TRADE FLOWS BETWEEN THE EUROPEAN UNION AND LATIN AMERICA: A GRAVITY MODEL

The increase of the economic and political relations among countries allows us to direct our attention to the approximation of the European Union and the countries of Latin America. In this paper there are studied and analyze the commercial flows added among several countries of the European Union and Latin America during the period 1995-2013. The analysis is carried out across the specification and estimation of a gravity equation that collect the impact that has on the international trade variable as the income of the countries that trade, the population, the distance that separates them as measure of the costs of transport and another variable across which we can observe if they share maritime border.

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DIAGRAMS AND CHARTS

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1. INTRODUCTION

The phenomenon of globalization has acquired great importance and interest for all the countries. By economic globalization we mean the total of trade exchanges, of capital and even migratory flows among different countries. In this framework, the countries of the European Union and Latin America have made the best use of globalization growth to strengthen the exchange of goods and services. Throughout history, the European Economic Community or the European Union as known today, has promoted and developed a series of political, commercial and cooperation initiatives with Latin American countries. Besides, during the last years, the European Union has shown a growing interest in strengthening commercial and economic relations with this region. For Spain and Portugal, due to the intensive historical and cultural existing links, progress in this area is becoming particularly important and in terms of evaluation of the effects of relations intensification and also from the perspective of the configuration of future European economic policy measures.

Therefore, we are going to focus our paper on the behaviour of trade flows among the countries of the European Union and Latin America. To do that, we carried out an analysis of trade flows in both areas during the last years. More specifically we address the modeling of a gravity equation that permits the identification of variables with higher explanatory power of the trade among those countries. We incorporate as variables the GDP of both sides, their population, the distance that separates them and the dummy variable sharing a maritime border or not. In order to estimate the equation we use the estimator of Ordinary Least Squares, Fixed Effects and Random Effects and we analyze the different behaviour of the obtained estimators.

The period analyzed covers from 1995 to 2013. Halfway this period, approximately, is when the current economic crisis began. Consequently, we can observe if there have been relevant changes in trade flows between both areas due to this crisis.

The countries considered have been the member states of the European Union and a selection of Latin American countries. On one hand, the members of the European Union are Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the UK. On the other hand, the Latin American countries included are: belonging to the Andean Community: Bolivia, Colombia, Ecuador and Peru; from Central America: Guatemala, Belize, Honduras, El Salvador, Nicaragua, Costa Rica and Panama; from Mercosur: Argentina, Brazil, Paraguay, Uruguay and Venezuela; and finally Mexico and Chile.

The structure that the rest of the paper has is the following: section 2 presents the descriptive framework where we can see a short description of trade flows between both areas and some of its characteristics; in section 3 we present a description of the literature where we see that most of papers about trade flows of countries carry a gravity model for their explanation that is similar to the one in this paper; in section 4 we observe an analytical framework where we give an explanation of the gravity equation and the data and series collected; in section 5 we find the empirical framework where we find the specification of the econometric model; the data and calculation are carried out in section 6; finally, conclusions about the paper are presented.

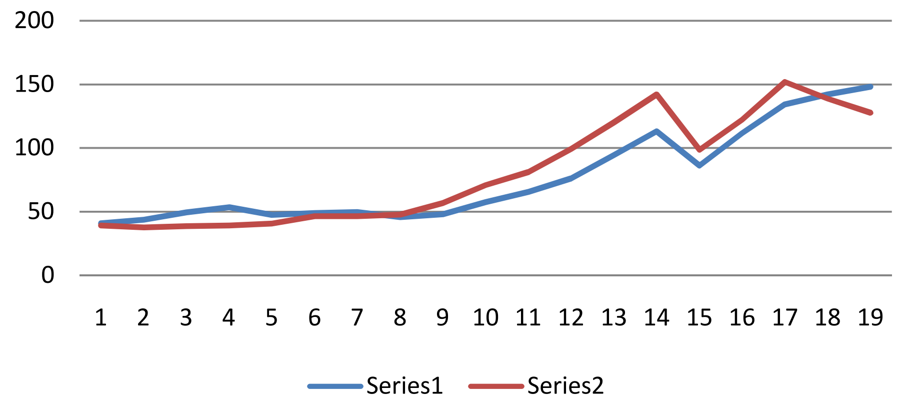
2. DESCRIPTIVE FRAMEWORK

In the following section I am going to analyze the behavior of trade flows between the European Union and Latin America in the last years. The period to be analyzed covers from the year 1995 to 2013. In this period we will be able to observe if the economic and financial crisis with the bankruptcy of Lehman Brothers bank on the 15th of September- 2008, that in the summer of 2007 started showing some signs of instability and problems in the world economy, has affected the trade relations between the European Union and Latin America. We will also observe how these trade flows have evolved and its possible causes.

Obtaining cheaper foreign products or with a higher quality is one of the main reasons why there is an exchange of goods among different nations. But the goods exchange between nations happens not only for the two reasons mentioned above. Among the most important reasons we find the different technologies used in each country, the total quantity of resources available in each country, the outsourcing costs and the physical distance between the countries.

In order to get a general vision of what has been happening from 1995 to 2013 in exports and imports from the European Union to Latin America, we will check a figure where both variables are represented, like the following:

FIGURE 1: EVOLUTION OF TRADE FLOWS FROM THE EU TO LATIN AMERICA
(Thousands of $)



SOURCE: Own elaboration on data from DataComex database.

In the last years, trade relations between both regions have considerably increased as they can be considered natural partners due to the close historical, cultural and economic ties they share. Besides, they show a growing convergence of basic values and principles.

The European Union (EU) and Latin America and the Caribbean (ALC) are natural allies tied by powerful historical, cultural and economic ties they share. They also share a common commitment to human rights, democracy, good governance, multilateralism and social cohesion, and they cooperate to achieve these objectives. This makes them well-matched partners to address global challenges together. The summits carried out every two years have strengthened this bilateral relation in the last years.

Between the years 1995 and 2000 fourth generation political agreements took place and these are marked by the economic partnership, coordination and political cooperation, by reciprocity agreements and common interest, by the institutionalization of political dialogue, by the liberalization of trade of goods and services in a bilateral and preferential way, on a gradual and reciprocal basis, by democratic and human rights principles, by the creation of a Joint Council, the cooperation if several sectors like the industrial one, financial investment, SMEs, future developments' clause, by agreements on public procurement, competition policies and property rights and by political dialogue conducted at different levels.

These fourth generation agreements provided better chances of accessing research and development intercommunity programs, training or education, advanced technology and telecommunications. Apart from that, at the same time than these agreements, the European Union created the Amsterdam Treaty in 1997 and the Treaty of Nice in the year 2000.

Therefore, in the period between 1995 and 2001 the bilateral trade balance of the European Union to Latin America was positive, as exports were higher than imports. We can observe a clear growth of exports until 1999 when there was a weakening of trade and economic relations of Latin America and there was a downturn of -6.183, 18 thousands of dollars in the products imported from the European Union. Exports started growing back, although at a low rate, until the year 2002 when they lowered again and we find the first negative value of the trade balance. As discussed earlier, in this period they carried out fourth generation agreements and the first Summit of the Strategic Partnership between the European Union and Latin America that took place in Rio de Janeiro based on three basic pillars: political dialogue, trade and economic relations and cooperation. That is why, exports as well as imports had a positive growth trend.

During the period between 2002 and 2008 there was a remarkable growth of exports and imports, although in this period, imports grew at a higher rate and their levels were higher to that of exports. Due to the higher level of exports, the trade balance was negative during all these years. During this 6 year period the four next summits after Rio de Janeiro's in 1999 took place, with them, trade relations between the two regions strengthened and that is reflected on the significant growth of trade flows.

However, by mid-2008, on the 15th of September exactly, due to the bankruptcy of Lehman Brothers Bank the countries experimented the beginning of one of the deepest and longest crisis until that moment that triggered a decrease of trade flows between the countries. In this case, exports and imports from the European Union with Latin American countries decreased considerably in the year 2009; exports decreased exactly by -26.821,3097 thousands of dollars and imports by -43.527, 31157 thousands of dollars. However, later on, in the year 2010 there was an improvement in goods exchange and they rose again. During that year they celebrated the sixth summit in Spain that, among other steps, focused on the re-launch of negotiations of the European Union with Mercosur. In other words, the celebration of this summit helped exports and imports with of the European Union with Latin America surge again.

Lastly we will observe a change of behaviour in trade flows. From 2011, imports fell while exports kept growing until, finally, in the year 2012, the European Union presented a positive trade balance with Latin America and in the year 2013 the balance is still positive.

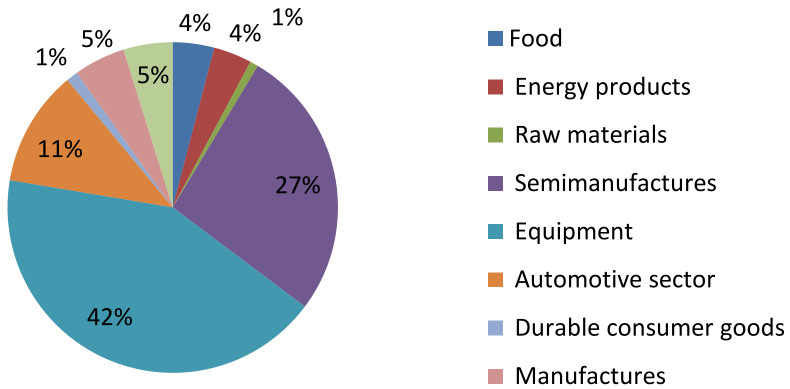
After all the aforesaid, we reach the conclusion that trade relations between the European Union are higher as time passes due to the increase of agreements and facilities between them; exports as well as imports present a growing tendency despite fluctuations throughout the period analyzed. On the other hand, the trade balance of the European Union with Latin America has been negative from 2002 to 2011 both included, and positive in the years between 1995 and 2001 and 2012 and 2013.

The main reason why the countries exchange different products among them is the existence of an absolute advantage and a comparative advantage. When a country has the best technology in the production of goods, they have an absolute advantage in the production of that good; however, absolute advantage is not a good explanation for trade patterns. The main reason why countries trade is the comparative advantage. A country has a comparative advantage in the production of the goods they make most efficiently comparing it to the way they produce others. This comparative advantage is materialized in many cases in some kind of Ricardo-type models, technology difference among countries, or in the model of Heckscher-Ohlin-Samuelson, resource difference among countries.

Exports and imports of the European Union with Latin America present a different structure, as we can see in the two figures below:

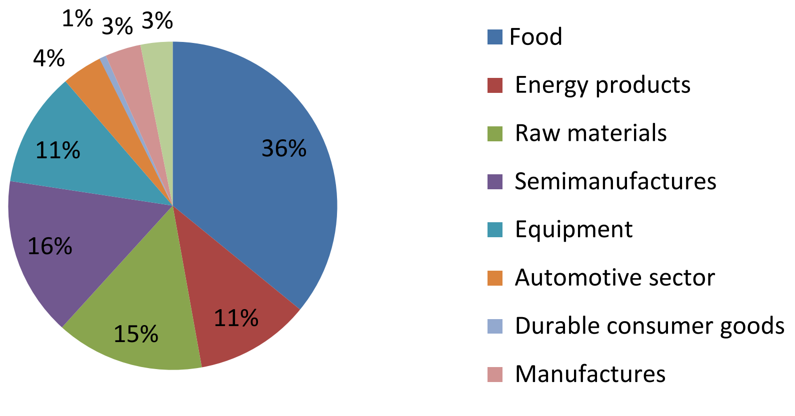
FIGURE 2: **EXPORT ESTRUCTURE FROM THE EUROPEAN UNION TO LATIN AMERICA 1995-2013**

(%)



SOURCE: Own elaboration on data from DataComex database.

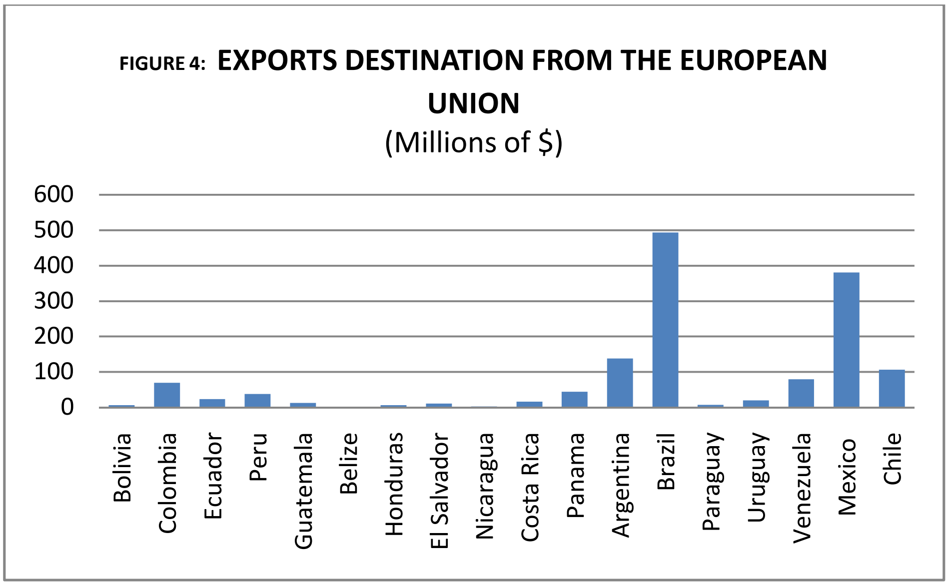
FIGURE 3: IMPORT ESTRUCTURE FROM THE EUROPEAN UNION TO LATIN AMERICA 1995-2013
(%)



SOURCE: Own elaboration on data from DataComex database.

