TRADE AND ROAD TRANSPORT. SPANISH EXPORTS TO THE EUROPEAN UNION

Abstract

This work attempts to study the relationship between trade and costs of road transport. First, we analyze trade and transport in the world economy and then we focus in more detail on European transport. To analyze the influence of the transports costs on the trade, we estimate a regression model where we include explanatory variables as distance, the GDP per capita for importer countries as well as for exporter country and dummies on specific characteristics of trade flows. In doing so, exports by road among Spain and EU-27 countries are considered. Furthermore, we make an estimation for three relevant sectors in road transport. The results of both estimations allow us to know more about the relevance of transport and logistics when explaining the determinants of European trade.

Classification JEL: F10, F14.

LAURA MOR LECHA
al185069 @uji.es
Degree: Bachelor's Degree in Economics
Tutor: Celestino Suárez Burguet
Academic year: 2014/2015

INDEX

ILLUSTRATIONS

TRADE AND ROAD TRANPORT. SPANISH EXPORTS TO THE EUROPEAN UNION

1. Introduction

Since the creation of the GATT in 1947, international trade has been benefited from major changes. From this period it can be seen a large increase in trade among countries and, over the years, more consolidation occurs. Many studies have analyzed the different factors that influence international trade. In the first moment, tariff barriers have been considered as one of the main obstacles to growth of international trade. In recent years, an increasing number of studies have begun to analyze the importance of transport costs and their main determinants. This recent interest may be caused, among other factors, by the fact that transport costs are not under the direct control of policy makers as are tariffs and the rest of trade barriers.

In many of the works carried out in recent decades, it has been determined that the transport costs are of great importance for the growth of trade flows. Besides, these are highly relevant for the volume of trade because with them the difficulty of distance is overcome and more effectiveness exists to perform such service. When there are transport costs this implies that commercial exchange between countries is developed from different prices between importing and exporting countries, in an indirect form. Similarly, transportation costs are a component of total production costs of goods and they have everything that is needed so the goods reach the final consumer.

In our study, the main objective is to see how some factors affect international trade. Especially we want to focus on the impact of the costs of road transport. The costs of road transport will be proxied through the distance in kilometers from a country to another since we consider that is a good substitute of the transport costs. For this analysis we will focus on the EU level where the main means of transporting goods is the road. Therefore, we analyze the exports by road of Spain to the of the EU, so we can observe how the distance as proxy for transport costs and some other variables that seem relevant when we are analyzing international trade.

All throughout this work, various components of transport costs in the analysis of trade relations among countries are analyzed. Thus, in the second section we make an analysis of freight transport. First, worldwide and then, we discuss further the freight at European level with the highest incidence in the transport goods by road. Finally, we observe how Spanish exports behave according to the mode of transportation of goods used. In the third section, we review the literature. There, we collect the most important

ideas of the studies that have been made over the years in reference to international trade and transport costs. In the fourth section, we explain the gravity equation and the importance of its application to international trade. We also discuss the gravity equation that we use, explaining the variables in our model and different data sources that we used to create them. In the fifth section, we estimate separate regression models and see the main ideas that we can find. Finally, the conclusion summarizes the most important ideas we have obtained throughout our work, both in the descriptive analysis and in the model estimation.

2. Trade and transport in the world economy.

International trade is an essential factor in the growth of the world economy. In the last twenty years, trade has experienced a significantly growth and this has a positive impact on world economy. But with the arrival of the crisis in 2008-2009, trade patterns have changed in developed countries as well as in developing. Together, the volume of imports and exports of the developed regions have been kept below their pre-crisis levels, with the exception of the United States. The report data about Trade and Development 2013 UNCTAD show that the volume of international trade grew at an average annual rate of less than 2% in the first five months of 2013. Among developed countries, exports and imports almost stalled in the United States and fell in the European Union and Japan. Exports from emerging economies slowed down during the same period, with the exception for those emerging in Asia, which increased by 6.2% in the first months of 2013.

