	
	(9.35)		(-0.35)		
Common Lang/Eth	0.430***		0.318*	-2.195	
	(7.00)		(2.03)		
Colony	0.690***		0.909***	0.311	
	(15.13)		(7.23)		
Common Colony	1.068***		1.374***	-6.837	
	(13.46)		(7.62)		
FTA	0.0857***	0.000837	-0.000220	0.000837	0.108
	(3.90)	(0.02)	(-0.01)	(0.03)	(1.59)
$OPEN_i$	1.103***	1.086***	1.063***	1.086***	
	(41.61)	(7.70)	(7.53)	(9.77)	
$OPEN_j$	0.508***	0.303***	0.298***	0.303***	
	(29.61)	(8.03)	(7.94)	(8.73)	
Constant	-45.97***	-10.60	3.652	-7.780	
	(-77.01)	(-1.48)	(0.52)	(.)	
R-sqr	0.786	0.092		0.924	1.000
F-Statistics	9784	101		.	
dfres	45261.0	4416.0		40835.0	

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Determinants of Two-way Trade for the Code **85** of the Industrial Sector for 28 EU Exporting Countries, 2005–2016

	Pooled OLS	**Fixed Effects**	**Random Effects**	**LSDV**	**PPML**
GDP_i	1.506***	-4.915***	-4.869***	-4.915***	
	(131.81)	(-9.68)	(-9.63)	(-14.53)	
GDP_j	1.086***	0.597**	0.572**	0.597***	
	(172.24)	(3.19)	(3.06)	(5.01)	
$GDPPC_i$	-0.428***	5.760***	5.687***	5.760***	
	(-19.98)	(11.60)	(11.49)	(17.48)	
$GDPPC_j$	-0.0216*	0.258	0.277	0.258*	
	(-2.28)	(1.29)	(1.39)	(1.99)	
Distance	-1.137***		-1.399***	-2.215	
	(-78.12)		(-13.56)	(-0.00)	
CPI_i	-0.127	0.474	0.429	0.474	
	(-0.68)	(1.19)	(1.08)	(1.73)	
CPI_j	-1.137***	-0.467***	-0.474***	-0.467***	
	(-16.91)	(-5.20)	(-5.30)	(-7.81)	
Not Common Language	-0.239***		0.630***	-0.278	
	(-3.33)		(3.75)	(-0.00)	
Contiguity	0.273***		-0.194	4.961	
	(5.04)		(-1.00)	(0.01)	
Common Lang/Eth	0.622***		0.288	-0.213	
	(8.06)		(1.51)	(-0.00)	
Colony	1.045***		1.082***	-0.501	
	(21.19)		(8.06)	(.)	
Common Colony	0.900***		1.088***	-3.553	
	(8.65)		(4.74)	(-0.00)	
FTA	0.191***	0.0942	0.0899	0.0942*	-0.00488
	(7.32)	(1.87)	(1.78)	(2.49)	(-0.05)
$OPEN_i$	0.864***	1.381***	1.371***	1.381***	
	(26.16)	(7.56)	(7.52)	(10.20)	
$OPEN_j$	0.695***	0.352***	0.351***	0.352***	
	(30.96)	(6.07)	(6.09)	(8.00)	
Constant	-39.32***	59.69***	68.94***	73.46	
	(-56.12)	(6.26)	(7.39)	(0.01)	
R-sqr	0.722	0.061		0.901	0.999
F-Statistics	7861	56		.	
dfres	43762.0	4388.0		39354.0	

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: Determinants of Two-way Trade for the Code **86** of the Industrial Sector for 28 EU Exporting Countries, 2005–2016

	Pooled OLS	**Fixed Effects**	**Random Effects**	**LSDV**	**PPML**
GDP_i	1.193***	0.227	0.0469	0.227	
	(48.62)	(0.16)	(0.03)	(0.20)	
GDP_j	0.895***	1.386***	1.271***	1.386***	
	(63.93)	(3.73)	(3.49)	(4.60)	
$GDPPC_i$	-1.012***	0.0846	0.157	0.0846	
	(-20.97)	(0.06)	(0.12)	(0.08)	
$GDPPC_j$	-0.0304	-0.516	-0.489	-0.516	
	(-1.53)	(-1.32)	(-1.27)	(-1.61)	
Distance	-0.884***		-1.356***	-0.650***	
	(-31.35)		(-11.69)	(-4.35)	
CPI_i	0.769*	1.027	0.802	1.027	
	(2.04)	(1.16)	(0.93)	(1.55)	
CPI_j	-0.901***	-0.961***	-0.912***	-0.961***	
	(-6.69)	(-5.57)	(-5.38)	(-7.12)	
Not Common Language	0.563***		0.552*	-1.526***	
	(5.79)		(2.26)	(-4.03)	
Contiguity	1.338***		0.949***	3.244***	
	(17.35)		(4.90)	(5.99)	
Common Lang/Eth	0.267*		0.559*	-0.384	
	(2.54)		(2.20)	(-0.80)	
Colony	0.650***		0.649***	1.550	
	(8.45)		(4.01)	(1.73)	
Common Colony	2.347***		2.648***	0.778	
	(12.91)		(7.58)	(1.08)	
FTA	0.0193	-0.0843	-0.0675	-0.0843	0.0664
	(0.36)	(-0.65)	(-0.54)	(-0.75)	(0.35)
$OPEN_i$	0.837***	1.296**	1.048*	1.296***	
	(12.69)	(2.74)	(2.31)	(3.39)	
$OPEN_j$	0.220***	0.170	0.0976	0.170	
	(5.03)	(1.11)	(0.77)	(1.35)	
Constant	-29.51***	-32.40	-8.954	-23.93	
	(-20.25)	(-1.19)	(-0.36)	(-1.36)	
R-sqr	0.452	0.028		0.782	0.991
F-Statistics	1197	14		.	
dfres	16958.0	2503.0		14450.0	

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Determinants of Two-way Trade for the Code **87** of the Industrial Sector for 28 EU Exporting Countries, 2005–2016

	Pooled OLS	**Fixed Effects**	**Random Effects**	**LSDV**	**PPML**
GDP_i	1.953***	-3.387***	-3.292***	-3.387***	
	(143.17)	(-5.99)	(-5.89)	(-7.86)	
GDP_j	0.933***	0.833***	0.793***	0.833***	
	(112.53)	(4.37)	(4.18)	(6.04)	
$GDPPC_i$	-0.941***	3.597***	3.474***	3.597***	
	(-35.25)	(6.63)	(6.47)	(8.72)	
$GDPPC_j$	-0.0406**	0.507*	0.544**	0.507***	
	(-3.27)	(2.48)	(2.67)	(3.39)	
Distance	-1.471***		-1.549***	-1.508	
	(-83.91)		(-14.23)		
CPI_i	1.392***	4.021***	4.068***	4.021***	
	(6.04)	(9.28)	(9.43)	(12.88)	
CPI_j	-1.456***	-0.818***	-0.816***	-0.818***	
	(-17.80)	(-7.93)	(-7.96)	(-11.64)	
Not Common Language	0.375***		1.129***	-5.473	
	(4.71)		(6.11)		
Contiguity	0.449***		0.0640	5.027	
	(7.95)		(0.31)		
Common Lang/Eth	-0.112		0.0318	4.002	
	(-1.31)		(0.16)		
Colony	1.109***		0.807***	-2.467	
	(18.76)		(5.34)		
Common Colony	2.449***		2.401***	16.26	
	(21.52)		(8.67)		
FTA	0.254***	-0.0549	-0.0512	-0.0549	0.157
	(7.80)	(-0.91)	(-0.85)	(-1.26)	(1.21)
$OPEN_i$	1.769***	0.838***	0.806***	0.838***	
	(43.04)	(3.76)	(3.63)	(4.95)	
$OPEN_j$	0.432***	0.399***	0.396***	0.399***	
	(16.22)	(5.19)	(5.24)	(7.44)	
Constant	-48.57***	22.08*	30.59**	30.69	
	(-54.96)	(2.07)	(2.97)		
R-sqr	0.664	0.081		0.908	0.999
F-Statistics	5417	59		.	
dfres	35480.0	3993.0		31477.0	