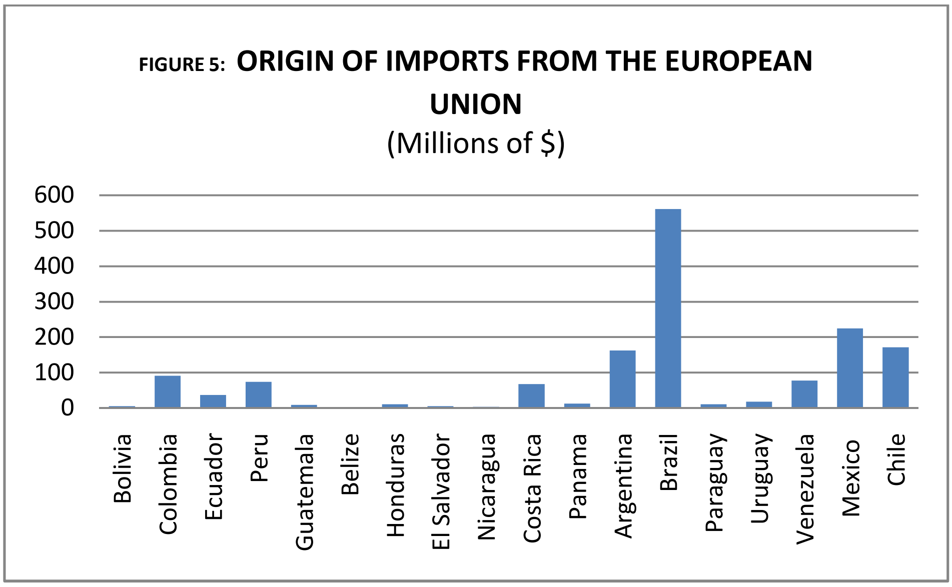
The type of trade between these two countries is in a relevant part inter-industry trade as an important percentage of products exchanged between both regions belong to different industries or sectors. The fact of carrying out an inter-industrial trade promotes resource optimization as each nation specializes in the products for which they have a comparative advantage. In this case, if we consider the sector specialization of trade flows between the European Union and Latin America, it shows a high concentration of capital goods products, semi-manufactures and automotive sector goods in the exports of the European Union to Latin America as shown in figure 2. During the period analyzed, more than 42% of exports belonged to the capital goods sector, 27% to the semi-manufactures sector and 11% to the automotive sector. On the imports side, the European Union procures goods and services from the food sector that takes 36% of their imports, in the first place, a 16% of semi-manufactures and a 15% of raw materials complete their imports. We can see, then, that the European Union and Latin America trade very different quantities of very different products. This is necessary as each region has comparative advantages in the goods production, that is to say, each region produces certain goods better than they produce others. Therefore, the countries will market the products for which they have a comparative advantage. In the case of the European Union, the comparative advantage is found in the products coming from the machinery and equipment sector as the level of technology development of the European Union is higher than Latin America's. The comparative advantage of Latin America is found, mainly, in the food sector, as Latin America is endowed with natural resources and biodiversity.

We can see a clear diversification of exports from the European Union to Latin America (figure 4). On the one hand, Brazil and Mexico stand out mainly, and they are followed by Argentina and Chile, as the main destinations of exports of goods and services from the European Union. The European Union has realized that Brazil has taken an important economic and diplomatic weight worldwide and that's why we have increased our trade relations and politics with the country; additionally, the European Union and Mexico have increased their trade relations due to the opening up of trade that Mexico started in the eighties of the twentieth century. On the other hand, the countries that purchase the smallest quantity of products are Belize, Nicaragua, Bolivia, Honduras and Paraguay. Exports to Belize are extremely low compared to the rest of Latin American countries that trade with the European Union.



SOURCE: Own elaboration on data from DataComex database.

It is not surprising that the countries that provide the biggest quantity of goods and services to the European Union are the ones that purchase from them. That is to say, Brazil and Mexico are the main source countries of goods and services the Europeans purchase, due to the increase of trade and political relations of the European Union and these two regions. The smallest quantity of imports comes from countries like Belize, Bolivia and Guatemala. Exports and Imports are higher in countries that trade more with the European Union due to its political ties, as it happens with Brazil and Mexico.



SOURCE: Own elaboration on data from DataComex database.

To conclude this section, we draw the main conclusions of trade flows between both regions through data and figures of exports and imports coming from DataComex database.

First of all, trade flows of goods and services among countries belonging to the European Union and Latin America have presented a positive growth over the past years due to the increase of trade and political relations between both regions. Fluctuations of exports and imports have caused trade balances of the European Union with Latin America with a positive and negative values, but this hasn´t been a barrier for the increase of transactions between them.

On the other hand, the European Union and Latin America carry out an inter-industrial trade as the goods they exchange don't come from the same sector, but each one takes advantage of their comparative advantage and benefits from it when carrying out inter-industrial trade. This trade promotes specialization and a better use of the resources of each region.

Finally, the countries that purchase the highest quantity of products from the European Union are the same countries that provide the biggest quantity of goods and services that are purchased by Europeans and come from Latin America, those countries being Brazil and Mexico. Furthermore, the countries that exchange the smallest quantity of products with European countries, in exports as well as in imports are Belize, Nicaragua, Bolivia and Guatemala. That is to say, the countries that purchase the highest quantity of European products are the ones that sell more products to the European Union and vice versa.

3. REVIEW OF THE LITERATURE

Traditionally, during the last decades many papers and research articles related to the analysis of trade flows among countries carry out a gravitation econometric model in order to analyze these flows. Others, however, are based on several explanations of trade relations. In this section, we present several articles related to trade flows among countries where a gravity equation is carried out in order to explain these trade relations. The articles are presented in chronological order to observe the improvements in this field. The first author to present a gravity equation as an explanation method of trade relations among countries was Tinbergen (1962) followed by Pöyhönen (1963) and Linneman (1966). These authors proposed a gravity model of trade based on the idea that trade flows between two countries depended on the demand of the importer, of the exporter's supply and the exchange costs. In this gravity equation they incorporated the income variables for countries, their population and the distance between them to explain the trade flow. Later, Bergstrand (1985) wanted to prove that the gravity model presented before was mis-specificated due to the omission of relevant variables, that's why he also included the prices. However, years later, the gravity model was modified and extended by incorporating dummy variables as explanatory variables in the gravity equation. This type of variables could represent, for example, if the trading countries share a maritime border or had regional trade agreements, among other things. The main authors of this modification were Wang and Winter (1994), Laaser and Schrader (2002) and Anderson and Wincoop (2003). On the other hand, Feenstra (2002) proved that the increasing returns to scale also explain trade among countries.

Among the latest papers about bilateral trade flows, we highlight the one (*Cuadros et al.,* 1999). This paper called "Trade relations European Union-Mercosur: modeling of an export function", studies the trade relations existing between the European area and Mercosur countries in the period from 1967 to 1995. In general, they study the interest of the European Union to strengthen economic ties with Latin America due to the expansion potential that Mercosur countries experimented at that time. The authors wanted to focus and give importance to the Mercosur region as it represented the most recent and ambitious attempt of regional integration among the Latin American economies. Besides, from 1995 they implemented the Common Customs Agreement from which Latin American countries experienced a fast liberalization of trade and its trade tariffs reduced drastically, therefore, its trade barriers decreased and they could increase trade with other areas. In order to carry out that study, they presented an export demand function, gravitation model, between both areas with the aim of knowing the added relations between them. The incorporated independent variables in the demanding function are, in the first place, the relative prices between the European Union and Mercosur, the relative prices between the European Union and the United States, Mercosur's income and the United States' income. We should note that the theoretical approach that is the starting point for the estimation of this exports function is the "model of imperfect substitutes", that is, exports or imports can not be considered as perfect substitutes of non-tradable national goods. Thanks to the estimations of the study they reached a series of conclusions. First of all, exchanges between both regions have increased from the 90s. The relation between both regions has consolidated by the effects that the different variables of relative prices and income cause over trade flows between the two regions and, therefore, the results are consistent with the imperfect substitutes model. Another conclusion is that the relations between them are stable through time; estimations have the expected sign and extent, with the exception of the income variable of the European Union. However, the combination of the rest of elasticities has confirmed that Mercosur has a high interest in European products, as it has an importing potential in its purchases to the European Union. A last conclusion is the quick adjustment of exports of the European Union to reach a stable balance long term. They reached this conclusion through the multivariate analysis that was completed with the error correction model that made it possible to examine the trade dynamic short term.

In another paper on trade modeling (Martínez, Cantavella, and Fernández, 2000), authors studied and analyzed the determinants of bilateral flows of international trade among 34 countries and the effects of the existence of the EU, NAFTA, CARICOM AND MCCA. For that purpose they carried out a study of the trade among countries that were at different stages of development and were immersed in trade liberalization processes. The period studied goes from 1980 to 1999. The authors specified and estimated a gravity equation that tries to capture the time pattern of the impacts that the different variables exercised over trade. In the gravity equation they applied logarithms and it was useful to estimate bilateral exports of the countries reviewed. The added independent variables are the country of origin's income, the population of the origin and destination countries, the distance between countries and a dummy that represents preferential trade agreements. For the annual estimates they used MCO; in the estimations of average data for five year periods, they used estimators of random effects; and for estimations with only one export country and all the time period, they applied the fixed effects estimator. The most important conclusions reached by the authors were that the variables normally used in the gravity equation are relevant and show the expected signs. From the block analysis we should note the importance of the exporter size as suppliers. Besides, the most important dummy variable is normally a language in common. From the country study we observe that the gravity equation presents a good behaviour in the case of Spain but not in the case of Mexico. The conclusion to be drawn with this paper is that the estimated potential trade is positive for the total amount of flows among the European Union, Mexico and Spain.

In other paper (Balaguer, and Martínez, 2003), the autors also focused on the analysis of trade flows between the European Union and Mercosur, like in the first paper discussed, and the variables that can influence bilateral trade between both areas. In order to carry out this study they calculated the revealed comparative advantage rate to calculate the sectorial competitiveness of the relations between both areas and the intra-industrial trade rate through the Grubel and Lloyd rates (G-L) (1975) in its two versions and the one carried out by Aquino (1978), and the structure of mutual trade has also been analyzed. They also used the gravity model by estimating a gravity equation for the bilateral trade among the countries belonging to both blocks. They used a gravity model from the bilateral trade flows data of each country of the EU with each country of Mercosur. All the data used in the estimation belongs to the year 1995. The dependent variable is the bilateral trade flow, from the exporting country to the importing country. The independent variables are the exporter's GDP, the importer's GDP, the GDP per capita of the exporting country, the GDP per capita of the importing country, the distance between the trading countries, a dummy that indicates if the countries share a border and another dummy that indicates if the countries belong to the same group or not. Through estimations and the analysis of the relations between both sides, the obtained results indicate that the income and the income per capita of the importing and exporting countries are relevant variables to explain the volume of bilateral trade among the countries analyzed, as well as the distance variable. Apart from that, the calculation of the Revealed Comparative Advantage Index indicates that Mercosur presents a comparative advantage in commodities, and the European Union has a comparative advantage in machinery and transport material. The intra-industrial trade rate shows a growing tendency in the period 1988-1995

On the other hand, other paper (Moreno, and Pérez, 2005) analyzes the trade and economic relations between Spain and Mexico in the last years before it was made, due to the fact that Mexico has established itself as a stable trade partner and it is the first destination of Spanish exports to Latin America. Besides, Spain is an important investor partner in Mexico. In order to carry out this analysis, the authors in this case did not use a gravity model. However, they provided an explanation of the trade exchange between Spain and Mexico where we see that the behaviour of Spanish exports to Mexico is positive. They also explained the foreign direct investment inflows received in Mexico that in the last years has had a negative evolution in the total world and the investment efforts from Spain to Mexico has been lower than the one we have done in other countries and its pattern is different. They also mentioned the tools for trade promotion and investment in Mexico. Finally, they presented the institutional framework of the relations between both countries. Through this paper one can observe that Mexico is a stable and important trade partner for Spain. However, the Spanish business presence is weak in tariffs with an important volume of imports to Mexico. Another conclusion is that the complexity of the legal framework can not be ignored and the resource to applying non-tariff measures for protectionist purposes although the trade regime of Mexico has liberalized.