World trade is affected by many factors. For many years, tariff barriers have been considered as one of the main obstacles to the growth of international trade. In recent years, continuous studies have begun to analyze the importance of transport costs and their main determinants. Therefore, nowadays transport costs have a major influence within the volume of trade. In world trade, transport is used in different modes for transporting goods. Generally, the ways most common used are shipping and road transport.

The maritime transport is one of the most used in the transport of goods in the world. This includes about 90 % of international trade in goods. This mode of goods transport is characterized by very low costs. Besides, it has a very high capacity, in relation to load in tons. Preferably many products are transported in bulk and containers. Asia is the region which has a greater global maritime trade. It downloads about 56 % of total load tonnage and loads about 39 % of the total. It is followed by the regions of America

and Europe that have a much lower percentage in loads and unloads compared to world maritime trade. The regions of Oceania and Africa have a percentage of about 10% of total tonnage.

The maritime flows are much higher in the northern hemisphere due to the great importance of two strategic steps: the Panama Channel and the Suez Channel, which avoid that ships have to go around the South American continent and African continent. The creation of the Suez Channel allowed to open a new fastest maritime route that connects Europe to Southeast Asia. On the other hand, the Panama Channel allowed to avoid all South American continent to get from one coast of America to the other.

The main route of maritime traffic of goods through the trade of containers is East-West. It connects the countries of Europe with North America which start in England and end in the Atlantic Drift seaboard of the United States and Canada, and others which do the contrary. The routes that connect Europe with Central and South America pass through the English Channel. Also, by this channel, routes connecting Western Europe and Southern Africa and the Indian Ocean pass. On the other hand, America communicates with the Mediterranean ports through routes which pass through the Strait of Gibraltar. In the area of the North Atlantic routes of the Soviet Union stand out which are connected with the Pacific Ocean through the Strait of Zembla and Bering and traveling from Leningrad to the Far East.

Another way of transport is rail transport. This emerged in the nineteenth century and became a central element in the mobility of people as well as load of goods. Today, its participation is very small in the transport of global goods. Basically, it is used to transport of some goods in bulk. This method of transport has a great advantage because it can transport large tons and it has an average speed. Nevertheless, the cost of road transport is minor. Also, many of the rail networks around the world are antiquated or in poor condition and this worsens the efficiency of rail transport.

Generally, in countries as the United States where the volumes transported are high, the railway moves more tons per kilometer in intercity tours than trucks. However, in other countries such as Japan and the European Union, transport rail load has little relevance, representing around the 10 % of the total tonnage per kilometers. In Latin American countries, goods of transport by rail only meet a small part of the market. Economic growth in these countries has caused the emergence of new markets where the train is not able to take this challenge.

Compared to other methods of transport, air transport is one of the means of international transport of goods used less frequently in international trade. Although it may seem unprofitable to adopt this mode of transport but on the contrary, its use is essential to the profitability of certain markets. This is most often used to transport high-value goods and perishable. It is a very fast means of transport, although it has a high cost and low capacity, due to its limited load capacity by weight and for volume that airplanes possess.

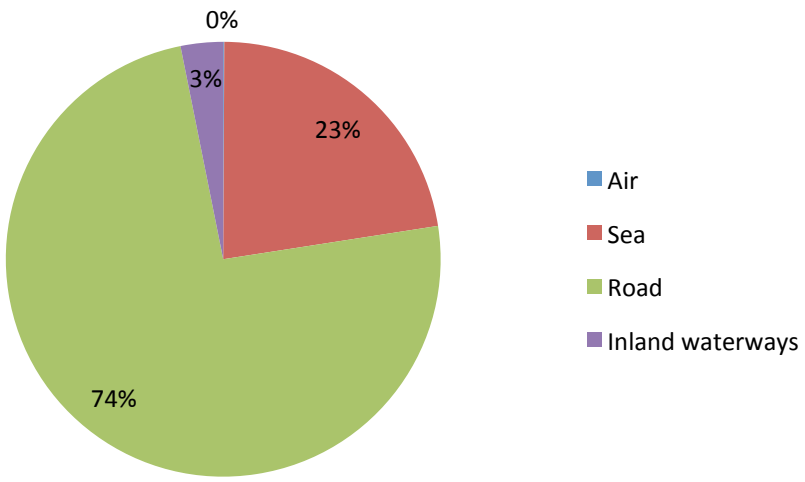
Goods transport by road is also a very used method in international trade. This allows transporting the goods to the exact destination facilitating trade flows which can be increased. On the other hand, it is one of the means of transport with great speed, so the goods arrive to their destination in less time. In addition, goods of transport by road have a very low cost of transport compared to other methods of transportation. Nevertheless, it has a major disadvantage because the capacity of load is much lower than in other modes of transport.