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: Determinants of Two-way Trade for the Code **88** of the Industrial Sector for 28 EU Exporting Countries, 2005–2016

	Pooled OLS	**Fixed Effects**	**Random Effects**	**LSDV**	**PPML**
GDP_i	1.452***	4.783***	4.502***	4.783***	
	(62.70)	(4.36)	(4.26)	(5.89)	
GDP_j	0.955***	0.368	0.288	0.368	
	(71.96)	(0.97)	(0.78)	(1.31)	
$GDPPC_i$	0.0277	-4.648***	-4.366***	-4.648***	
	(0.66)	(-4.43)	(-4.30)	(-5.89)	
$GDPPC_j$	0.113***	0.846*	0.890*	0.846**	
	(6.16)	(2.12)	(2.28)	(2.79)	
Distance	-0.352***		-0.610***	0.671	
	(-12.99)		(-4.74)	(0.00)	
CPI_i	-1.588***	-0.890	-0.828	-0.890	
	(-4.32)	(-1.10)	(-1.04)	(-1.36)	
CPI_j	-0.259	-0.542**	-0.539**	-0.542***	
	(-1.94)	(-3.03)	(-3.07)	(-4.12)	
Not Common Language	0.474***		0.407	6.654	
	(4.13)		(1.66)	(0.00)	
Contiguity	0.909***		1.086***	1.896	
	(10.61)		(5.23)	(0.00)	
Common Lang/Eth	0.00846		-0.183	-2.131	
	(0.07)		(-0.69)		
Colony	0.947***		0.597***	-6.275	
	(12.46)		(3.46)	(-0.00)	
Common Colony	2.320***		1.086***	-6.604	
	(13.41)		(3.33)		
FTA	-0.221***	-0.132	-0.0677	-0.132	0.255
	(-4.31)	(-1.13)	(-0.59)	(-1.41)	(0.61)
$OPEN_i$	0.535***	1.581***	1.493***	1.581***	
	(8.23)	(3.92)	(3.78)	(4.97)	
$OPEN_j$	0.237***	0.114	0.0846	0.114	
	(5.67)	(0.84)	(0.68)	(1.23)	
Constant	-44.27***	-85.49***	-74.92***	-93.79	
	(-31.79)	(-4.19)	(-3.94)		
R-sqr	0.469	0.025		0.770	0.998
F-Statistics	1256	14		.	
dfres	22266.0	3110.0		19146.0	

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: Determinants of Two-way Trade for the Code **89** of the Industrial Sector for 28 EU Exporting Countries, 2005–2016

	Pooled OLS	**Fixed Effects**	**Random Effects**	**LSDV**	**PPML**
GDP_i	0.692***	-0.487	-0.466	-0.487	
	(28.51)	(-0.37)	(-0.37)	(-0.46)	
GDP_j	0.330***	0.675	0.557	0.675	
	(21.80)	(1.54)	(1.30)	(1.92)	
$GDPPC_i$	-0.300***	0.409	0.278	0.409	
	(-5.14)	(0.32)	(0.23)	(0.39)	
$GDPPC_j$	0.481***	0.759	0.763	0.759*	
	(21.05)	(1.62)	(1.67)	(2.01)	
Distance	-0.366***		-1.285***	-1.697	
	(-12.38)		(-13.82)	(-0.00)	
CPI_i	-0.689	1.057	1.127	1.057	
	(-1.57)	(1.15)	(1.25)	(1.41)	
CPI_j	-1.029***	-0.709***	-0.798***	-0.709***	
	(-6.17)	(-3.56)	(-4.11)	(-4.27)	
Not Common Language	-0.462***		-0.227	-7.007	
	(-3.34)		(-0.83)	(-0.00)	
Contiguity	1.110***		0.874***	-1.421	
	(12.59)		(5.03)		
Common Lang/Eth	0.531***		0.556*	10.57	
	(3.87)		(2.04)		
Colony	0.559***		0.335*	-3.519	
	(6.81)		(2.07)		
Common Colony	1.395***		1.196***	2.927	
	(8.46)		(3.93)		
FTA	-0.0496	0.0340	0.00843	0.0340	-0.184
	(-0.86)	(0.23)	(0.06)	(0.29)	(-0.91)
$OPEN_i$	-0.917***	1.085*	0.848	1.085**	
	(-12.54)	(2.25)	(1.80)	(2.67)	
$OPEN_j$	0.0679	0.885***	0.658**	0.885***	
	(1.30)	(4.28)	(3.23)	(5.18)	
Constant	-1.215	-12.78	-1.183	15.78	
	(-0.72)	(-0.52)	(-0.05)	(0.00)	
R-sqr	0.248	0.021		0.707	0.975
F-Statistics	382	12		.	
dfres	17880.0	2679.0		15194.0	

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The coefficients obtained from the above estimations were used to calculate the trade potential of the 28 European exporting countries by employing the formula (16). As a second step, the trade potential is being illustrated through the use of the following maps.

Figures 1 through 6 depict the trade potential for the 28 EU countries for each commodity code separately. The commodity codes are from 84 to 89 and each resembles a specific product category. The map colors indicate a scale of magnitude of trading potentials. Red resembles the minimum or no number of the exporting countries who seem to have an opportunity to increase their trade with the areas colored in red. Green on the other hand, depicts the highest number of the exporting countries who can increase their trade flows with the according areas. The areas which appear with white color and no borders, mean that no available data existed to examine the trade potential.

Figure 1 illustrates trade potential for the commodity code 84; products with the code of 84 are nuclear reactors, boilers and machinery. As can be clearly seen, European countries seem to have a great trade potential with countries of both the East and the West. More specifically, 18 to 23 European countries indicate a high trade potential value with North America, Brazil and several countries of the East such as Japan, China, India and Pakistan. Furthermore, an average of 16 EC (European Countries) present a rather high trade potential for nuclear energy with Russia and Australia. On the other hand the potentials for trade with countries of the African continent and the Eastern Europe seem very low and therefore Europe should seek to conclude in various trade agreements with the Americas and the continents of Asia and Oceania. Nuclear energy is a rather technical field that requires modern technology and skilled human capital, which are factors that are not commonly found in non-developed countries such as the African ones; this could be an explanation of the lack of potential exporting for Europe.