Another paper *(*Jacobo*,* 2010) whose autor studied the determiners of trade flows of 28 manufacturing sectors between Mercosur and the EU because from a sector perspective, trade between both areas is distinguished by the high concentration of European exports in manufacturing sectors. This paper is similar to the paper called "Trade relations European Union-Mercosur: modeling of an export function" mentioned before. However, an important difference is that in this paper they only consider bilateral flows of manufactures. Its main aim is to observe which are the variables that influence trade and how they influence it. In order to do the investigation, the author estimated a gravity equation through models using panel data taking into account the manufacture bilateral trade flows among 16 countries of both areas, 12 of which belong to the European Union and 4 to Mercosur, during the period from 1991 to 2004. The dependent variable is the bilateral trade flow among the trading countries. The independent variables are the exporter's country GDP, the importer's country GDP, the distance between them, the population of the exporter, the population of the importer, a dummy that shows if the countries belong to the same group and another dummy that indicates if the countries share a language or not. The author made use of the method Ordinary Least Squares for the estimation. After carrying out the necessary estimates, the conclusions reached are that the traditional gravitational effects are reasonable, as the authors of the paper explain in "Estimation and applications of a gravity equation for the Atlantic trade of the European Union" in their conclusions.

Finally, it is important to underline other paper (Costa*,* 2014) that analyzed the trade relation that ties the European Union to Brazil. Besides, in the analysis she included the relations of the European Union with Latin America and the Caribbean and specifically, with Brazil. The fact that Brazil is a member of Mercosur's region is also an important fact to analyze the relations of the European Union with Brazil. In order to explain these relations, the author has explained the trade relations of the European Union with Brazil due to their importance for the European Union as Brazil has reached a significant economic and diplomatic weight in the last years worldwide, apart from being considered a fundamental country for the success and achievement of negotiations of the European Union with Mercosur. In this explanation of trade relations, the author wanted to focus on two aspects. On the one hand she explained bilateral relations, where she also analyzed the summits celebrated between the European Union and Brazil, and on the other the inter-regional relations because Brazil, as we have said, is a member of Mercosur. From these explanations we observe that trade relations of the European Union with Brazil have developed with time. On the one hand, they should do trade agreements that are more comprehensive and beneficial for both areas in such a way that the European Union could benefit from them and ride out the current crisis. Additionally, for the European Union to keep being Brazil's main trade partner, their relations have to strengthen. On the other hand, they should advance on the Free Trade Agreement, either from Brazil or Mercosur. Although the relations between both may have reached one of the highest points in their politic relations, it is still not potential, just like it happens in the trade aspect.

4. ANALYTICAL FRAMEWORK

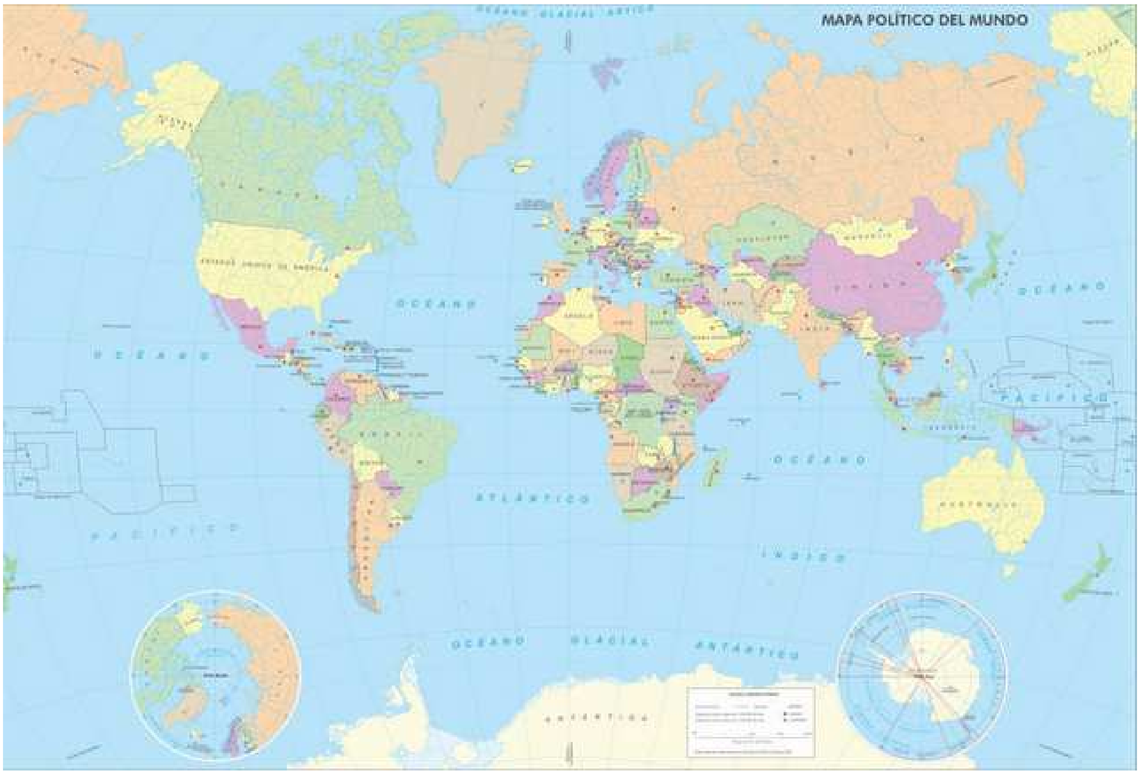
The traditional gravity model was based on Newton's Law of Gravitation where a mass of goods and services supplied by the origin country is attracted by a mass of demand for the country of destination. Nevertheless, the distance reduces the potential flow of products and services exchanges among them, especially for the costs of transport. The first authors to apply a gravity equation to explain this trend were Tinbergen (1962) and Pöyhönen (1963). In order to observe what factors cause trade flows between Latin America and the European Union we are going to present a gravity equation as a simplified representation of the forces of demand and supply that influence trade between these two regions. We will call "i" the exporting country and "j" the importing country. Therefore, if the country we call "I" is the country of origin for exports we know that their income level represents the quantity of goods and services they can offer and export; on the other hand, the level of income of the importing country "j" tells us about the quantity of goods and services demanded by them. Distance is considered as an approximate variable of the costs involved in transporting goods or services from the country of origin to the country of destination, because the greater the distance is between countries, the higher their transport costs. The number of inhabitants of the country of origin can be a useful variable to report -the quantity of workforce that operates in that country, while the population of the importing country can tell us about the demanded quantity by the inhabitants of that country.

The gravity equation presents a multiplicative nature that will make it necessary to apply natural logarithms to the equation to get a linear relationship between the logarithm of trade flows and that of income, the maritime border as a dummy variable, distance and population. In this case and in general, the income of countries is measured through their gross domestic product (GDP). I obtained the distance taking into account the kilometers between the capitals of countries "i" and "j". We measure population through the quantity of people from each country.

The independent variables to take into account when making a gravity equation are, as I have said before, GDP, maritime border, distance and population.

The data collected on the GDP are data about the gross domestic product, with a bid price, that is the sum of gross value added by all resident producers plus any product taxes less subsidies not included in the valuation of output. The data were collected from the World Bank website as they're data from the national accounts of the World Bank and data files from OECD.

A dummy variable that will help us show if the countries have maritime border, where this variable takes a value of 0 when they don't share a maritime border and 1 when they do. We can see this in a political world map like the one shown below.



This is a political world map where we find all the countries and their capitals marked with a red dot so they are easier to spot. It is a map from the cartography learning resources from the Spain National Geographic Institute. Thanks to it we can see if the different countries that interact with each other share a maritime border or not. We analyze this to check how that affects the trade flow.

Another variable to take into account in the model is the distance between the countries of the European Union considered and the countries of Latin America we are working with in this document. In order to get data more easily, we measured the distance from one country to the other through their capital cities, that is, we take into account the distance between the capital of a country and the other. The data can be found in CEPII website, which is an international research centre of French origin where studies, researches, databases and analysis are done on world economy and its evolution. The chosen database to gather the distance between the countries includes different measures of bilateral distance, in kilometers, available for most countries. In this case, the distances to take into account are, as I said, the distance of the countries capitals.

Finally, another independent variable in the model is the countries' population. Population is based on the facto definition of population, which includes all the residents regardless of their citizenship status, except for refugees not permanently settled in the country of asylum, who are normally considered a part of the population of their country of origin. The values have been gathered from the World Bank website. The values shown are mid-year estimates.

5. DATA AND STATISTICS

The period analyzed covers from 1995 to 2013. 2013 was the last year for which there is a minimum data set required to do the explanation and analysis of international trade flows in this paper. With this information we estimate an equation of gravity that makes possible to compare the weight of influence of trade preference, and also of other variables that determine trade as the gross domestic product, geographical proximity, population and having the same maritime border. The analysis in this paper is done for each of the chosen years in the sample to gather and understand the time evolution of impacts that the different considered variables have on trade.

Specifically, in this paper we have estimated bilateral exports from 5 countries of the European Union with 18 countries from Latin America during a period of 19 years (1995-2013 both included).We have a data panel of 1.710 observations (5x18x19). Following, I specify the gravity equation used:

$$\ln X_{ijt} = \alpha_{ij} + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln N_{it} + \beta_4 \ln N_{jt} + \beta_5 \ln D_{ij} + \beta_6 M_{ij} + u_{ijt} \qquad [1]$$

where:

X_{ijt} Represents exports from country *I* to country *j* in a period *t.*
Y_{it} and Y_{jt} are the Gross Domestic Products of *i* and *j* respectively in the year *t*.
N_{it} y N_{jt} indicate the population of *i* and *j* respectively in the year *t*.
D_{ij} represents the distance between the countries trading.
M_{ij} is a dummy that represents if there is a maritime border between *i* and *j*.
α_{ij} are the specific effects associated to each trade flow. They allow the control of omitted variables that are specific to each bilateral flow and do not change over time.

The set of data collected in order to carry out the estimation of the gravity equation described above is a set of panel data. In order to get panel data there has to be a follow up of these people, families, companies, cities, states, etc, over time. In this case, we have followed the exchange flows among the countries during 19 years.

Although we have collected a set of independent or explanatory variables for the trade flows among countries, we have to recognize that there are unobserved factors that affect the independent variable, ln $X_{ijt.}$ These unobserved variables may be one of two types: some are constant and others vary with time. In the gravity equation [1] the country of origin is *i* , *j* is the country of destination of exports and *t* each time period.

$$\ln X_{ijt} = \alpha_{ij} + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln N_{it} + \beta_4 \ln N_{jt} + \beta_5 \ln D_{ij} + \beta_6 M_{ij} + a_{ij} + u_{ijt}$$

The a_{ij} variable collects all the unobserved factors that remain constant along the period and affect the dependent variable, which in this case are exports.

6. EMPIRICAL METHODOLOGY

In order to estimate the gravity equation [1] we have used Ordinary Least Squares (OLS) on one hand, a model of fixed effects considering that a_{ij} is uncorrelated with all the explanatory variables. These estimations have been done with the Gretl econometric software which is an econometric calculation package that includes a shared library, a line of instructions client program and a graphic user interface (GUI).

First, we will carry out a specific 7-year estimation, exactly for 1995, 2000, 2005, 2010, 2011, 2012, 2013. In this way, we can observe the time differences and the changes that have been occurring over the period. Once we have explained that, we will carry out the estimation with the total of years in a panel.

Ordinary Least Squares

The statistics of Ordinary Least Squares (OLS) present algebraic properties like 1) The sum, therefore the sample average of OLS residuals are null. 2) The sample covariance between regressors and OLS residuals is null and 3) the point ($\bar{x}$, $\bar{y}$) is always over the OLS regression line.

When obtaining the Ordinary Least Squares estimators of a gravity equation with a given number of independent variables (k) the OLS estimations that give values to (k+1) parameters, are chosen in a way that minimize the sum of squared residuals.

Before carrying out the estimations we have to focus on the expected signs of each independent variable. For the country of origin's GDP we expect a positive sign as the higher the GDP from a country is, the more products they can offer and better quality ones; for the GDP of the country of destination, the expected sign is also positive as the higher the GDP is the higher the demand of foreign products. For the distance variable, we expect a negative GDP, as the longer the distance, the higher are the transport costs associated to exports. For the population variables, for both the origin and destination, signs can be negative as well as positive. And, finally, for the dummy variable of maritime border we expect a positive sign.

In order to get the estimations it has been necessary to import Excel data to the Gretl program with a panel data structure of stacked cross sections, with 19 periods and 90 observations in each period. As, in the first place, we want to estimate the gravity equation for specific years, we have to open the Gretl dashboard and indicate what year we want to take into account only to make the calculation. Beforehand, we have to remember to add the logarithms of the gravity equation variables because, as previously said, this gravity equation presents a multiplicative form that makes it necessary to apply natural logarithms to the equation in order to obtain a linear correlation between the logarithm of the dependent variable and the independent or explanatory variables.

Carrying out an estimation by OLS through the Gretl program for different years, we observe the following results:

TABLE 1: RESULTS OF THE ANNUAL ESTIMATES FOR ALL THE FLOWS

	Coefficient						
Variables	1995	2000	2005	2010	2011	2012	2013
Const	-27.875***	-19.100***	-11.359*	-25.093***	-22.663***	-23.760***	-21.335***
GDP_i	-0.363	-0.685**	-0.879	-0.836	-0.748*	-0.143	-0.873**
GDP_j	1.036***	1.137***	1.349***	1.264***	1.211***	1.283***	1.222***
$Distcap_{ij}$	0.802	0.003	-0.291	1.434**	1.058*	0.297	1.151*
Pop_i	1.109***	1.446***	1.524***	1.299***	1.231***	0.729	1.309***
Pop_j	-0.146	-0.221	-0.570***	-0.416**	-0.345**	-0.466**	-0.368**
$Marbound_{ij}$	0.096	0.235	0.018	0.011	0.072	0.087	0.118
R-squared	0.895	0.900	0.898	0.904	0.905	0.871	0.889

Note: ***,**,* prove that the estimated coefficients are statistically significant, respectively, of 1, 5 and 10 per cent

Table 1 shows the estimated coefficients though the method of Ordinary Least Squares for the entire sample 7 in different periods.