2.1 European transport: Modal split and policy

Road transport is relevant throughout the international area to promote international trade but our study focuses on the area of the European Union since this has a special relevance.

As we can see in Figure 1, in the transport of goods within the European Union (EU) the transport most widely used is road. Maritime transport also has a great relevance within Europe, as we can see, it represents a significant proportion within the methods of transport more used for goods transport. Although the railway does not appear in this figure, if we look at the data for 2011, we can see that railway is also a way of transport which is used more often than the air, but this is used less often than maritime and road transport. Railway should be strengthened because it is cheaper and less polluting than road transport. Nevertheless, it has a main problem that is the railway infrastructure is antiquated and damaged, so the improvement of these would be a big cost. Besides, it is also necessary to develop intermodal formulas that allow door to door, which is the big advantage of road transport.

Figure 1 : Goods freight transport by mode (2012)



Source: European Commission. Eurostat

Since 1957, the European Community has a transport policy in order to establish measures in terrestrial transport (road and railway) and water transport (river and sea). In the 70s, it was extended by incorporating air transport, which has become more important in recent years. The basic objectives of the current transport policy are: transportation security, the Transeuropean network and environmental protection. Quality and cost of transport services significantly affect the competitive opportunities of enterprises, economic growth and quality of life. Transport is essential for the efficiency of European economy. Therefore, the European transport policy is essential in improving the economic and social cohesion of the EU and in the area of trade within as well as outside the EU.

Since the 90s, there is a fundamental problem affecting the economic competitiveness of some member states and the EU itself to foreign markets, this is the phenomenon of congestion on some concrete regions and axes. Although most congestion happens in urban areas, the Transeuropean network is under this problem. Approximately 10 % of the network suffers the problem of congestion on a continuous way and about 16.000 kilometers of rail line is congested.

There is also a large congestion at European airports (congestion index is measured by the average delay of flights). Therefore, approximately 30 % of flights are delayed within the top 16 airports in the European Union. In the aviation sector, it must continue

to improve the efficiency of aircraft operations and air traffic management. However, it should not impose excessive loads to air operations in the EU and optimize airport capacity, increasing it in order to meet the growing demand of travels to and from third countries and poorly served areas in Europe. This could result in a doubled air transport in 2050 in the EU. Hence, the problem of congestion is essential and the EU must solve it as this phenomenon has great relevance in the economic and commercial sphere.

In the last decade, Europe has lead large maritime corridors that serve to relieve congestion that is produced through the goods transport by road since it would save time, cost and have environmental benefits. In 2004, the European Commission designed a network of trusted corridors to promote maritime transport. A) Route from the Baltic Sea, B) Western European route, C) route from Europe and South-West and D) South-East European route. These four major markets are shown in the map. Today, European ports have a high volume of goods corresponding to over 90 % of EU trade with other countries. As regards to the scope of intra freight, goods volume represents about 30 % of the total.