The potential to trade for the commodity code 85 are being presented on the second map. This code includes products of electronic equipment. Europe can increase its trade for electronics with the Northern and a significant part of the Southern America as well as with the peripheral countries of the African continent and the countries of Oceania. Asia does not seem to play an important role on these kind of trade products since Russia and China present a rather low trade potential level. The low trade potential level implies that for most EU28 countries the potential to trade has been exhausted given the economic conditions.

Figure 3 presents the trade potential Europe has for the commodities of code 86 which includes railway and tramway equipment. It is strongly observable that Europe has a very high trade potential level with both the largest countries of Asia and America; more specifically with USA, Brazil, Russia, Japan, China and India. Moreover, benefits form increasing the trade of railway equipment is found inside the European Zone and with some developing African countries such as South Africa. In addition approximately 8 to 9 EC show a rather high trade potential with the UAE (United Arab Emirates), Australia and Kazakhstan. Japan and China hold enormous railway networks and the maintenance of them require various importing parts; the UAE on the other hand are developing in the last decade high-speed railway systems to reduce the cost of time and money of human and product transportation through the dessert from one emirate to the other.

Besides railway equipment Europe can benefits from increasing trade for vehicles other than trains and the results are illustrated on figure 4. Particularly, 14 to 17 EC show that there is great potential to trade with the USA, Brazil, India, Japan and Australia. Again, Russia and China are also countries with which Europe can increase its trade but in a lower level than the previously mentioned countries. African countries continue to show very low trade potential except South Africa and Algeria. Given the fact that vehicles can be considered luxury goods, it makes sense for the undeveloped countries to not form a market that Europe could expand its exports with.

Figure 5 refers to the trade potential Europe has with the rest of the world for aircraft and spacecraft equipment. It seems that Europe has taken advantage of its trade for these products with many countries since only Australia, Finland and Chile present a high trade potential. In addition with countries such as Russia, Mexico and Brazil only 8 out of the 28 countries of Europe present to have a relatively high trade potential. Moreover, India and most of the African countries show that Europe has nothing to gain by increasing the trade of aircraft and spacecraft with them.

The last map accounts for the commodities of code 89 which includes ships, boats and other floating structures. USA, Russia and Australia seem for once more the countries with which Europe has great trade potential in contrast with most of the African countries and India which present very low or no trade potential at all.

Overall, for the commodities 84 to 89 EC present a high level of trade potential with USA, Russia and Australia. This means that Europe can take advantage of this finding and increase its trade flows with these countries to benefit more. More specifically, Europe can increase its trade with these countries for nuclear reactors, railway equipment, vehicles and ships and boats.

In order to achieve a higher rate of exporting EU28 countries can implement various trade policy agreements, such as creating duty drawback schemes (in example to eliminate or minimize duty pre-payment for the exporting firms in order to reduce credit requirements). Another possible policy could focus on increasing credit availability by simplifying various existing regulations (for example long bureaucracy procedures on exporting) or applying short and long-term export growth policies (for example enhance the productivity of the more demanded technological and machinery products).