If we use the goodness-of-fit we can consider that they are good explanatory models of the bilateral trade flows among the 5 countries chosen from the European Union and the 18 from Latin America as the R squares obtained in all the years estimated are over 85 per cent.

By observing the obtained signs in the variables, not all of them coincide with the expected signs commented on before. In all the years analyzed, the elasticity sign of the origin GDP's variable is negative (it should be positive) and the sign of elasticity of the distance variable is positive (it should be negative). The reason why the sign of the distance is positive is, possibly, the small difference of distance among the different Latin American countries and the European Union that we have collected in the sample. However, in the year 2005 the elasticity of the distance does present the expected sign, but only in that year.

In the previous table we also observe that the dummy variable of maritime border is not statistically significant at any level in any of the years, that is, if the rest stays constant, the fact that two countries share a maritime border is not statistically significant in this case. This could be owed to the lack of diversity, as all the European countries chosen for the sample have access to direct sea transport as they have a coast and, only a few countries of Latin America do not have it, as it happens with Bolivia and Paraguay.

Total period OLS estimates

Carrying out the estimations for the total period with the three methods seen in this paper: OLS, fixed and variable effects, we obtain the following results:

TABLE 2: RESULTS OF THE OLS ESTIMATES

Variables	Coefficient	t-statistic
Const	-22.632***	-5.536
GDP_i	-0.494***	-3.627
GDP_j	1.191***	13.99
$Distcap_{ij}$	0.414	1.041
Pop_i	1.149***	8.792
Pop_j	-0.309***	-2.819
$Marbound_{ij}$	0.139	0.953
R-squared	0.889	

Note: ***,**,* prove that the estimated coefficients are statistically significant, respectively, of 1, 5 and 10 per cent

$\ln \hat{X}_{ijt}$ = - 22.6322 - 0.494209 ln Y_{it} + 1.191940 ln Y_{jt} + 1.14940 ln N_{it} – 0.309040 ln N_{jt} + 0.414348 ln D_{ij} + 0.139316 M_{ij}

The fixed effects and the random effects

Once estimated the model through the Ordinary Least Squares (OLS) we are going to estimate the gravitational model of data panel presented in this paper through two methods: the first is the fixed effects estimator and the second the variable effects estimator.

The fixed effects estimator uses a transformation to eliminate the unobserved effects a_i before carrying out the estimation. All the independent variables that remain constant in time are eliminated together with a_i. When this method is implemented, they only use variables that have deviated from their standard and then we run a regression for merged OLS. However, under the assumption of strict exogeneity of the independent variables, this method is unbiased, as the idiosyncratic error u_{it} is required to be uncorrelated with all the independent variables in all the periods. Besides, this method allows the possibility of correlation between a_i and the independent variables in any period. Therefore, the independent variables that remain constant through time during all the period will be eliminated when carrying out the fixed effects estimator. The errors u_{it} have to be homoscedastic and not have an autocorrelation.

The random effects estimator is necessary when we think that the unobserved effects are not correlated with the independent variables. When we work with this method there is the possibility of working with the assumption that the unobserved effects a_i have a zero average. When the fixed effects estimator is carried out the objective is the elimination of the unobserved effects, a_i, because it could be correlated with one or several independent variables. But if we think that is not correlated with any in each of the periods, using the fixed effects estimator will result in inefficiency in the obtained estimates. The ideal assumptions of the random effects estimator include all the assumptions of the fixed effects estimator plus the requirement that a_i, is independent from all the explanatory variables in all the time periods.

Therefore, the fixed effects estimator is used when the unobserved heterogeneity, a_i, is thought to be correlated with an independent variable; and the estimator of random effects when $a_{i,}$ is thought not to be correlated with any independent variable in all the periods.

In table 3 we can observe estimations though the method of fixed effects. We see that the variables that remain constant through time disappear. In this case these variables are distance, as the geographic distance among countries does not change with time, and the dummy variable that tells us if the countries share a maritime border or not, does not change with time either, at least in such a short period of time as the one analyzed.

TABLE 3: RESULTS OF THE ESTIMATED FIXED EFFECTS

Variables	Coefficient	t-statistic
Const	-2.259	-0.171
GDP_i	0.024	0.234
GDP_j	0.818***	9.488
Pop_i	-0.726	-0.846
Pop_j	0.377	0.616
R-squared	0.958	

Note: ***,**,* prove that the estimated coefficients are statistically significant, respectively, of 1, 5 and 10 per cent

$$\ln \hat{X}_{ijt} = -\ 2.25916 + 0.0244351 \ln Y_{it} + 0.818694 \ln Y_{jt} - 0.726452 \ln N_{it} + 0.377620 \ln N_{jt}$$

With the method of fixed effects we observe that the elasticity (it is called 'elasticity' because the function has been estimated with the variables in logarithms) of the coountry of origin's income has the expected sign. Not as in the previous case, where we observed a negative elasticity of this same variable.

TABLE 4: RESULTS OF THE ESTIMATED RANDOM EFFECTS

Variables	Coefficient	t-statistic
Const	-26.416***	-5.719
GDP_i	-0.129**	-2.366
GDP_j	0.888***	23.87
$Distcap_{ij}$	0.657	1.334
Pop_i	0.756***	7.886
Pop_j	0.026	0.467
$Marbound_{ij}$	0.411**	2.303

Note: ***,**,* prove that the estimated coefficients are statistically significant, respectively, of 1, 5 and 10 per cent

$$\ln \hat{X}_{ijt} = -\ 26.4167 - 0.129072 \ln Y_{it} + 0.888622 \ln Y_{jt} + 0.756068 \ln N_{it} - 0.0265440 \ln N_{jt}$$

$$+ 0.657976 \ln D_{ij} + 0.411037\ M_{ij}$$

Estimating the equation through the method of random effects we observe that we still have the same problem than when we estimated it with the Ordinary Least Squares method. The independent variables related to the country of origin's income and distance does not present the expected signs.

The previous estimations have been estimated through an export function. That is to say, we wanted to observe the impact that have over exports factors like, the country of origin's income, the country of destination's income, the population of both countries, the geographical distance which separates them and if they share a maritime border or not. Therefore, seeing that the estimations did not get the expected signs, above all the country of origin's GDP, we'll suggest the same gravity equation but from the imports perspective.

$$\ln IM_{ijt} = \alpha_{ij} + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln N_{it} + \beta_4 \ln N_{jt} + \beta_5 \ln D_{ij} + \beta_6 M_{ij} + a_{ij} + u_{ijt} \quad [2]$$

TABLE 5: RESULTS OF THE ANNUAL ESTIMATES FOR ALL THE FLOWS

	Coefficient						
Variables	1995	2000	2005	2010	2011	2012	2013
Const	-31.380***	-22.011**	-6.110	-10.349	-21.962**	-13.991	-17.312*
GDP_i	0.097	-1.126*	-2.301***	-3.060***	-2.631***	-2.435***	-2.249***
GDP_j	0.644***	0.650***	1.026***	0.714***	0.540***	0.579***	0.598***
$Distcap_{ij}$	1.344	1.578*	1.652**	3.700***	4.041***	3.176***	3.305***
Pop_i	0.400	1.513**	2.370***	2.797***	2.575***	2.342***	2.215***
Pop_j	0.296	0.403	-0.001	0.462*	0.754***	0.571**	0.517**
$Marbound_{ij}$	0.504*	1.053***	0.418	-0.034	0.147	0.502	-0.016
R-squared	0.760	0.769	0.805	0.803	0.797	0.817	0.801

Note: ***,**,* prove that the estimated coefficients are statistically significant, respectively, of 1, 5 and 10 per cent

In table 5 we observe, in this case, that the sign of the independent variables still has problems when we calculate it in years. Even so, we can consider that they are good explanatory models as the R squared is higher than 75% in all the years calculated.

The same happens when we calculate it through the OLS method because, as we can see in table 6, the sign of the independent variable of the origin's income is negative and it should be positive; and the sign of distance is positive and should be negative. In fact, in this case, due to a low *t* statistical, the coefficient of the country of origin's income variable is not statistically significant, keeping the rest constant.

TABLE 6: RESULTS OF THE OLS ESTIMATES

Variables	Coefficient	t-statistic
Const	-29.750***	-4.439
GDP_i	-0.183	-0.923
GDP_j	0.813***	6.455
$Distcap_{ij}$	1.623**	2.486
Pop_i	0.404*	1.737
Pop_j	0.257	1.549
$Marbound_{ij}$	0.458*	1.786
R-squared	0.768	

Note: ***,**,* prove that the estimated coefficients are statistically significant, respectively, of 1, 5 and 10 per cent

$\ln \widehat{IM}_{ijt}$ = - 29.7504 - 0.183179 ln Y_{it} + 0.813930 ln Y_{jt} + 0.404454 ln N_{it} – 0.257500 ln N_{jt} + 1.62324 ln D_{ij} + 0.458236 M_{ij}

However, with the imports function, when calculating the estimations through the fixed effects and variable effects method, the coefficient of the origin GDP variable gives the expected positive sign because a high GDP in a given country increases the product offer that can be purchased by other countries, it also improves the productive processes and can, with it, reduce the associated costs of the production process. Therefore, we observe in tables 7 and 8, that elasticities of the independent variables when considering an import function show the expected signs except for the distance, which, as we have said before, can be due to the small distance difference among capitals of the countries that trade.

TABLE 7: RESULTS OF THE ESTIMATES FIXED EFFECTS

Variables	Coefficient	t-statistic
Const	-12.729	-0.627
GDP_i	1.102***	6.566
GDP_j	0.443***	4.060
Pop_i	0.882	0.579
Pop_j	-2.015**	-2.524
R-squared	0.918	

Note: ***,**,* prove that the estimated coefficients are statistically significant, respectively, of 1, 5 and 10 per cent

$\ln \widehat{IM}_{ijt}$ = - 12.7299 + 1.10274 ln Y_{it} + 0.443052 ln Y_{jt} + 0.882473 ln N_{it} – 2.01507 ln N_{jt}

TABLE 8: RESULTS OF THE ESTIMATES RANDOM EFFECTS

Variables	Coefficient	t-statistic
Const	-36.995***	-4.950
GDP_i	0.662***	7.583
GDP_j	0.356***	5.969
$Distcap_{ij}$	1.836**	2.300
Pop_i	-0.398***	-2.580
Pop_j	0.664***	7.271
$Marbound_{ij}$	0.906***	3.140

Note: ***,**,* prove that the estimated coefficients are statistically significant, respectively, of 1, 5 and 10 per cent

$\ln \widehat{IM}_{ijt}$ = - 36.9950 + 0.662849 ln Y_{it} + 0.356134 ln Y_{jt} – 0.398941 ln N_{it} + 0.664192 ln N_{jt} + 1.83641 ln D_{ij} + 0.906608 M_{ij}

But still, we will try to correct this sign carrying out a gravity equation that takes into account all trade flows during the period 1995-2013 among all the considered countries. In order to do that we have created another Excel document where we have extended the sample, including as well the Latin American countries as countries of origin and the European Union countries have been considered countries of destination after what we have indicated in the two previous Excel documents where the countries of origin belonged to the European Union and the destination ones to Latin America. In this way, we consider all the trade flows between them during the period analyzed. Consequently the gravity equation to be considered in this case is the following:

$$\ln F_{ijt} = \alpha_{ij} + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln N_{it} + \beta_4 \ln N_{jt} + \beta_5 \ln D_{ij} + \beta_6 M_{ij} + u_{ijt} \quad [3]$$

Carrying out the same estimation methods we get the following results:

TABLE 9: RESULTS OF THE ANNUAL ESTIMATES FOR ALL THE FLOWS

	Coefficient						
Variables	1995	2000	2005	2010	2011	2012	2013
Const	-35.205***	-31.680***	-33.606***	-47.238***	-46.694***	-38.878***	-41.346***
GDP_i	0.732***	0.850***	1.160***	1.011***	0.911***	0.944***	0.934***
GDP_j	0.798***	0.865***	1.280***	1.210***	1.103***	1.064***	0.974***
$Distcap_{ij}$	0.377	-0.404	-0.560	0.979*	0.863	0.251	0.637
Pop_i	0.190	0.162	-0.195	0.028	0.212	0.089	0.061
Pop_j	0.012	-0.046	-0.604***	-0.530***	-0.365**	-0.371**	-0.244
$Marbound_{ij}$	0.267***	0.626***	0.132	-0.163	-0.045	0.184	-0.039
R-squared	0.789	0.785	0.796	0.758	0.761	0.763	0.748

Note: ***,**,* prove that the estimated coefficients are statistically significant, respectively, of 1, 5 and 10 per cent

In this case the signs improve, as in all the estimated years, the sign of the coefficient of the origin income variable is positive, as expected. However, we still have the same problem with the sign of the coefficient of the geographic distance variable. What we infer from the estimation is that the longer the geographic distance is the higher the trade flows are among the countries and that does not work like that. We can relate the geographic distance to the associated costs of the goods exchange among countries. Therefore, the bigger the distance is the higher the costs that, keeping the rest constant, should result in a decrease of the quantity of exchanged products among countries.