Map 1 : New network of maritime corridors

Source: Expansión

In relation to the railway network, the EU also needs to make a redefinition of the railway sector to solve congestion problems as well as to solve mobility problems affecting the EU. Currently, railway transport of load in the EU is marginal (an average less than 10 % of all tone-kilometers) since much of the existing infrastructure is used

by passenger railway. In any case, in Europe there is not a common criterion for the railway and substantial differences are observed depending on the country. For example, Germany favors more load rail than France, a nation that gives priority to passenger high speed. Despite the above mentioned, the enhancement of rail load is now a priority for the European Union.

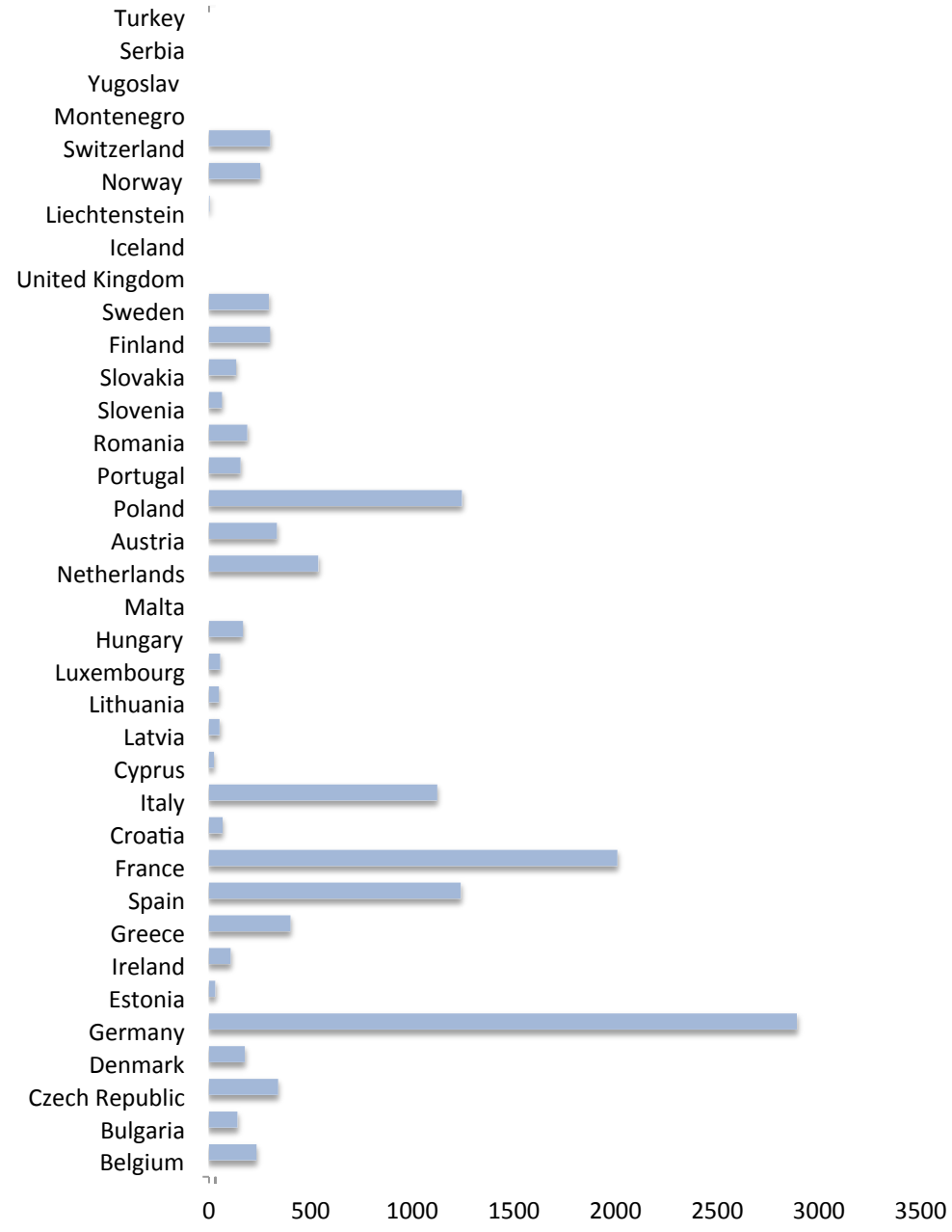
Our study focuses on the costs of transport by road within the EU. Road transport is a fundamental part of European economy and single market. It is a fast, efficient, flexible and economical way of transport of goods throughout entire Europe. The flexibility of road transport connects all EU regions with each other and with the main European goods networks.