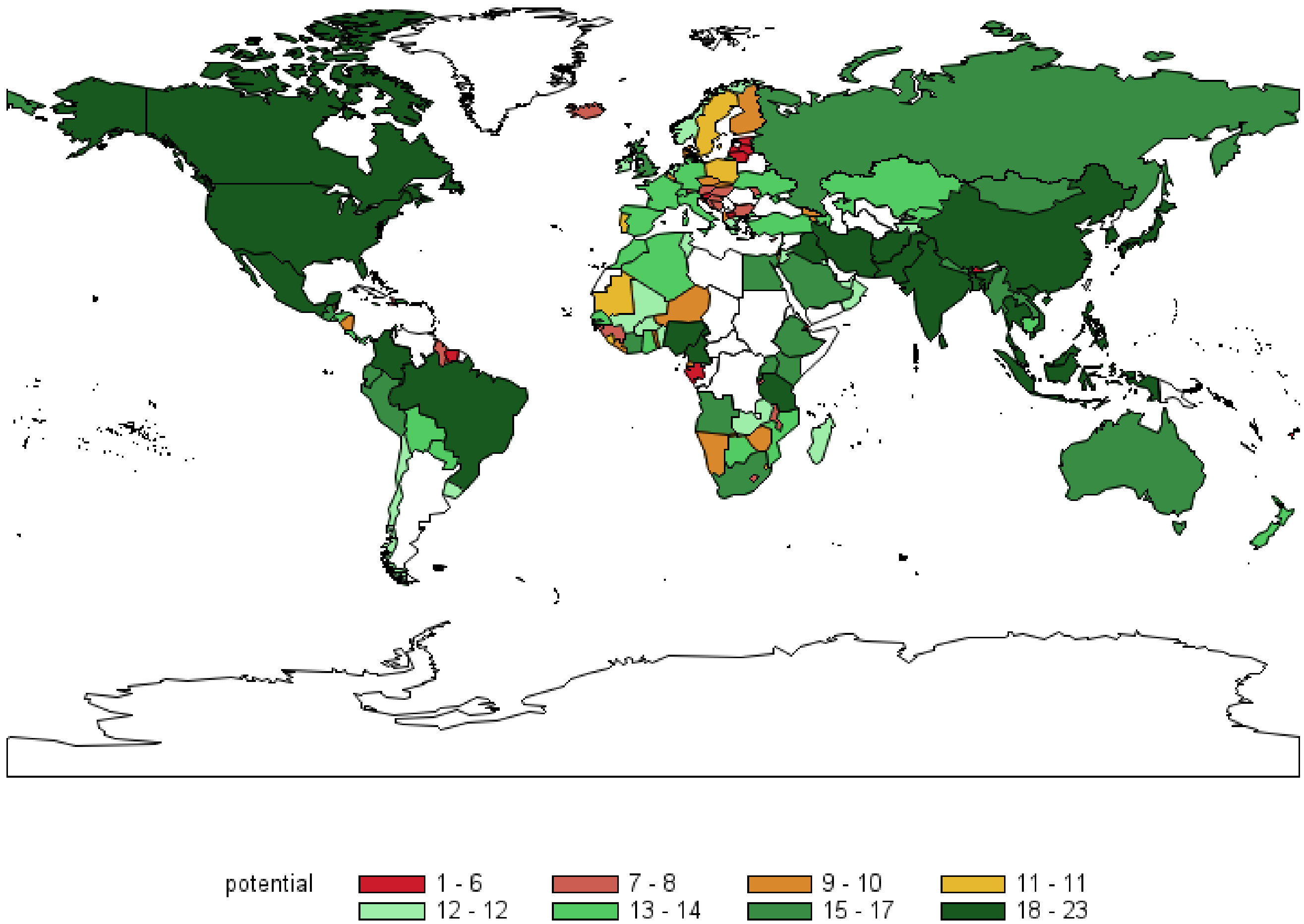

Figure 1: Trade Potential for Commodity Code 84

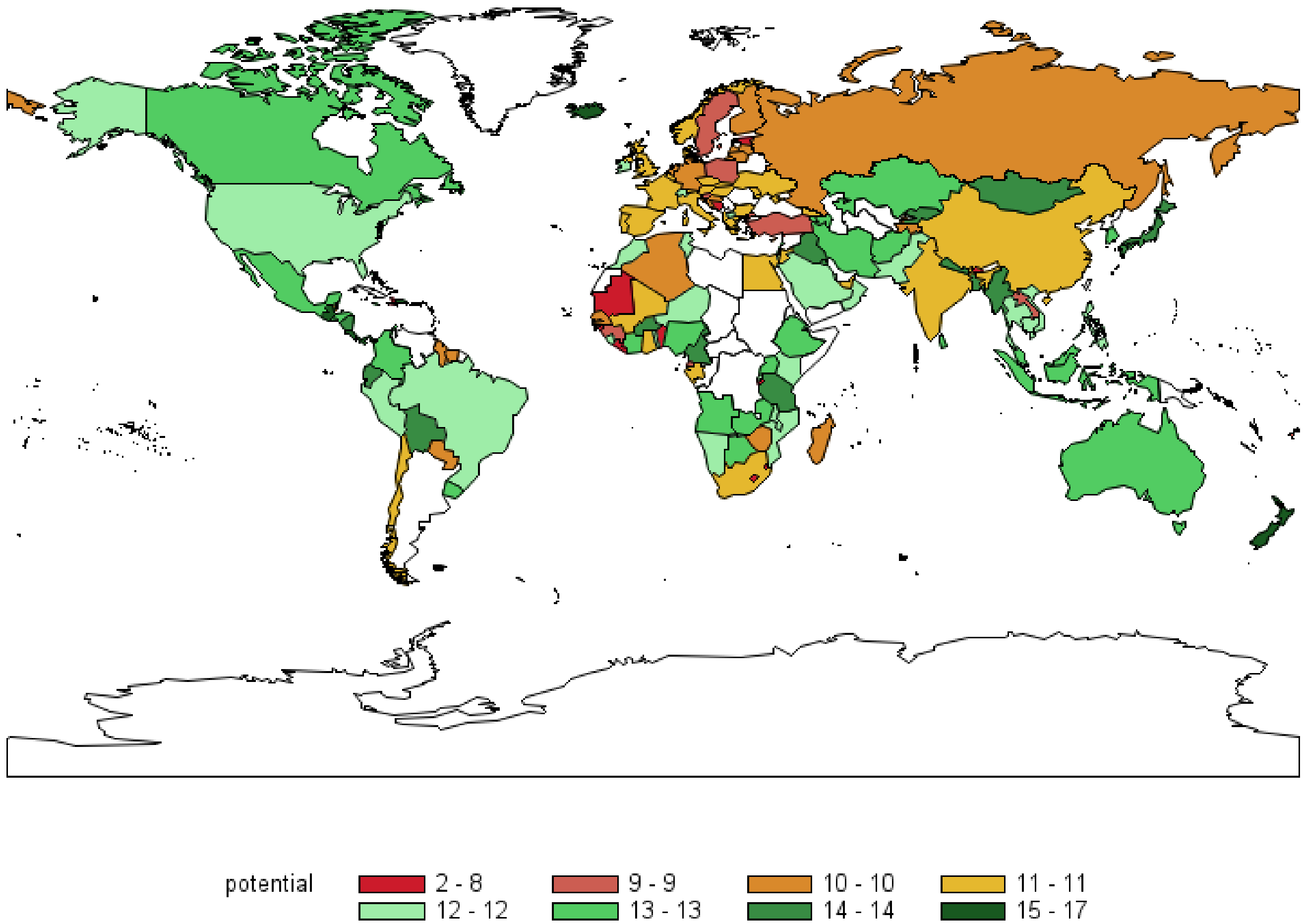

Figure 2: Trade Potential for Commodity Code 85

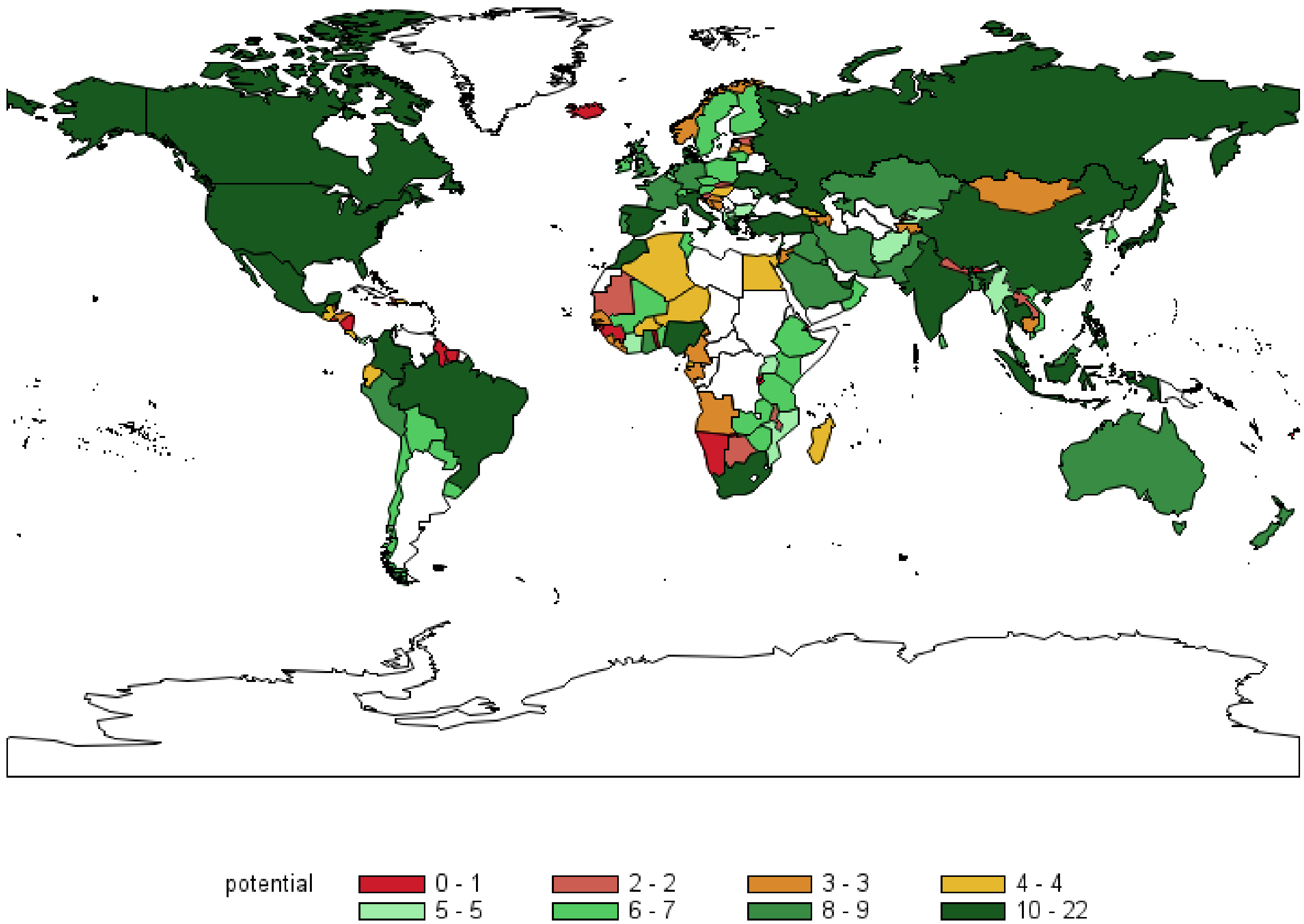

Figure 3: Trade Potential for Commodity Code 86

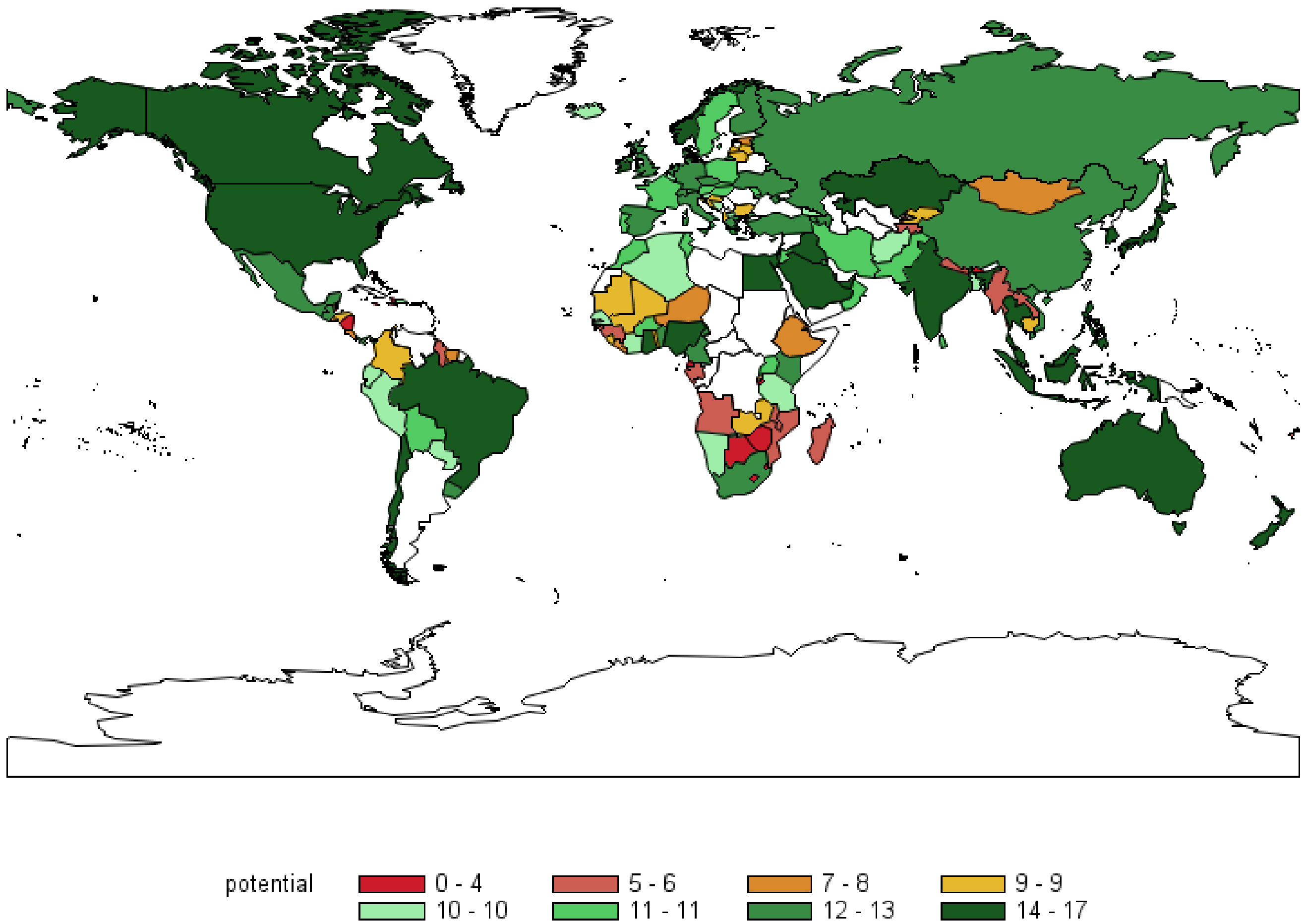

Figure 4: Trade Potential for Commodity Code 87

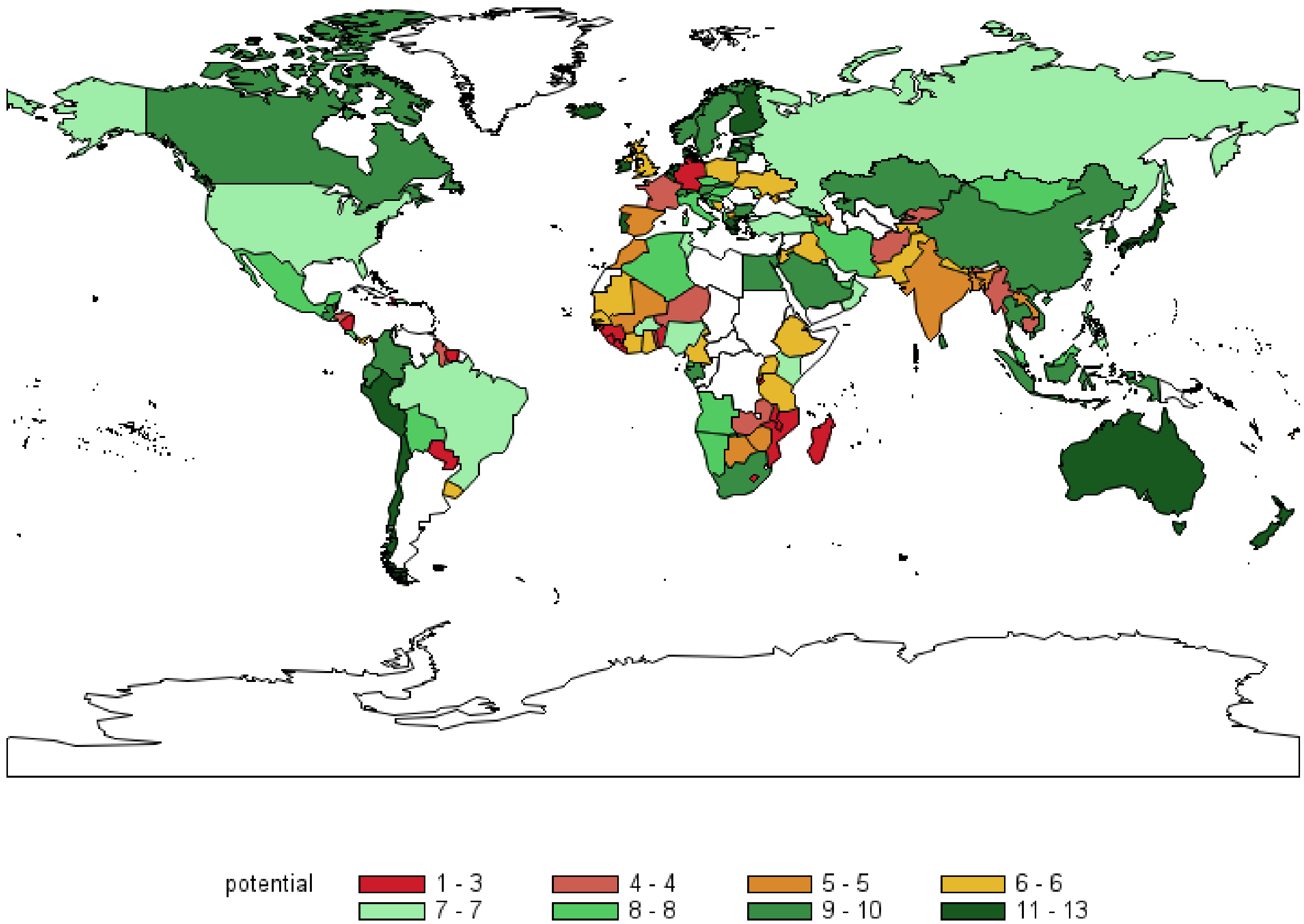

Figure 5: Trade Potential for Commodity Code 88

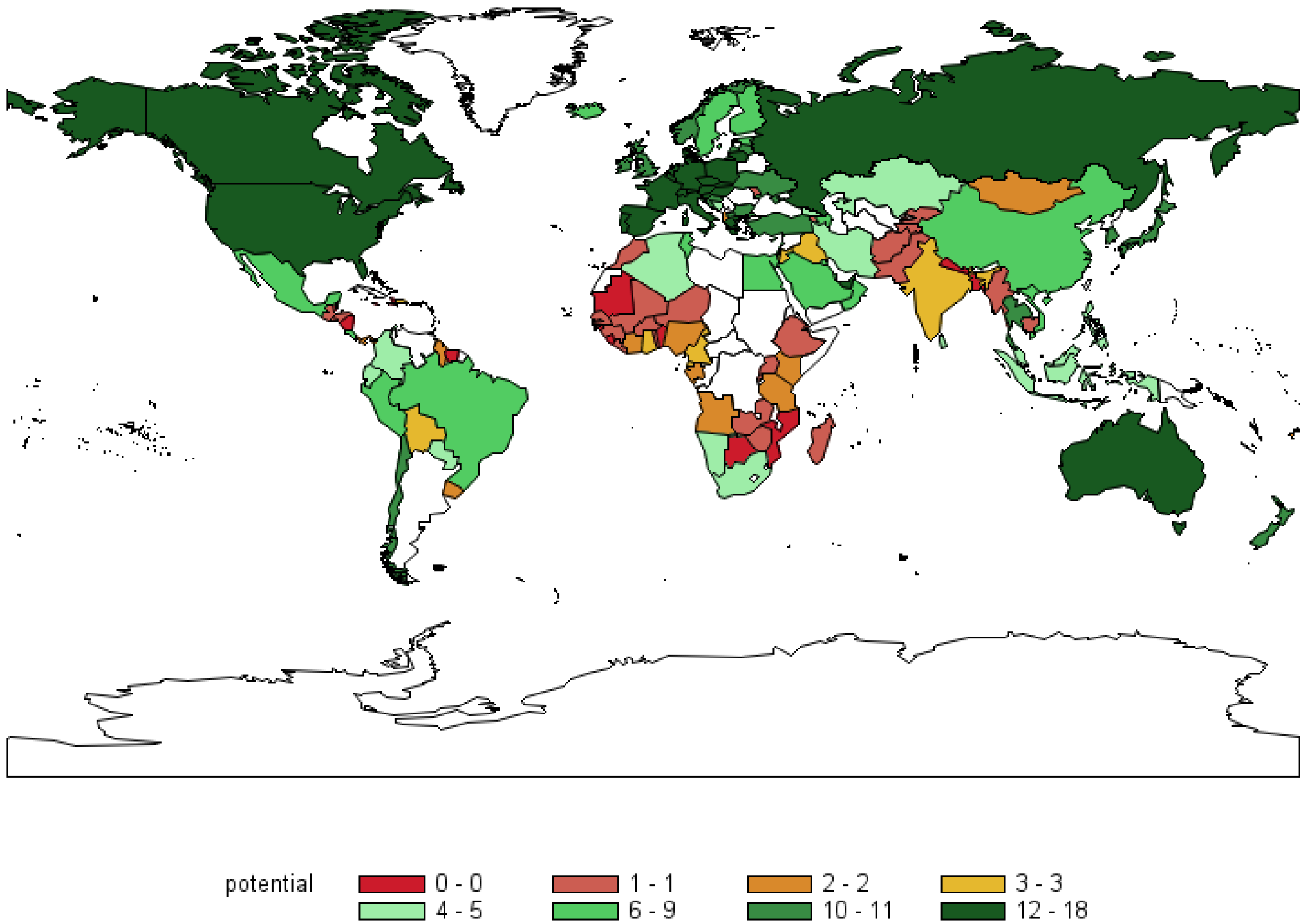

Figure 6: Trade Potential for Commodity Code 89

5. Conclusions

The scope of this thesis was to estimate the trade potential for 28 EU countries for the 6 major exporting commodities of the manufacturing products (84-89). The contribution of this analysis lies in two parts. The first one is that no previous study has examined the trade potential of manufacturing products for the 28 European countries using panel data. The second one, lies in the way our results are shown. We present the magnitude of trade potential using colored maps and thus give a more clear and understandable image of our analysis results.