TABLE 10: RESULTS OF THE OLS ESTIMATES

Variables	Coefficient	t-statistic
Const	-37.661***	-26.58
GDP_i	0.668***	29.23
GDP_j	0.752***	32.90
$Distcap_{ij}$	0.607***	3.893
Pop_i	0.345***	11.21
Pop_j	0.018	0.616
$Marbound_{ij}$	0.568***	9.813
R-squared	0.765	

Note: ***,**,* prove that the estimated coefficients are statistically significant, respectively, of 1, 5 and 10 per cent

$$\ln \hat{F}_{ijt} = -37.6615 + 0.668034 \ln Y_{it} + 0.752059 \ln Y_{jt} + 0.345389 \ln N_{it} - 0.0189981 \ln N_{jt}$$

$+ 0.607375 \ln D_{ij} + 0.568707 M_{ij}$

TABLE 11: RESULTS OF THE ESTIMATES FIXED EFFECTS		
Variables	Coefficient	t-statistic
Const	1.602	0.156
GDPi	0.395***	4.436
GDPj	0.837***	10.80
Popi	-0.937	-1.552
Popj	-0.373	-0.704
R-squared	0.935	
Note: ***,**,* prove that the estimated coefficients are statistically significant, respectively, of 1, 5 and 10 per cent		

$$\ln \hat{F}_{ijt} = 1.60234 + 0.395210 \ln Y_{it} + 0.837617 \ln Y_{jt} – 0.937005 \ln N_{it} – 0.373164 \ln N_{jt}$$

TABLE 12: RESULTS OF THE ESTIMATES RANDOM EFFECTS		
Variables	Coefficient	t-statistic
Const	-36.394***	-7.035
GDPi	0.342***	11.03
GDPj	0.614***	19.79
Distcapij	1.084*	1.953
Popi	0.653***	9.231
Popj	0.079	1.118
Marboundij	0.832***	4.192
Note: ***,**,* prove that the estimated coefficients are statistically significant, respectively, of 1, 5 and 10 per cent		

$$\ln \hat{F}_{ijt} = - 36.3945 + 0.342696 \ln Y_{it} + 0.614699 \ln Y_{jt} + 0.653270 \ln N_{it} – 0.0791202 \ln N_{jt}$$

$$+ 1.08443 \ln D_{ij} + 0.832609 M_{ij}$$

As we can observe, the signs of the coefficients of the country of origin’s income that with the other two gravity equations [1] and [2], were negative (contrary sign to the one expected) in this case, taking into account all the trade flows, the sign is positive when calculating it with the three explained methods: OLS, fixed effects and variable effects.

7. CONCLUSIONS

The purpose of this paper is to study the main factors that can influence bilateral trade flows among the EU countries and Latin American countries. The European Union and Latin America are natural partners linked by strong economic, cultural and historical links, as well as an increasing convergence of basic values and principles. Bilateral trade flows among the countries of both areas have presented a strong growth in the last decades due to agreements and the emergence of trade facilities. The trade that both areas present is inter-industrial as the exchanged products between both areas belong to different industries or sectors.

In the last years, bilateral trade balance of the European Union with Latin America has been negative, that is to say, the European Union has purchased more Latin American products than Latin America has purchased from the European Union. Plus, in the year 2009, trade flows lowered considerably due to the world financial crisis that later presented a new growth.

Most of the papers about trade flows among countries carry out a gravity model for the explanation of goods exchange among them. In this work has been done the estimation of three models, using export, import and total trade. Nevertheless, the principal aim of this work has been realized the estimation of a gravity equation of the total of flows of the trade between the European Union and Latin America because it reflects in a clearer and more evident way the determinants of the exchange of goods produced between both areas. In order to do that panel data has been used and the explanatory variables coefficients of this trade flows have been estimated. The variables used are GDPs of countries (origin and destination), population, distance between them and a dummy variable that showing if they have maritime connexion or not. In order to estimate the equation we have used ordinary least squares, fixed effects and random effects.

The goodness-of-fit of the explanatory variables, in the estimation of the total of flows of trade, we observe that it is good, as in all the estimations carried out the R-squared is higher than 70%. The result indicates that the explanatory variables considered in the gravity equation are relevant and show the expected signs, except the distance. This is probably due to the fact that the explanatory power that would be associated to differences in distances it is lost due to the closeness among the countries in this group, Europeans and Latin Americans. So the long maritime less of the journey is quite similar for all of them. The importance of the size of the countries is relevant at the moment of analyzing the exchange of products because, both the income and the population, exercises a great influence as demand and suppliers of goods and services. The dummy variable included, maritime accession is significant and with the expected sign what it is in line with a reduction in transport costs.

It is important to know that the gravity equation of trade flows between the European Union and Latin America presents better estimations when we consider the total of trade flows compared to the use of only exports or imports. This is also quite logical in terms of the eclectic approach we have followed when specifying our trade gravity equation.

Finally, we should note that the obtained results depend on the restrictions of information availability and data gathered. The paper could be extended considering the areas where the countries present higher and unequal distances in order to get the expected sign. Besides, in the future, the number of years taken into account could be expanded in order to get more precise estimations. And, considering more countries, other dummys variables might be included as common language or other relevant links.

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ANNEXES

ASSUMPTIONS FOR FIXED AND RANDOM EFFECTS

ASSUMPTION FE.1
For each *i*, the model is

$$y_{it} = \beta_1 x_{it1} + \ldots + \beta_k x_{itk} + a_i + u_{it}, \qquad t = 1, \ldots, T$$

where the β_j are the parameter to estimate.

ASSUMPTION FE.2
We have a random sample in the cross-sectional dimension.

ASSUMPTION FE.3
For each *t*, the expected value of the idiosyncratic error given the explanatory variables in all time periods and the unobserved effect is zero: $E(u_{it}|\mathbf{X}_i, a_i) = 0$.

ASSUMPTION FE.4
Each explanatory variable changes over time (for at least some *i*), and there are no perfect linear relationships among the explanatory variables.

Under these first four assumptions—which are identical to the assumptions for the first-differencing estimator—the fixed effects estimator is unbiased. Again, the key is the strict exogeneity assumption, FE.3. Under these same assumptions, the FE estimator is consistent with a fixed T as N = ∞.

ASSUMPTION FE.5
$Var(u_{it}|\mathbf{X}_i, a_i) = Var(u_{it}) = \delta^2_u$, for all $t = 1, \ldots, T$.

ASSUMPTION FE.6
For all $t \neq s$, the idiosyncratic errors are uncorrelated (conditional on all explanatory variables and a_i): $Cov(u_{it}, u_{is}|\mathbf{X}_i, a_i) = 0$.

Under Assumptions FE.1 through FE.6, the fixed effects estimator of the β_j is the best linear unbiased estimator. Since the FD estimator is linear and unbiased, it is necessarily worse than the FE estimator. The assumption that makes FE better than FD is FE.6, which implies that the idiosyncratic errors are serially uncorrelated.

ASSUMPTION FE.7
Conditional on $\mathbf{X}_i$ and a_i, the u_{it} are independent and identically distributed as Normal(0, δ^2_u).

Assumption FE.7 implies FE.3, FE.5, and FE.6, but it is stronger because it assumes a normal distribution for the idiosyncratic errors. If we add FE.7, the FE estimator is normally distributed, and t and F statistics have exact t and F distributions. Without FE.7, we can rely on asymptotic approximations. But, without making special assumptions, these approximations require large N and small T. The ideal random effects assumptions include FE.1, FE.2, FE.3, FE.5, and FE.6. We can now allow for time-constant variables. (FE.7 could be added, but it gains us little in practice.)

However, we need to add assumptions about how a_i is related to the explanatory variables. Thus, the third assumption is strengthened as follows.

ASSUMPTION RE.3
In addition to FE.3, the expected value of a_i given all explanatory variables is zero: $E(a_i|\mathbf{X}_i) = 0$.

This is the assumption that rules out correlation between the unobserved effect and the explanatory variables. Because the RE transformation does not completely remove the time average, we can allow explanatory variables that are constant across time for all i.

ASSUMPTION RE.4
There are no perfect linear relationships among the explanatory variables.

ASSUMPTION RE.5
In addition to FE.5, the variance of ai given all explanatory variables is constant: $Var(a_i|\mathbf{X}_i) = \delta^2_a$.

Under the six random effects assumptions (FE.1, FE.2, RE.3, RE.4, RE.5, and FE.6), the random effects estimator is consistent as N gets large for fixed T. (Actually, only the first four assumptions are needed for consistency.) The RE estimator is not unbiased unless we know, which keeps up from having to estimate it. The RE estimator is also approximately normally distributed with large N, and the usual standard errors, t statistics, and F statistics obtained from the quasi-demeaned regression are valid with large N. [For more information, see Wooldridge (1999, Chapter 10).]

ORDINARY LEAST SQUARES

Imagine the following gravity equation:

$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2 + \ldots + \hat{\beta}_k x_k$

When it is estimated by Ordinary Least Squares (OLS), the method of ordinary least squares chooses the estimates to minimize the sum of squared residuals

$\sum_{i=1}^{n} (y_i - \hat{\beta}_0 + \hat{\beta}_1 x_{i1} - \ldots - \hat{\beta}_k x_{ik})^2$

The minimization problema can be solved using multivariable calculus. This leads to k+1 linear equations in k+1 unknowns $\hat{\beta}_0$, $\hat{\beta}_1$, …, $\hat{\beta}_k$:

$\sum_{i=1}^{n} (y_i - \hat{\beta}_0 + \hat{\beta}_1 x_{i1} - \ldots - \hat{\beta}_k x_{ik}) = 0$

$\sum_{i=1}^{n} x_{i1} (yi - \hat{\beta}_0 + \hat{\beta}_1 x_{i1} - \ldots - \hat{\beta}_k x_{ik}) = 0$

$\sum_{i=1}^{n} x_{i2} (yi - \hat{\beta}_0 + \hat{\beta}_1 x_{i1} - \ldots - \hat{\beta}_k x_{ik}) = 0$

⋮

$\sum_{i=1}^{n} x_{ik} (yi - \hat{\beta}_0 + \hat{\beta}_1 x_{i1} - \ldots - \hat{\beta}_k x_{ik}) = 0$

These equations are the OLS first order conditions. The OLS first order conditions can be motivated by the method of moments under assumption E(*u*) = 0, $E(x_j u) = 0$ where *j* = 1,2, …, *k*.

SUMMARY OF FUNCTIONAL FORMS INVOLVING LOGARITHMS

Model	Dependent variable	Independent variable	Interpretation of β_1
level-level	y	x	$\Delta y = \beta_1 \Delta x$
level-log	y	log(x)	$\Delta y = (\beta 1/100)\%\Delta x$
log-level	log(y)	x	$\%\Delta y = (100\beta_1)\Delta x$
log-log	log(y)	log(x)	$\%\Delta y = \beta_1 \%\Delta x$

GRETL: EXPORTS ESTIMATIONS

- **1995**

```
Modelo 1: MCO, usando las observaciones 1-90
Variable dependiente: l_Exports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                     Coeficiente  Desv. Típica  Estadístico t   Valor p
  ----------------------------------------------------------------------
  const               -27.8754      4.89098        -5.699       1.78e-07  ***
  l_GDPi               -0.363861    0.260175       -1.399       0.1657
  l_GDPj                1.03635     0.132341        7.831       1.41e-011 ***
  l_Distcapij           0.802402    0.563686        1.423       0.1583
  l_Popi                1.10916     0.274350        4.043       0.0001    ***
  l_Popj               -0.146179    0.159371       -0.9172      0.3617
  Maritime_Boundary     0.0966831   0.203066        0.4761      0.6352

Media de la vble. dep.  11.36820   D.T. de la vble. dep.   1.834723
Suma de cuad. residuos  31.22609   D.T. de la regresión    0.613366
R-cuadrado              0.895772   R-cuadrado corregido    0.888237
F(6, 83)                99.80539   Valor p (de F)          7.94e-36
Log-verosimilitud      -80.06946   Criterio de Akaike      174.1389
Criterio de Schwarz     191.6376   Crit. de Hannan-Quinn   181.1954

Sin considerar la constante, el valor p más alto fue el de la variable 7 (Maritime_Boundary)
```