At present, the road transport sector in the EU is facing different problems. The roads are more and more congested every time and sometimes, one in four vehicles loading large tonnage circulates empty. Other problems facing the sector are the high price of fuel that causes a large increase in transport costs. In addition, air and noise pollution are due mainly to road transport, which is also a problem to be controlled. In general, traffic congestion costs Europe about 1% of gross domestic product (GDP) per year. To reduce these costs, the EU needs more efficient transport and logistics, an improvement of infrastructure and optimization of capacity use.

Transport infrastructure is an important determinant for regional development. An efficient transport network is fundamental for sustainable economic growth as well as fundamental balance. Less advanced regions face problems of economic development that are caused in part by inadequate transportation system and the lack of connections with other regions of their respective countries as well as with other EU regions.

Figure 2 shows the geographic areas which transport more road goods volume in a given year. In 2012, approximately 12.281 billion tons of goods were transported by road in the EU. Of this amount, 22% were transported on the roads in Germany, followed by France (16 %), Poland (10%), Spain (10%) and Italy (9 %). Currently, if we compare between road and railway transport goods it shows that the quantities of goods transported by road in the EU exceed 9 times the amount transported by rail.

Figure 2: Goods transport by road in EU, 2012 (Millions of tonnes)

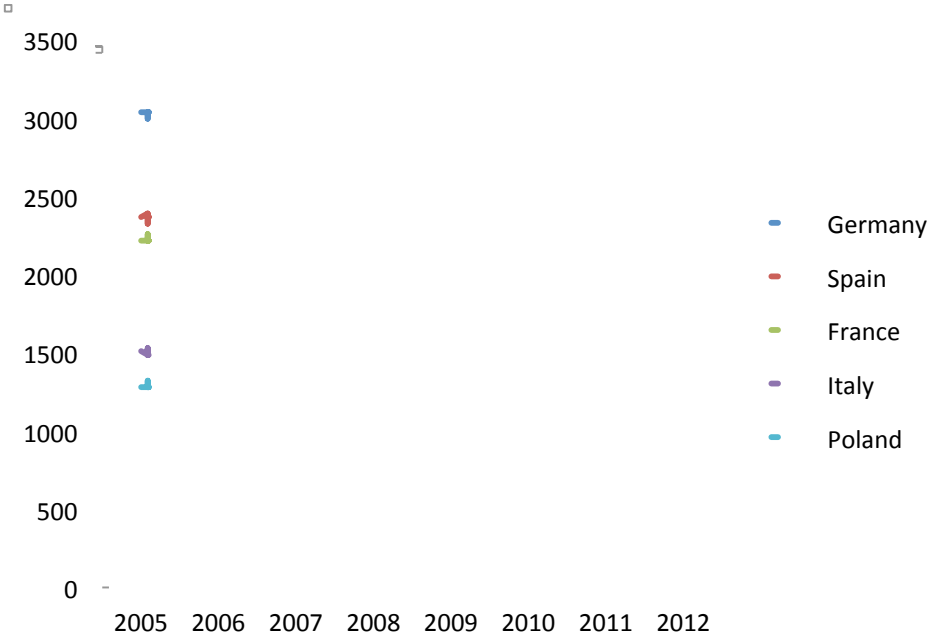


Source: European Commission. Eurostat

As noted in Figure 2, the main geographical areas of the transport network of goods in the EU where more goods are transported are Germany, France, Poland, Spain and Italy. In the next picture we can see the evolution of volume goods transport in these

areas since 2005-2012. We observe that Germany through all the period remains a leader in the transportation of goods by road. Mainly, it is affected by the crisis in 2008 and its volume of goods transported decreases, just as it happens to France. However, in early 2007 Spain begins to decrease the volume of goods transported by road and continues going down to very low levels compared to the period 2005-2006. Here you can see how the current crisis in the Spanish economy has affected trade in goods in large proportion. Italy and Poland are at lower levels throughout the period but constant, although in 2010 a drop of goods transported by road is appreciated.