Our sample included 237 countries of the world and all the commodity codes 1 through 99 for the years 2005-16. The 2-digit HS (Harmonized System) classification was used and all the data were downloaded from the United Nations Comtrade database. The focus of this analysis was turned onto the manufacturing products and thus as an initial step we specified the sample only for the codes resembling the industry sector. In order to derive the trade potential, the predicted values of trade were needed. We employed a two step approach using the "augmented" gravity model to acquire the predicted values. Our estimations were made using the fixed effects method, but we also offered estimation results by using 4 other methods: Pooled OLS, Random Effects, LSDV and PPML. These were made in order to compare the benchmarks of each estimation and point out the differences in the estimations.

The estimation process came up to be restrained by the computing power and program ability, because of the magnitude of the sample, so due to these issues our analysis narrowed the scope furthermore. A table was presented for the major exporting categories for the time interval of 2005-16 and thus the groups of 16 and 17 emerged. These two categories included the commodity codes 84 to 89 so the estimation process changed. We regressed our model 6 separate times using the 6 different commodity codes and derived the predicted values for each one of them. Our estimation results fell very close to our expectations and aligned with the existing literature; however some key fummy variables such as FTA did not present the expected signs or any statistical significance. Furthermore, all of the effects that are traditionally observed in the "gravity" approach were reasonable and statistically significant. The estimations allowed us to calculate trade potential for each code, for the 28 EU exporting countries.

After the trade potential was derived, 6 separate maps - one for each commodity - were created for better visualizing of trade potential. We illustrated the trade potential the European Countries have for the year of 2016 for each commodity code separately by allowing color coding for a clearer picture. Specifically, Europe showed a great trade potential with major countries of both the West and the East. The estimates of EU countries' global trade potential revealed that the magnitude of their trade potential is at its highest level in the North America region alongside with the Asia-Pacific region and later on with Western Europe. USA, Russia and Australia formed a pattern of countries that maintained a rather high and steady level of trade potential, especially for products of nuclear reactors.