- **2000**

```
Modelo 1: MCO, usando las observaciones 1-90
Variable dependiente: l_Exports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                     Coeficiente   Desv. Típica  Estadístico t   Valor p
  -----------------------------------------------------------------------
  const               -19.1000       4.95633       -3.854        0.0002    ***
  l_GDPi               -0.685100     0.319792      -2.142        0.0351    **
  l_GDPj                1.13704      0.0959535     11.85         1.56e-019 ***
  l_Distcapij           0.00348178   0.501839       0.006938     0.9945
  l_Popi                1.44604      0.342891       4.217        6.27e-05  ***
  l_Popj               -0.221199     0.141677      -1.561        0.1223
  Maritime_Boundary     0.235331     0.190821       1.233        0.2210

Media de la vble. dep.  11.50095   D.T. de la vble. dep.   1.874911
Suma de cuad. residuos  31.13063   D.T. de la regresión    0.612428
R-cuadrado              0.900497   R-cuadrado corregido    0.893304
F(6, 83)                154.7698   Valor p (de F)          6.71e-43
Log-verosimilitud      -79.93168   Criterio de Akaike      173.8634
Criterio de Schwarz     191.3620   Crit. de Hannan-Quinn   180.9199

Sin considerar la constante, el valor p más alto fue el de la variable 11 (l_Distcapij)
```

- **2005**

```
Modelo 2: MCO, usando las observaciones 1-90
Variable dependiente: l_Exports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                     Coeficiente  Desv. Típica  Estadístico t   Valor p
  ---------------------------------------------------------------------
  const              -11.3594      6.55259       -1.734        0.0867    *
  l_GDPi              -0.879298    0.533480      -1.648        0.1031
  l_GDPj               1.34909     0.145178       9.293        1.70e-014 ***
  l_Distcapij         -0.291747    0.498013      -0.5858       0.5596
  l_Popi               1.52454     0.525562       2.901        0.0048    ***
  l_Popj              -0.570176    0.180389      -3.161        0.0022    ***
  Maritime_Boundary    0.0184112   0.209658       0.08782      0.9302

Media de la vble. dep.   11.74594   D.T. de la vble. dep.    1.739086
Suma de cuad. residuos   27.40423   D.T. de la regresión     0.574605
R-cuadrado               0.898191   R-cuadrado corregido     0.890831
F(6, 83)                 132.4380   Valor p (de F)           2.38e-40
Log-verosimilitud       -74.19442   Criterio de Akaike       162.3888
Criterio de Schwarz      179.8875   Crit. de Hannan-Quinn    169.4453

Sin considerar la constante, el valor p más alto fue el de la variable 7 (Maritime_Boundary)
```

- **2010**

```
Modelo 1: MCO, usando las observaciones 1-90
Variable dependiente: l_Exports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                     Coeficiente  Desv. Típica  Estadístico t   Valor p
  ---------------------------------------------------------------------
  const              -25.0931      6.25179       -4.014        0.0001    ***
  l_GDPi              -0.836211    0.559843      -1.494        0.1391
  l_GDPj               1.26451     0.126566       9.991        6.86e-016 ***
  l_Distcapij          1.43494     0.652575       2.199        0.0307    **
  l_Popi               1.29974     0.489939       2.653        0.0096    ***
  l_Popj              -0.416260    0.158589      -2.625        0.0103    **
  Maritime_Boundary    0.0116247   0.185528       0.06266      0.9502

Media de la vble. dep.   12.12438   D.T. de la vble. dep.    1.878456
Suma de cuad. residuos   29.98226   D.T. de la regresión     0.601026
R-cuadrado               0.904529   R-cuadrado corregido     0.897627
F(6, 83)                 156.7640   Valor p (de F)           4.13e-43
Log-verosimilitud       -78.24030   Criterio de Akaike       170.4806
Criterio de Schwarz      187.9793   Crit. de Hannan-Quinn    177.5371

Sin considerar la constante, el valor p más alto fue el de la variable 7 (Maritime_Boundary)
```

- **2011**

```
Modelo 1: MCO, usando las observaciones 1-90
Variable dependiente: l_Exports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                     Coeficiente  Desv. Típica  Estadístico t   Valor p
  ---------------------------------------------------------------------
  const              -22.6637      6.55741       -3.456        0.0009    ***
  l_GDPi              -0.748727    0.446615      -1.676        0.0974    *
  l_GDPj               1.21149     0.123209       9.833        1.42e-015 ***
  l_Distcapij          1.05804     0.632761       1.672        0.0983    *
  l_Popi               1.23167     0.402015       3.064        0.0029    ***
  l_Popj              -0.345726    0.155941      -2.217        0.0294    **
  Maritime_Boundary    0.0724065   0.191485       0.3781       0.7063

Media de la vble. dep.   12.33907   D.T. de la vble. dep.    1.867894
Suma de cuad. residuos   29.23905   D.T. de la regresión     0.593530
R-cuadrado               0.905839   R-cuadrado corregido     0.899033
F(6, 83)                 126.9750   Valor p (de F)           1.14e-39
Log-verosimilitud       -77.11077   Criterio de Akaike       168.2215
Criterio de Schwarz      185.7202   Crit. de Hannan-Quinn    175.2780

Sin considerar la constante, el valor p más alto fue el de la variable 7 (Maritime_Boundary)
```

- **2012**

Modelo 1: MCO, usando las observaciones 1-90
Variable dependiente: l_Exports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

	Coeficiente	Desv. Típica	Estadístico t	Valor p	
const	−23.7605	6.25751	−3.797	0.0003	***
l_GDPi	−0.143731	0.523988	−0.2743	0.7845	
l_GDPj	1.28316	0.137201	9.352	1.29e-014	***
l_Distcapij	0.297773	0.732480	0.4065	0.6854	
l_Popi	0.729683	0.455125	1.603	0.1127	
l_Popj	−0.466958	0.184406	−2.532	0.0132	**
Maritime_Boundary	0.0871126	0.206001	0.4229	0.6735	

Media de la vble. dep.	12.43138	D.T. de la vble. dep.	1.863851
Suma de cuad. residuos	39.74057	D.T. de la regresión	0.691955
R-cuadrado	0.871465	R-cuadrado corregido	0.862173
F(6, 83)	113.1591	Valor p (de F)	8.13e-38
Log-verosimilitud	−90.91980	Criterio de Akaike	195.8396
Criterio de Schwarz	213.3383	Crit. de Hannan-Quinn	202.8961

Sin considerar la constante, el valor p más alto fue el de la variable 9 (l_GDPi)

- **2013**

Modelo 1: MCO, usando las observaciones 1-90
Variable dependiente: l_Exports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

	Coeficiente	Desv. Típica	Estadístico t	Valor p	
const	−21.3350	6.16163	−3.463	0.0008	***
l_GDPi	−0.873959	0.431120	−2.027	0.0459	**
l_GDPj	1.22280	0.122609	9.973	7.44e-016	***
l_Distcapij	1.15117	0.686716	1.676	0.0974	*
l_Popi	1.30931	0.369297	3.545	0.0006	***
l_Popj	−0.368261	0.157466	−2.339	0.0218	**
Maritime_Boundary	0.118343	0.188366	0.6283	0.5316	

Media de la vble. dep.	12.49332	D.T. de la vble. dep.	1.858697
Suma de cuad. residuos	34.24821	D.T. de la regresión	0.642362
R-cuadrado	0.888614	R-cuadrado corregido	0.880562
F(6, 83)	140.7470	Valor p (de F)	2.43e-41
Log-verosimilitud	−84.22658	Criterio de Akaike	182.4532
Criterio de Schwarz	199.9518	Crit. de Hannan-Quinn	189.5096

Sin considerar la constante, el valor p más alto fue el de la variable 7 (Maritime_Boundary)

- **OLS**

Modelo 1: MCO combinados, utilizando 1710 observaciones
Se han incluido 90 unidades de sección cruzada
Largura de la serie temporal = 19
Variable dependiente: l_Exports
Desviaciones típicas robustas (HAC)

	Coeficiente	Desv. Típica	Estadístico t	Valor p	
const	−22.6322	4.08801	−5.536	3.57e-08	***
l_GDPi	−0.494209	0.136266	−3.627	0.0003	***
l_GDPj	1.19199	0.0851868	13.99	3.41e-042	***
l_Distcapij	0.414348	0.398172	1.041	0.2982	
l_Popi	1.14940	0.130740	8.792	3.53e-018	***
l_Popj	−0.309040	0.109621	−2.819	0.0049	***
Maritime_Boundary	0.139316	0.146142	0.9533	0.3406	

Media de la vble. dep.	11.78241	D.T. de la vble. dep.	1.889134
Suma de cuad. residuos	673.6606	D.T. de la regresión	0.628946
R-cuadrado	0.889548	R-cuadrado corregido	0.889159
F(6, 1703)	2285.909	Valor p (de F)	0.000000
Log-verosimilitud	−1629.933	Criterio de Akaike	3273.867
Criterio de Schwarz	3311.977	Crit. de Hannan-Quinn	3287.971
rho	0.806505	Durbin-Watson	0.371189

Sin considerar la constante, el valor p más alto fue el de la variable 7 (Maritime_Boundary)

- **Fixed effects**

```
Modelo 1: Efectos fijos, utilizando 1710 observaciones
Se han incluido 90 unidades de sección cruzada
Largura de la serie temporal = 19
Variable dependiente: l_Exports
Desviaciones típicas robustas (HAC)
Omitidas debido a colinealidad exacta: l_Distcapij Maritime_Boundary

             Coeficiente   Desv. Típica   Estadístico t    Valor p
  ----------------------------------------------------------------
  const       -2.25916      13.1888          -0.1713       0.8640
  l_GDPi       0.0244351     0.104093         0.2347       0.8144
  l_GDPj       0.818694      0.0862891        9.488        8.12e-021 ***
  l_Popi      -0.726452      0.858058        -0.8466       0.3973
  l_Popj       0.377620      0.612981         0.6160       0.5380

Media de la vble. dep.   11.78241   D.T. de la vble. dep.    1.889134
Suma de cuad. residuos   252.4196   D.T. de la regresión     0.395222
R-cuadrado               0.958614   R-cuadrado corregido     0.956232
F(93, 1616)              402.4819   Valor p (de F)           0.000000
Log-verosimilitud       -790.6367   Criterio de Akaike       1769.273
Criterio de Schwarz      2281.033   Crit. de Hannan-Quinn    1958.673
rho                      0.489578   Durbin-Watson            0.970377

Contraste de diferentes interceptos por grupos -
  Hipótesis nula: Los grupos tienen un intercepto común
  Estadístico de contraste: F(89, 1616) = 30.3011
  con valor p  = P(F(89, 1616) > 30.3011) = 1.15058e-280
```

- **Random effects**

```
Modelo 2: Efectos aleatorios (MCG), utilizando 1710 observaciones
Se han incluido 90 unidades de sección cruzada
Largura de la serie temporal = 19
Variable dependiente: l_Exports

                     Coeficiente   Desv. Típica   Estadístico t   Valor p
  ------------------------------------------------------------------------
  const              -26.4167       4.61905         -5.719        1.26e-08  ***
  l_GDPi              -0.129072     0.0545592       -2.366        0.0181    **
  l_GDPj               0.888622     0.0372271       23.87         7.16e-109 ***
  l_Distcapij          0.657976     0.493398         1.334        0.1825
  l_Popi               0.756068     0.0958741        7.886        5.53e-015 ***
  l_Popj               0.0265440    0.0567396        0.4678       0.6400
  Maritime_Boundary    0.411037     0.178478         2.303        0.0214    **

Media de la vble. dep.   11.78241   D.T. de la vble. dep.   1.889134
Suma de cuad. residuos   732.8431   D.T. de la regresión    0.655799
Log-verosimilitud       -1701.929   Criterio de Akaike      3417.858
Criterio de Schwarz      3455.967   Crit. de Hannan-Quinn   3431.962

Varianza 'dentro' (Within) = 0.1562
Varianza 'entre' (between) = 0.255927
theta usado para quasi-demeaning (casi quitar la media) = 0.820772

Contraste de Breusch-Pagan -
  Hipótesis nula: Varianza del error específico a la unidad = 0
  Estadístico de contraste asintótico: Chi-cuadrado(1) = 5191.73
  con valor p  = 0

Contraste de Hausman -
  Hipótesis nula: Los estimadores de MCG son consistentes
  Estadístico de contraste asintótico: Chi-cuadrado(4) = 28.4252
  con valor p  = 1.02269e-005
```

GRETL: IMPORTS ESTIMATIONS

- **1995**

Modelo 1: MCO, usando las observaciones 1-90
Variable dependiente: l_Imports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

	Coeficiente	Desv. Típica	Estadístico t	Valor p	
const	-31.3809	8.84283	-3.549	0.0006	***
l_GDPi	0.0971689	0.403426	0.2409	0.8103	
l_GDPj	0.644884	0.189550	3.402	0.0010	***
l_Distcapij	1.34424	0.924121	1.455	0.1495	
l_Popi	0.400122	0.477301	0.8383	0.4043	
l_Popj	0.296950	0.282293	1.052	0.2959	
Maritime_Boundary	0.504412	0.294226	1.714	0.0902	*

Media de la vble. dep.	11.26966	D.T. de la vble. dep.	1.893961
Suma de cuad. residuos	76.59571	D.T. de la regresión	0.960646
R-cuadrado	0.760077	R-cuadrado corregido	0.742733
F(6, 83)	42.50163	Valor p (de F)	2.62e-23
Log-verosimilitud	-120.4474	Criterio de Akaike	254.8948
Criterio de Schwarz	272.3934	Crit. de Hannan-Quinn	261.9513

Sin considerar la constante, el valor p más alto fue el de la variable 9 (l_GDPi)