Figure 3 : Trade transport by road in the EU (Millions of tonnes)



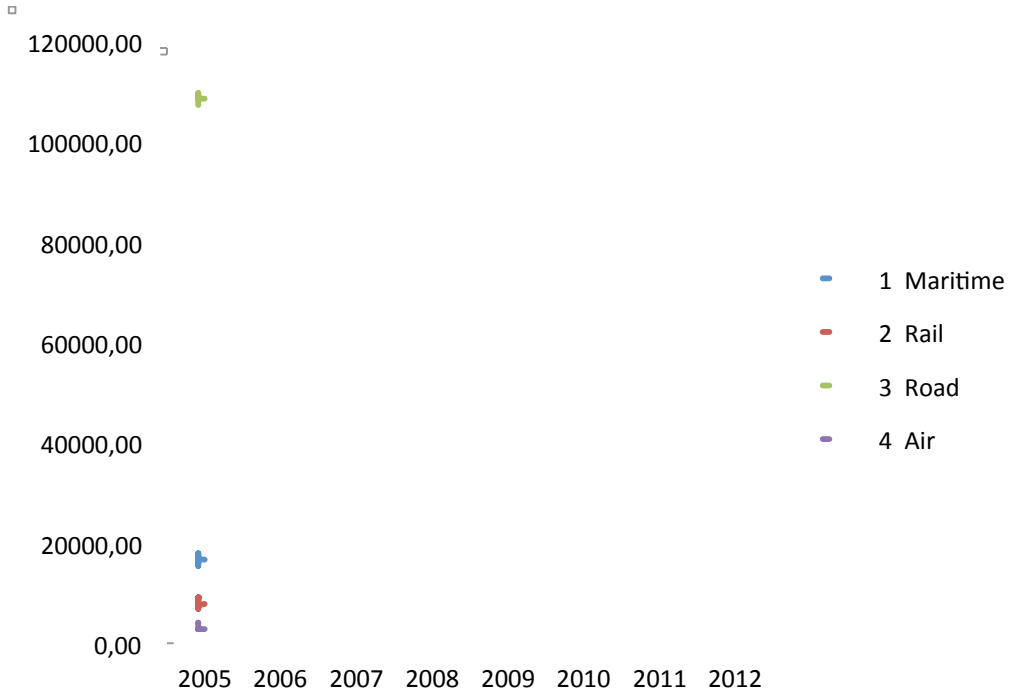
Source: European Commission. Eurostat

Therefore, we can say that road is essential within the EU economy and has a great relevance in European trade. In addition, the major geographical areas in this area have been affected in recent years due to the global economic crisis and this has had a serious effect on the transport of goods and therefore, in the European trade.

Therefore, in our study we analyze the exports of Spain by road to the various member countries of the European Union, since the road is one of the most used ways of transport for trading goods within the European Union. Thus, we could see a more intuitive form of how some variables affect Spain exports such as the distance among countries. As shown in the following chart, Spain's exports to the EU are generally done through road transport. Spanish road exports in 2012 are EUR 109900 although

in other modes of transport, the amount is much lower. In Spain, maritime transport accounts the 13% in Spanish exports to the EU, air transport and railways represent less than 10% of Spain's exports to the EU.