The way the maps illustrate the trade potential EU countries have with the rest of the world makes it easier to comprehend and comment upon. These findings were very important and essential in order to derive some policy making decisions - which were offered and explained on the last part of our estimation results section - that EU countries could implement to increase their trade flows. For example, as mentioned above, nuclear energy appeared to be a sector in which the European countries presented great potential. A rather logical outcome of this analysis and of these outcomes would be for Europe to create a specific trade agreement for nuclear reactors with countries of B.R.I.C (Brazil, Russia, India and China). This could increase Europe's exports in nuclear products; nuclear energy is a sector which requires a lot of knowledge and specialization and appears to be very profitable and promising. Since few countries obtain this kind of energy, it seems that Europe can be a very wealthy and trustworthy provider.

Furthermore, the countries which presented a great potential to trade are considered large both in population and in economic factors. This is something extremely profitable for the European countries who wish to export more, since these trading partners will present a rather high and steady demand rate. Commodities which also appeared important were ships, railways and vehicles. All of these products fall under the "heavy machinery" of Europe's production and they are sectors which can very quickly enhance the financial status of the EC. More exactly, some of the countries that emerged as high potential partners for trade were China, Japan, India and the UAE. China and Japan maintain one of the largest high-speed railway systems in the world while their transportation relies heavily on trams, metros and bullet trains. In addition, India due to its huge country size is developing high-speed railway networks for transportation of people and goods.The UAE in their effort of finding a fast and reliable way of transportation through the dessert from one emirate to the other, are also developing high-speed and low cost railway networks. Thus, Europe can indeed take advantage of the need for railway and tramway parts these countries have and increase its trade by boosting the production of these goods and by forming trade agreements that enhance heavy equipment exportation.

Overall, the results obtained from the maps show that Europe can form if not make better the trade agreements and relations with many countries outside of its "safe zone". EC did not show any significant signs of trade potential within the continent of Europe and so if Europe wishes to expand its trade zones and take advantage of its trade potential, then it must expand in both directions of East and West.

It is very important to note that this study suffers from numerous limitations both in the econometric approach as well as in the methodological one. As mentioned above the computational power showed up to be a significant barrier. The approach of the study while theoretically stable and correct stumbled upon the regression limitations. Perhaps a more narrow sample of either countries or commodities should be considered in order to derive the initially wished results or a differently structured model should be employed.

Finally, the traditional approach of the gravity equation however important is not something the future studies should rest upon. Since the method of SFA, which is included in the literature section of this thesis, is strongly supported and well established, future researches should turn their scope towards that direction. Regarding the constraints of both scope and econometric approach, when they are both solved the next step of this research is to widen the field of products and the number of countries considered and derive more interesting and versatile results for the trade potential.

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Appendix

Tables 9-15 present all the countries our data-sample include. All countries are listed alphabetically.

Table 9: Countries Pt1

Country name	Continent	EU
Afghanistan	Asia	
Albania	Europe	
Algeria	Africa	
American Samoa	North America	
Andora	Europe	
Angola	Africa	
Anguila	North America	
Antarcticta	Antarctica	
Antigua and Barbuda	North America	
Argentina	South America	
Armenia	Europe	
Aruba	South America	
Australia	Oceania	
Austria	Europe	Yes
Azerbaijan	Europe	Yes
Bahamas	North America	
Bahrain	Asia	
Bangladesh	Asia	
Barbados	North America	
Belarus	Europe	
Belgium	Europe	Yes
Belize	North America	
Benin	Africa	
Bermuda	North America	
Bhutan	Asia	
Bolivia	South America	
Bonaire	South America	
Bosnia Herzegovina	Europe	
Botswana	Africa	
Bouvet Island	Europe	
British Indian Ocean T.	Africa	
British Virgin Isds	North America	
Brazil	South America	
Brunei Darussalam	Asia	

Table 10: Countries Pt2

Country name	Continent	EU
Bulgaria	Europe	Yes
Burkina Faso	Africa	
Burundi	Africa	
Cabo verde	Africa	
Colombia	South America	
Cameroon	Africa	
Canada	North America	
Cayman Isds	North America	
Central African Re	Africa	
Chad	Africa	
Chile	South America	
China	Asia	
China, Hong-Kong S	Asia	
China, Macao SAR	Asia	
Christmas Isds	Asia	
Cocos Isds	Asia	
Colombia	South America	
Comoros	Africa	
Congo	Africa	
Cook Isds	Oceania	
Costa Rica	South America	
Croatia	Europe	Yes
Cuba	South America	
Curacao	South America	
Cyprus	Europe	Yes
Czechia	Europe	Yes
Cote d'Ivoire	Africa	
Dem. People's Rep.	Africa	
Dem. Rep. of Congo	Africa	
Denmark	Europe	Yes
Djibouti	Africa	
Dominican Rep.	South America	
Ecuador	South America	
Egypt	Africa	
El Salvador	South America	
Equatorial Guinea	Africa	

Table 11: Countries Pt3

Country name	Continent	EU
Eritrea	Africa	
Estonia	Europe	Yes
Ethiopia	Africa	
FS Micronesia	Oceania	
Faeroe Isds	Europe	
Falkland Isds	South America	
Fiji	Oceania	
Finland	Europe	Yes
Fmr Sudan	Africa	
Fr. South Antarctica	Europe	
France	Europe	Yes
French Polynesia	Oceania	
Gabon	Africa	
Gambia	Africa	
Georgia	Europe	
Germany	Europe	Yes
Ghana	Africa	
Gibraltar	Europe	
Greece	Europe	Yes
Greenland	Europe	
Grenada	North America	
Guam	Asia	
Guatemala	South America	
Guinea-Bissau	Africa	
Guyana	South America	
Haiti	North America	
Heard Island and M	Oceania	
Holy See (Vatican)	Europe	
Honduras	North America	
Hungary	Europe	Yes
Iceland	Europe	
India	Asia	
Indonesia	Asia	
Iran	Asia	
Iraq	Asia	
Ireland	Europe	Yes

Table 12: Countries Pt4

Country name	Continent	EU
Israel	Asia	
Italy	Europe	Yes
Jamaica	North America	
Japan	Asia	
Jordan	Asia	
Kazakhstan	Asia	
Kenya	Africa	
Kiribati	Oceania	
Kuwait	Asia	
Kyrgyzstan	Asia	
Lao People's Dem.	Africa	
Latvia	Europe	Yes
Lebanon	Asia	
Lesotho	Africa	
Liberia	Africa	
Libya	Africa	
Lithuania	Europe	
Luxembourg	Europe	Yes
Madagascar	Africa	
Malawi	Africa	
Malaysia	Asia	
Maldives	Asia	
Mali	Africa	
Malta	Europe	Yes
Marshall Isds	Oceania	
Mauritania	Africa	
Mauritius	Africa	
Mayotte	Africa	
Mexico	North America	
Mongolia	Asia	
Montenegro	Europe	
Montserrat	North America	
Morocco	Africa	
Mozambique	Africa	
Myanmar	Asia	