- **2000**

Modelo 1: MCO, usando las observaciones 1-90
Variable dependiente: l_Imports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

	Coeficiente	Desv. Típica	Estadístico t	Valor p	
const	-22.0113	9.83573	-2.238	0.0279	**
l_GDPi	-1.12626	0.662150	-1.701	0.0927	*
l_GDPj	0.650407	0.181131	3.591	0.0006	***
l_Distcapij	1.57862	0.927735	1.702	0.0926	*
l_Popi	1.51388	0.706836	2.142	0.0351	**
l_Popj	0.403659	0.272218	1.483	0.1419	
Maritime_Boundary	1.05391	0.382884	2.753	0.0073	***

Media de la vble. dep.	11.21195	D.T. de la vble. dep.	2.078351
Suma de cuad. residuos	88.47711	D.T. de la regresión	1.032468
R-cuadrado	0.769854	R-cuadrado corregido	0.753217
F(6, 83)	39.77918	Valor p (de F)	1.98e-22
Log-verosimilitud	-126.9365	Criterio de Akaike	267.8730
Criterio de Schwarz	285.3717	Crit. de Hannan-Quinn	274.9295

Sin considerar la constante, el valor p más alto fue el de la variable 13 (l_Popj)

- **2005**

Modelo 1: MCO, usando las observaciones 1-90
Variable dependiente: l_Imports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

	Coeficiente	Desv. Típica	Estadístico t	Valor p	
const	-6.11062	8.64747	-0.7066	0.4818	
l_GDPi	-2.30191	0.753946	-3.053	0.0030	***
l_GDPj	1.02644	0.216099	4.750	8.42e-06	***
l_Distcapij	1.65240	0.805733	2.051	0.0434	**
l_Popi	2.37052	0.730123	3.247	0.0017	***
l_Popj	-0.00184396	0.270529	-0.006816	0.9946	
Maritime_Boundary	0.418057	0.392785	1.064	0.2903	

Media de la vble. dep.	11.63474	D.T. de la vble. dep.	2.041260
Suma de cuad. residuos	72.24058	D.T. de la regresión	0.932935
R-cuadrado	0.805197	R-cuadrado corregido	0.791115
F(6, 83)	45.07179	Valor p (de F)	4.23e-24
Log-verosimilitud	-117.8131	Criterio de Akaike	249.6262
Criterio de Schwarz	267.1249	Crit. de Hannan-Quinn	256.6827

Sin considerar la constante, el valor p más alto fue el de la variable 13 (l_Popj)

- **2010**

```
Modelo 1: MCO, usando las observaciones 1-90
Variable dependiente: l_Imports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                     Coeficiente  Desv. Típica  Estadístico t  Valor p
  --------------------------------------------------------------------
  const              -10.3498      10.5920        -0.9771       0.3313
  l_GDPi              -3.06027      0.831761      -3.679        0.0004   ***
  l_GDPj               0.714409     0.170875       4.181        7.16e-05 ***
  l_Distcapij          3.70091      0.883784       4.188        6.99e-05 ***
  l_Popi               2.79776      0.760100       3.681        0.0004   ***
  l_Popj               0.462875     0.256614       1.804        0.0749   *
  Maritime_Boundary   -0.0349675    0.353308      -0.09897      0.9214

Media de la vble. dep.  11.98943   D.T. de la vble. dep.   2.218649
Suma de cuad. residuos  86.16927   D.T. de la regresión    1.018913
R-cuadrado              0.803309   R-cuadrado corregido    0.789090
F(6, 83)                40.91745   Valor p (de F)          8.42e-23
Log-verosimilitud      -125.7471   Criterio de Akaike      265.4943
Criterio de Schwarz     282.9930   Crit. de Hannan-Quinn   272.5508

Sin considerar la constante, el valor p más alto fue el de la variable 7 (Maritime_Boundary)
```

- **2011**

```
Modelo 1: MCO, usando las observaciones 1-90
Variable dependiente: l_Imports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                     Coeficiente  Desv. Típica  Estadístico t  Valor p
  --------------------------------------------------------------------
  const              -21.9622      10.3542        -2.121        0.0369   **
  l_GDPi              -2.63140      0.740306      -3.554        0.0006   ***
  l_GDPj               0.540918     0.191267       2.828        0.0059   ***
  l_Distcapij          4.04174      0.979260       4.127        8.69e-05 ***
  l_Popi               2.57586      0.734200       3.508        0.0007   ***
  l_Popj               0.754166     0.275799       2.734        0.0076   ***
  Maritime_Boundary    0.147822     0.383859       0.3851       0.7012

Media de la vble. dep.  12.15448   D.T. de la vble. dep.   2.354824
Suma de cuad. residuos  99.80941   D.T. de la regresión    1.096596
R-cuadrado              0.797761   R-cuadrado corregido    0.783141
F(6, 83)                34.94026   Valor p (de F)          9.40e-21
Log-verosimilitud      -132.3598   Criterio de Akaike      278.7197
Criterio de Schwarz     296.2184   Crit. de Hannan-Quinn   285.7762

Sin considerar la constante, el valor p más alto fue el de la variable 7 (Maritime_Boundary)
```

- **2012**

```
Modelo 1: MCO, usando las observaciones 1-90
Variable dependiente: l_Imports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                     Coeficiente  Desv. Típica  Estadístico t  Valor p
  --------------------------------------------------------------------
  const              -13.9910       9.63023       -1.453        0.1500
  l_GDPi              -2.43574      0.586055      -4.156        7.83e-05 ***
  l_GDPj               0.579975     0.176246       3.291        0.0015   ***
  l_Distcapij          3.17668      0.886002       3.585        0.0006   ***
  l_Popi               2.34231      0.550382       4.256        5.45e-05 ***
  l_Popj               0.571292     0.223426       2.557        0.0124   **
  Maritime_Boundary    0.502760     0.409207       1.229        0.2227

Media de la vble. dep.  12.13714   D.T. de la vble. dep.   2.118932
Suma de cuad. residuos  72.79584   D.T. de la regresión    0.936514
R-cuadrado              0.817828   R-cuadrado corregido    0.804659
F(6, 83)                61.60960   Valor p (de F)          1.67e-28
Log-verosimilitud      -118.1577   Criterio de Akaike      250.3154
Criterio de Schwarz     267.8140   Crit. de Hannan-Quinn   257.3719

Sin considerar la constante, el valor p más alto fue el de la variable 7 (Maritime_Boundary)
```

- **2013**

```
Modelo 1: MCO, usando las observaciones 1-90
Variable dependiente: l_Imports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                      Coeficiente  Desv. Típica  Estadístico t  Valor p
  ------------------------------------------------------------------
  const               -17.3120       9.83413       -1.760       0.0820  *
  l_GDPi               -2.24937      0.578166      -3.891       0.0002  ***
  l_GDPj                0.598549     0.176839       3.385       0.0011  ***
  l_Distcapij           3.30543      0.992693       3.330       0.0013  ***
  l_Popi                2.21573      0.555653       3.988       0.0001  ***
  l_Popj                0.517874     0.223147       2.321       0.0228  **
  Maritime_Boundary    -0.0165939    0.349626      -0.04746     0.9623

Media de la vble. dep.  12.11017   D.T. de la vble. dep.   2.059954
Suma de cuad. residuos  74.80168   D.T. de la regresión    0.949329
R-cuadrado              0.801936   R-cuadrado corregido    0.787618
F(6, 83)                48.73571   Valor p (de F)          3.58e-25
Log-verosimilitud      -119.3808   Criterio de Akaike      252.7617
Criterio de Schwarz     270.2604   Crit. de Hannan-Quinn   259.8182

Sin considerar la constante, el valor p más alto fue el de la variable 7 (Maritime_Boundary)
```

- **OLS**

```
Modelo 1: MCO combinados, utilizando 1710 observaciones
Se han incluido 90 unidades de sección cruzada
Largura de la serie temporal = 19
Variable dependiente: l_Imports
Desviaciones típicas robustas (HAC)

                      Coeficiente   Desv. Típica  Estadístico t   Valor p
  ---------------------------------------------------------------------
  const               -29.7504       6.70258        -4.439       9.63e-06  ***
  l_GDPi               -0.183179     0.198322       -0.9236      0.3558
  l_GDPj                0.813930     0.126086        6.455       1.40e-010 ***
  l_Distcapij           1.62324      0.652953        2.486       0.0130    **
  l_Popi                0.404454     0.232910        1.737       0.0827    *
  l_Popj                0.257500     0.166258        1.549       0.1216
  Maritime_Boundary     0.458236     0.256547        1.786       0.0743    *

Media de la vble. dep.   11.58369   D.T. de la vble. dep.   2.111080
Suma de cuad. residuos   1761.977   D.T. de la regresión    1.017168
R-cuadrado               0.768661   R-cuadrado corregido    0.767846
F(6, 1703)               943.0819   Valor p (de F)          0.000000
Log-verosimilitud       -2451.986   Criterio de Akaike      4917.973
Criterio de Schwarz      4956.083   Crit. de Hannan-Quinn   4932.077
rho                      0.797736   Durbin-Watson           0.386040

Sin considerar la constante, el valor p más alto fue el de la variable 9 (l_GDPi)
```

- **Fixed effects**

Modelo 2: Efectos fijos, utilizando 1710 observaciones
Se han incluido 90 unidades de sección cruzada
Largura de la serie temporal = 19
Variable dependiente: l_Imports
Desviaciones típicas robustas (HAC)
Omitidas debido a colinealidad exacta: l_Distcapij Maritime_Boundary

	Coeficiente	Desv. Típica	Estadístico t	Valor p	
const	−12.7299	20.2770	−0.6278	0.5302	
l_GDPi	1.10274	0.167940	6.566	6.93e-011	***
l_GDPj	0.443052	0.109120	4.060	5.14e-05	***
l_Popi	0.882473	1.52235	0.5797	0.5622	
l_Popj	−2.01507	0.798507	−2.524	0.0117	**

Media de la vble. dep.	11.58369	D.T. de la vble. dep.	2.111080
Suma de cuad. residuos	620.4504	D.T. de la regresión	0.619631
R-cuadrado	0.918538	R-cuadrado corregido	0.913850
F(93, 1616)	195.9295	Valor p (de F)	0.000000
Log-verosimilitud	−1559.583	Criterio de Akaike	3307.167
Criterio de Schwarz	3818.926	Crit. de Hannan-Quinn	3496.566
rho	0.425836	Durbin-Watson	1.075997

Contraste de diferentes interceptos por grupos -
Hipótesis nula: Los grupos tienen un intercepto común
Estadístico de contraste: F(89, 1616) = 33.4065
con valor p = P(F(89, 1616) > 33.4065) = 8.578e-302

- **Random effects**

Modelo 3: Efectos aleatorios (MCG), utilizando 1710 observaciones
Se han incluido 90 unidades de sección cruzada
Largura de la serie temporal = 19
Variable dependiente: l_Imports

	Coeficiente	Desv. Típica	Estadístico t	Valor p	
const	−36.9950	7.47375	−4.950	8.16e-07	***
l_GDPi	0.662849	0.0874136	7.583	5.52e-014	***
l_GDPj	0.356134	0.0596603	5.969	2.89e-09	***
l_Distcapij	1.83641	0.798401	2.300	0.0216	**
l_Popi	−0.398941	0.154644	−2.580	0.0100	***
l_Popj	0.664192	0.0913494	7.271	5.42e-013	***
Maritime_Boundary	0.906608	0.288723	3.140	0.0017	***

Media de la vble. dep.	11.58369	D.T. de la vble. dep.	2.111080
Suma de cuad. residuos	1957.347	D.T. de la regresión	1.071764
Log-verosimilitud	−2541.893	Criterio de Akaike	5097.785
Criterio de Schwarz	5135.895	Crit. de Hannan-Quinn	5111.889

Varianza 'dentro' (Within) = 0.383942
Varianza 'entre' (between) = 0.643601
theta usado para quasi-demeaning (casi quitar la media) = 0.822807

Contraste de Breusch-Pagan -
Hipótesis nula: Varianza del error específico a la unidad = 0
Estadístico de contraste asintótico: Chi-cuadrado(1) = 5228.73
con valor p = 0

Contraste de Hausman -
Hipótesis nula: Los estimadores de MCG son consistentes
Estadístico de contraste asintótico: Chi-cuadrado(4) = 100.291
con valor p = 8.52915e-021

GRETL: ALL FLOWS ESTIMATIONS

- **1995**

```
Modelo 1: MCO, usando las observaciones 1-180
Variable dependiente: l_Exports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                    Coeficiente  Desv. Típica  Estadístico t   Valor p
  ----------------------------------------------------------------------
  const              -35.2057     5.38600        -6.537       6.80e-010 ***
  l_GDPi               0.732718   0.126380        5.798       3.12e-08  ***
  l_GDPj               0.798085   0.127816        6.244       3.20e-09  ***
  l_Distcapij          0.377994   0.573157        0.6595      0.5105
  l_Popi               0.190762   0.198023        0.9633      0.3367
  l_Popj               0.0122403  0.168717        0.07255     0.9422
  Maritime_Boundary    0.267443   0.213404        1.253       0.2118

Media de la vble. dep.   11.32602   D.T. de la vble. dep.   1.855718
Suma de cuad. residuos   129.6476   D.T. de la regresión    0.865684
R-cuadrado               0.789677   R-cuadrado corregido    0.782382
F(6, 173)                89.09838   Valor p (de F)          2.71e-50
Log-verosimilitud       -225.8766   Criterio de Akaike      465.7532
Criterio de Schwarz      488.1039   Crit. de Hannan-Quinn   474.8155

Sin considerar la constante, el valor p más alto fue el de la variable 13 (l_Popj)
```