Figure 4: Spanish Exports to de EU-27 (2005-2012). Modes of transport (millions of tonnes)



Source: European Commission. Eurostat

3. Literature Review

Despite its big importance, there are not many studies that focus on the transport costs and the majority, do so at the aggregate level. A work that has great relevance and that was one of the first studies to use the equations of gravity is the work of Jan Tinbergen (1962). This author tried to explain the behavior of trade flows between the member countries of a preferential group and the rest of the world through a regression that considered the gross national product, the geographical distance and dummy variables to measure the effects on preferred groups as the explanatory variables in the equation. In fact, a large part of the literature considers approximate variables of transport costs. For example, the gravity models use geographic distance between the capitals of the countries as a proxy variable for transport costs (Deardorff, 1995; Bergstrand, 1985, 1989). In these works it has been shown that geographic distance is a fundamental factor in the cost of trade. Also, it argues that the distance could be

picking up a number of factors and not being very representative of the maritime transport tariffs, which are set by the market of supply and demand.

Within the studies of transport costs, Hummels (1998b) and Moneta (1989) demonstrated the importance of geography. A very important article that we stand out is Limão and Venables (2001), as this is one of the first works that included and gave importance to the transport costs. A study is realized on the factors of transport costs and it is shown as depending on geographical factors and the state of infrastructure.

One of the main conclusions is that the capacity of the infrastructure has a major impact on the volume of trade and indirectly, on national competitiveness. When there are more or better infrastructures, it can be observed that transport costs are higher, as this enables a greater trade there. Another idea developed in this article is the importance of the countries which share a border. It is observed that countries that share a border have a minor transport costs. These is because firstly, the bordering countries have transport networks more constituted which reduces the number of transactions and this decreases the cost of transport and secondly, this type of countries that have common border tend to have transit agreements or customs unions and this helps to decrease the time of transport and therefore, transport costs are also reduced. Indeed, it is concluded that the border effect on trade is positive and of great importance in determining transport costs. Comparing the coastal countries and those without access to the sea we note that the countries which have no access to the sea have higher transport costs. In general, the cost of transport and the volume of trade business depend on several factors related to geography, infrastructure and administration barriers of each country.

In different articles the gravity models are used to measure international trade as well as transport costs. The use of gravity models in international trade have been used since the last century, as it has been seen in the articles cited above. Also, these models have been modified by adding dummy variables. Furthermore, in some investigations, these gravity models have been extended with variables of logistical hardware and software. The logistical hardware is used to represent the transport capacity in a country and logistical software includes variables that capture the communication links among countries, such as access to the Internet and the telephone network.

One investigation that uses this extended model is that of Coca-Castaño, Márquez-Ramos and Martínez-Zarzoso (2005) where authors evaluated the effect of differences in the degree of logistics competitiveness on national competitiveness. For this, a

gravity model of trade is conducted by means of increasing with representative hardware variables and logistic software. When the model is increased and hardware variables are included, the main conclusion is that the most terrestrial infrastructure endowment, the greatest port efficiency and the furthest progress in the telecommunications sector, promote international trade. Furthermore, when the variables are included and logistic software TAI variable is positive, this reflects that a greater supply of logistics software promotes international trade.

In the same year, another work is done which studies the determinants of transport costs and the different effects of transport costs on international trade in a specific case. This is the article by Martinez-Zarzoso and Nowak-Lehmann (2005) where its demonstrated the influence of transport costs in international trade, since the international trade flows are influenced largely by the costs of road transport and maritime. It mainly analyzes the major determinants of maritime and road transport, and the importance of distance on transport costs.

Over the years various investigations have studied the determinants of maritime transport costs. This helps us to figure out general conclusions about the influence of transport costs on international trade since both maritime and road transports are the more used ways of transport more used and more important when making a commercial exchange. There are different works where this issue is discussed. For example, the work of Márquez-Ramos, Zarzoso-Martínez, Pérez-García and Wilmsmeier (2007), where the determinants of the costs of maritime transport are analyzed and the influence of these in world trade in the case of Spanish exports. The first part of this paper focuses on an estimation of transportation costs. We show that trade imbalances have a great influence on transport costs. In addition, a better connectivity between source and destination ports reduce transport costs. The traffic on the port is the variable that most influences freight rates, so that the high port traffic, would result in a significant diminution in the freight. A second part focuses on an estimation of the trade equation. Which reflected the importance of the population in the target market, as well as language, these positively influence the volume of trade.