Table 13: Countries Pt5

Country name	Continent	EU
N. Mariana Isds		
Namibia	Africa	
Nauru		
Nepal	Asia	
Neth. Antilles		
Netherlands	Europe	Yes
New Caledonia		
New Zealand	Oceania	
Nicaragua		
Nigeria	Africa	
Niue		
Norfolk Isds		
Norway	Europe	
Oman		
Pakistan	Asia	
Palau		
Panama	South America	
Papua New Guinea	Oceania	
Paraguay	South America	
Peru	South America	
Philippines	Asia	
Pitcairn		
Poland	Europe	Yes
Portugal	Europe	Yes
Qatar	Asia	
Rep. of Korea	Asia	
Rep. of Moldova	Europe	
Romania	Europe	Yes
Russian Federation	Asia	
Rwanda	Africa	
Saint Barthélemy		
Saint Helena		
Saint Kitts and Ne		
Saint Lucia		

Table 14: Countries Pt6

Country name	Continent	EU
Saint Maarten		
Saint Pierre and M		
Saint Vincent and		
Samoa		
San Marino	Europe	
Sao Tome and Princ		
Saudi Arabia	Asia	
Senegal	Africa	
Serbia and Montenegro	Europe	Yes
Seychelles		
Sierra Leone	Asia	
Singapore	Asia	
Slovakia	Europe	Yes
Slovenia	Europe	Yes
Solomon Isds		
Somalia	Africa	
South Africa	Africa	
South Georgia and	Europe	
South Sudan	Africa	
Spain	Europe	Yes
Sri Lanka	Asia	
State of Palestine	Asia	
Sudan	Africa	
Suriname	South America	
Swaziland		
Sweden	Europe	Yes
Switzerland	Europe	
Syria	Asia	
TFYR of Macedonia	Europe	
Tajikistan	Asia	
Thailand	Asia	
Timor-Leste		
Togo		
Tokelau		

Table 15: Countries Pt7

Country name	Continent	EU
Tonga	Oceania	
Trinidad and Tobago	South America	
Tunisia	Africa	
Turkey	Europe	
Turkmenistan	Asia	
Turks and Caicos I	North America	
Tuvalu	Oceania	
USA	North America	
Uganda	Africa	
Ukraine	Europe	
United Kingdom	Europe	Yes
United Rep. of Tan	Africa	
United States M.O Isds	North America	
Uruguay	South America	
Uzbekistan	Asia	
Vanuatu	Oceania	
Venezuela	South America	
Viet Nam	Asia	
Wallis and Futuna	Oceania	
Western Sahara	Africa	
Yemen	Asia	
Zambia	Africa	
Zimbabwe	Africa	

Hausman Test Results by Commodity Group

Commodity Group: 84

b = consistent under H_0 and H_1; obtained from xtreg
B = inconsistent under H_1, efficient under H_0; obtained from xtreg
Test: H_0: difference in coefficients not systematic
$chi2(20) = (b - B)'[(V_b - V_B)^(-1)](b - B) = 54.26$
$Prob > chi2 = 0.0001$

Commodity Group: 85

b = consistent under H_0 and H_1; obtained from xtreg
B = inconsistent under H_1, efficient under H_0; obtained from xtreg
Test: H_0: difference in coefficients not systematic
$chi2(20) = (b - B)'[(V_b - V_B)^(-1)](b - B) = 121.76$
$Prob > chi2 = 0.0000$

Commodity Group: 86

b = consistent under H_0 and H_1; obtained from xtreg
B = inconsistent under H_1, efficient under H_0; obtained from xtreg
Test: H_0: difference in coefficients not systematic
$chi2(20) = (b - B)'[(V_b - V_B)^(-1)](b - B) = 52.37$
$Prob > chi2 = 0.0001$

Commodity Group: 87

b = consistent under H_0 and H_1; obtained from xtreg
B = inconsistent under H_1, efficient under H_0; obtained from xtreg
Test: H_0: difference in coefficients not systematic
$chi2(20) = (b - B)'[(V_b - V_B)^(-1)](b - B) = 65.52$
$Prob > chi2 = 0.0000$

Commodity Group: 88

b = consistent under H_0 and H_1; obtained from xtreg
B = inconsistent under H_1, efficient under H_0; obtained from xtreg
Test: H_0: difference in coefficients not systematic
$chi2(20) = (b - B)'[(V_b - V_B)^(-1)](b - B) = 81.46$
$Prob > chi2 = 0.0000$

Commodity Group: 89

b = consistent under H_0 and H_1; obtained from xtreg
B = inconsistent under H_1, efficient under H_0; obtained from xtreg
Test: H_0: difference in coefficients not systematic
$chi2(20) = (b - B)'[(V_b - V_B)^(-1)](b - B) = 58.05$
$Prob > chi2 = 0.0000$

Table 16: Industrial Products; HS 2002 Classification by Section

CC Section	Section Title	CC No
SECTION IX	WOOD AND ARTICLES OF WOOD; WOOD CHARCOAL; CORK AND ARTICLES OF CORK; MANUFACTURES OF STRAW, OF ESPARTO OR OF OTHER PLAITING MATERIALS; BASKETWARE AND WICKERWORK	44-46
SECTION X	PULP OF WOOD OR OF OTHER FIBROUS CELLULOSIC MATERIAL; RECOVERED (WASTE AND SCRAP) PAPER OR PAPERBOARD; PAPER AND PAPERBOARD AND ARTICLES THEREOF	47-49
SECTION XI	TEXTILES AND TEXTILE ARTICLES	50-63
SECTION XII	FOOTWEAR, HEADGEAR, UMBRELLAS, SUN UMBRELLAS, WALKING-STICKS, SEAT-STICKS, WHIPS, RIDING-CROPS AND PARTS THEREOF; PREPARED FEATHERS AND ARTICLES MADE THEREWITH; ARTIFICIAL FLOWERS; ARTICLES OF HUMAN HAIR	64-67
SECTION XIII	ARTICLES OF STONE, PLASTER, CEMENT, ASBESTOS, MICA OR SIMILAR MATERIALS; CERAMIC PRODUCTS; GLASS AND GLASSWARE	68-70
SECTION XIV	NATURAL OR CULTURED PEARLS, PRECIOUS OR SEMI-PRECIOUS STONES, PRECIOUS METALS, METALS CLAD WITH PRECIOUS METAL AND ARTICLES THEREOF; IMITATION JEWELLERY; COINE	71
SECTION XV	BASE METALS AND ARTICLES OF BASE METAL	72-83
SECTION XVI	MACHINERY AND MECHANICAL APPLIANCES; ELECTRICAL EQUIPMENT; PARTS THEREOF; SOUND RECORDERS AND REPRODUCERS, TELEVISION IMAGE AND SOUND RECORDERS AND REPRODUCERS, AND PARTS AND ACCESSORIES OF SUCH ARTICLES	84-85
SECTION XVII	VEHICLES, AIRCRAFT, VESSELS AND ASSOCIATED TRANSPORT EQUIPMENT	86-89
SECTION XVIII	OPTICAL, PHOTOGRAPHIC, CINEMATOGRAPHIC, MEASURING, CHECKING, PRECISION, MEDICAL OR SURGICAL INSTRUMENTS AND APPARATUS; CLOCKS AND WATCHES; MUSICAL INSTRUMENTS; PARTS AND ACCESSORIES THEREOF	90-92
SECTION XIX	ARMS AND AMMUNITION; PARTS AND ACCESSORIES THEREOF	93
SECTION XX	MISCELLANEOUS MANUFACTURED ARTICLES	94-96
SECTION XXI	WORKS OF ART, COLLECTORS' PIECES AND ANTIQUES	97-98