- **2000**

```
Modelo 1: MCO, usando las observaciones 1-180
Variable dependiente: l_Exports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                    Coeficiente  Desv. Típica  Estadístico t   Valor p
  ----------------------------------------------------------------------
  const              -31.6808     5.72697        -5.532       1.15e-07  ***
  l_GDPi               0.850109   0.124188        6.845       1.27e-010 ***
  l_GDPj               0.865863   0.112518        7.695       1.03e-012 ***
  l_Distcapij         -0.404435   0.568492       -0.7114      0.4778
  l_Popi               0.162005   0.209305        0.7740      0.4400
  l_Popj              -0.0463463  0.156388       -0.2964      0.7673
  Maritime_Boundary    0.626135   0.226001        2.770       0.0062    ***

Media de la vble. dep.   11.35645   D.T. de la vble. dep.   1.979022
Suma de cuad. residuos   150.2145   D.T. de la regresión    0.931822
R-cuadrado               0.785732   R-cuadrado corregido    0.778301
F(6, 173)                102.9994   Valor p (de F)          1.88e-54
Log-verosimilitud       -239.1286   Criterio de Akaike      492.2572
Criterio de Schwarz      514.6079   Crit. de Hannan-Quinn   501.3195

Sin considerar la constante, el valor p más alto fue el de la variable 13 (l_Popj)
```

- **2005**

```
Modelo 2: MCO, usando las observaciones 1-180
Variable dependiente: l_Exports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                    Coeficiente  Desv. Típica  Estadístico t   Valor p
  ----------------------------------------------------------------------
  const              -33.6061     4.66874        -7.198       1.78e-011 ***
  l_GDPi               1.16038    0.145883        7.954       2.26e-013 ***
  l_GDPj               1.28058    0.140605        9.108       2.03e-016 ***
  l_Distcapij         -0.560991   0.488729       -1.148       0.2526
  l_Popi              -0.195187   0.195151       -1.000       0.3186
  l_Popj              -0.604125   0.167709       -3.602       0.0004    ***
  Maritime_Boundary    0.132507   0.230690        0.5744      0.5664

Media de la vble. dep.   11.69034   D.T. de la vble. dep.   1.891719
Suma de cuad. residuos   130.3338   D.T. de la regresión    0.867971
R-cuadrado               0.796535   R-cuadrado corregido    0.789478
F(6, 173)                106.3174   Valor p (de F)          2.22e-55
Log-verosimilitud       -226.3517   Criterio de Akaike      466.7034
Criterio de Schwarz      489.0541   Crit. de Hannan-Quinn   475.7656

Sin considerar la constante, el valor p más alto fue el de la variable 7 (Maritime_Boundary)
```

- **2010**

```
Modelo 1: MCO, usando las observaciones 1-180
Variable dependiente: l_Exports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                     Coeficiente  Desv. Típica  Estadístico t   Valor p
  ---------------------------------------------------------------------
  const               -47.2382     5.70522        -8.280      3.23e-014 ***
  l_GDPi                1.01139    0.132195        7.651      1.34e-012 ***
  l_GDPj                1.21081    0.120305       10.06       4.78e-019 ***
  l_Distcapij           0.979379   0.571661        1.713      0.0885    *
  l_Popi                0.0282133  0.216690        0.1302     0.8966
  l_Popj               -0.530014   0.156965       -3.377      0.0009    ***
  Maritime_Boundary    -0.163049   0.247046       -0.6600     0.5101

Media de la vble. dep.   12.05690   D.T. de la vble. dep.    2.050969
Suma de cuad. residuos   181.8788   D.T. de la regresión     1.025340
R-cuadrado               0.758448   R-cuadrado corregido     0.750070
F(6, 173)                82.88577   Valor p (de F)           2.82e-48
Log-verosimilitud       -256.3435   Criterio de Akaike       526.6869
Criterio de Schwarz      549.0376   Crit. de Hannan-Quinn    535.7492

Sin considerar la constante, el valor p más alto fue el de la variable 12 (l_Popi)
```

- **2011**

```
Modelo 1: MCO, usando las observaciones 1-180
Variable dependiente: l_Exports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                     Coeficiente  Desv. Típica  Estadístico t   Valor p
  ---------------------------------------------------------------------
  const               -46.6943     6.17458        -7.562      2.23e-012 ***
  l_GDPi                0.911555   0.142544        6.395      1.45e-09  ***
  l_GDPj                1.10314    0.131700        8.376      1.81e-014 ***
  l_Distcapij           0.863215   0.657157        1.314      0.1907
  l_Popi                0.212960   0.221505        0.9614     0.3377
  l_Popj               -0.365802   0.168577       -2.170      0.0314    **
  Maritime_Boundary    -0.0458128  0.257095       -0.1782     0.8588

Media de la vble. dep.   12.24678   D.T. de la vble. dep.    2.121425
Suma de cuad. residuos   192.1644   D.T. de la regresión     1.053934
R-cuadrado               0.761458   R-cuadrado corregido     0.753185
F(6, 173)                78.94764   Valor p (de F)           6.13e-47
Log-verosimilitud       -261.2944   Criterio de Akaike       536.5888
Criterio de Schwarz      558.9395   Crit. de Hannan-Quinn    545.6511

Sin considerar la constante, el valor p más alto fue el de la variable 7 (Maritime_Boundary)
```

- **2012**

```
Modelo 1: MCO, usando las observaciones 1-180
Variable dependiente: l_Exports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                     Coeficiente  Desv. Típica  Estadístico t   Valor p
  ---------------------------------------------------------------------
  const               -38.8781     5.81752        -6.683      3.09e-010 ***
  l_GDPi                0.944303   0.137471        6.869      1.12e-010 ***
  l_GDPj                1.06434    0.127022        8.379      1.78e-014 ***
  l_Distcapij           0.251263   0.646313        0.3888     0.6979
  l_Popi                0.0891690  0.191691        0.4652     0.6424
  l_Popj               -0.371986   0.160000       -2.325      0.0212    **
  Maritime_Boundary     0.184667   0.261081        0.7073     0.4803

Media de la vble. dep.   12.28426   D.T. de la vble. dep.    1.995351
Suma de cuad. residuos   168.3849   D.T. de la regresión     0.986571
R-cuadrado               0.763728   R-cuadrado corregido     0.755534
F(6, 173)                92.33218   Valor p (de F)           2.65e-51
Log-verosimilitud       -249.4055   Criterio de Akaike       512.8111
Criterio de Schwarz      535.1618   Crit. de Hannan-Quinn    521.8733

Sin considerar la constante, el valor p más alto fue el de la variable 11 (l_Distcapij)
```

- **2013**

```
Modelo 1: MCO, usando las observaciones 1-180
Variable dependiente: l_Exports
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                     Coeficiente  Desv. Típica  Estadístico t   Valor p
  ----------------------------------------------------------------------
  const               -41.3461      6.26680        -6.598      4.90e-010 ***
  l_GDPi                0.934447    0.134038        6.972      6.34e-011 ***
  l_GDPj                0.974765    0.129438        7.531      2.68e-012 ***
  l_Distcapij           0.637054    0.726485        0.8769     0.3818
  l_Popi                0.0619705   0.183828        0.3371     0.7364
  l_Popj               -0.244808    0.160682       -1.524      0.1294
  Maritime_Boundary    -0.0393191   0.238116       -0.1651     0.8690

Media de la vble. dep.  12.30174   D.T. de la vble. dep.   1.965830
Suma de cuad. residuos  173.7136   D.T. de la regresión    1.002060
R-cuadrado              0.748876   R-cuadrado corregido    0.740166
F(6, 173)               80.07600   Valor p (de F)          2.51e-47
Log-verosimilitud      -252.2096   Criterio de Akaike      518.4191
Criterio de Schwarz     540.7698   Crit. de Hannan-Quinn   527.4814

Sin considerar la constante, el valor p más alto fue el de la variable 7 (Maritime_Boundary)
```

- **OLS**

```
Modelo 1: MCO combinados, utilizando 3420 observaciones
Se han incluido 180 unidades de sección cruzada
Largura de la serie temporal = 19
Variable dependiente: l_Exports

                     Coeficiente   Desv. Típica  Estadístico t    Valor p
  ------------------------------------------------------------------------
  const               -37.6615     1.41682        -26.58        1.17e-141 ***
  l_GDPi                0.668034   0.0228578       29.23        8.98e-168 ***
  l_GDPj                0.752059   0.0228578       32.90        1.87e-206 ***
  l_Distcapij           0.607375   0.156033         3.893       0.0001    ***
  l_Popi                0.345389   0.0308157       11.21        1.17e-028 ***
  l_Popj                0.0189981  0.0308157        0.6165      0.5376
  Maritime_Boundary     0.568707   0.0579572        9.813       1.96e-022 ***

Media de la vble. dep.   11.68342   D.T. de la vble. dep.    2.005078
Suma de cuad. residuos   3229.475   D.T. de la regresión     0.972742
R-cuadrado               0.765053   R-cuadrado corregido     0.764640
F(6, 3413)               1852.279   Valor p (de F)           0.000000
Log-verosimilitud       -4754.751   Criterio de Akaike       9523.502
Criterio de Schwarz      9566.463   Crit. de Hannan-Quinn    9538.852
rho                      0.856543   Durbin-Watson            0.284353

Sin considerar la constante, el valor p más alto fue el de la variable 13 (l_Popj)
```

- **Fixed effects**

```
Modelo 2: Efectos fijos, utilizando 3420 observaciones
Se han incluido 180 unidades de sección cruzada
Largura de la serie temporal = 19
Variable dependiente: l_Exports
Desviaciones típicas robustas (HAC)
Omitidas debido a colinealidad exacta: l_Distcapij Maritime_Boundary

             Coeficiente   Desv. Típica   Estadístico t    Valor p
  ----------------------------------------------------------------
  const        1.60234      10.2149         0.1569        0.8754
  l_GDPi       0.395210      0.0891013      4.436         9.49e-06  ***
  l_GDPj       0.837617      0.0775808     10.80          1.01e-026 ***
  l_Popi      -0.937005      0.603863      -1.552         0.1208
  l_Popj      -0.373164      0.529475      -0.7048        0.4810

Media de la vble. dep.   11.68342   D.T. de la vble. dep.    2.005078
Suma de cuad. residuos   892.8940   D.T. de la regresión     0.525286
R-cuadrado               0.935041   R-cuadrado corregido     0.931368
F(183, 3236)             254.5364   Valor p (de F)           0.000000
Log-verosimilitud       -2556.363   Criterio de Akaike       5480.726
Criterio de Schwarz      6610.007   Crit. de Hannan-Quinn    5884.227
rho                      0.455377   Durbin-Watson            1.022647

Contraste de diferentes interceptos por grupos -
  Hipótesis nula: Los grupos tienen un intercepto común
  Estadístico de contraste: F(179, 3236) = 47.3082
  con valor p  = P(F(179, 3236) > 47.3082) = 0
```

- **Random effects**

```
Modelo 3: Efectos aleatorios (MCG), utilizando 3420 observaciones
Se han incluido 180 unidades de sección cruzada
Largura de la serie temporal = 19
Variable dependiente: l_Exports

                     Coeficiente  Desv. Típica  Estadístico t   Valor p
  ---------------------------------------------------------------------
  const              -36.3945     5.17311        -7.035       2.39e-012 ***
  l_GDPi               0.342696   0.0310675      11.03        7.98e-028 ***
  l_GDPj               0.614699   0.0310675      19.79        1.42e-082 ***
  l_Distcapij          1.08443    0.555403        1.953       0.0510    *
  l_Popi               0.653270   0.0707686       9.231       4.58e-020 ***
  l_Popj               0.0791202  0.0707686       1.118       0.2636
  Maritime_Boundary    0.832609   0.198628        4.192       2.84e-05  ***

Media de la vble. dep.  11.68342   D.T. de la vble. dep.   2.005078
Suma de cuad. residuos  3493.516   D.T. de la regresión    1.011579
Log-verosimilitud      -4889.138   Criterio de Akaike      9792.276
Criterio de Schwarz     9835.238   Crit. de Hannan-Quinn   9807.627

Varianza 'dentro' (Within) = 0.275925
Varianza 'entre' (between) = 0.644311
theta usado para quasi-demeaning (casi quitar la media) = 0.849869

Contraste de Breusch-Pagan -
  Hipótesis nula: Varianza del error específico a la unidad = 0
  Estadístico de contraste asintótico: Chi-cuadrado(1) = 13916.5
  con valor p  = 0

Contraste de Hausman -
  Hipótesis nula: Los estimadores de MCG son consistentes
  Estadístico de contraste asintótico: Chi-cuadrado(4) = 113.55
  con valor p  = 1.27282e-023
```