Another work that was done later and increased the gravity model on trade in Central and Western Europe is that of the authors Monika-Voicu and Horsewood (2007), a gravity model is estimated for the new EU members and for OECD countries. The objective is to measure the importance of preferential trade agreements among commercial blocks. In the extended model the logistical hardware and logistics software are introduced. The main results of this study agree that the distance is the

main determinant of bilateral trade. Also, it is observed that income elasticity have decreased over time and the effect of the distance among two countries has been a constant barrier to quantity of exports. Another interesting result is that the importance of the number of Internet users and mobile phone are determinants for trade, this suggests a possible policy to implement by the countries of Central and Eastern Europe in order to strengthen trade flows since these are factors that positively influence trade because they optimize the transmission of all kinds of information.

Moreover, an important issue to deal with is competitiveness. When it refers to international competitiveness, geographical factors are one of the most influential factors in this area. In addition, as it has been discussed in many other investigations of geographical distance, a country which has no outlet to the sea and transport costs is of great significance in international trade. However, an additional factor to consider is the connectivity of the transportation services since this has a big influence on transport costs and therefore, on trade among countries.

A work that develops this issue is that of Martinez-Zarzoso and Hoffmann (2007). In this paper the relationship between connectivity, transport costs and trade research are studied. The main conclusion in this article is that both transport costs and international trade are significantly influenced by the connectivity of transport services among different countries. Thus, if we consider a 1% improvement in connectivity for the specific case of Latin America (discussed in this article) transport costs would be reduced by 1.9%. In addition, this would affect international trade increasing it by 1.33%. Consequently, economies that undertake economic policies to improve connectivity of transport services will lead to a reduction in transport costs and directly, to an increase in international trade of the countries who commit it.

On the other side, when considering transport costs, the geographic distance is a variable that is always taken into account in many researches when measuring the impact of transport costs. Another work that attempts to break down the determinants of the costs of maritime transport and studies the importance of geographical distance in the field of transport costs is the one conducted by Martinez-Zarzoso and Wilmsmeier (2008). In this paper they analyzed the main determinants of maritime transport costs for intra-Latin American trade in the period between 1999 and 2004. The results show that the network structure of on line services has a major impact on transport costs than geographical distance when both variables are introduced. It is also noted that the use of open registers reduces transport costs. Indeed, this negative impact on transport costs means that exports from Latin America benefit from open

records, which could lead to an increase in the competitiveness of their products in the destination countries.

When it comes to world trade, we have to take into account not only transport costs but also, trade barriers since world trade is negatively affected when there are trade barriers. In addition, we must take into account trade facilitation since improvements in trade facilitation help to broaden transactions among the different countries in the commercial area. Therefore, trade policy that the different economies carry out must take into account improvements in trade facilitation, since they have a great importance in international trade. An interesting article that develops and analyzes this question is one by Márquez-Ramos, Martínez-Zarzoso and Suárez-Burguet (2011). The article attempts to measure and compare the impact on bilateral trade flows of a number of facilities of trade and trade policy barriers. There, the effect of reducing trade barriers is analyzed and contrasted with the effect of improving trade facilitation data from different sectors. The main conclusion of this work is that world trade increases when we reduce tariff barriers and it does it differently across countries and sectors.

Finally, I would like to stand out two recent studies about the importance of road transport costs in trade. In the article by Blyde (2010) there is an interesting section where it is simulated what would be the regional export effect on a reduction in transport costs generated by improvements in the quality of the road. Here, we observe that the improvement in road conditions reduces transport costs by 12% and increases regional exports by an average of around 9%. In regions that transportation costs are initially higher, a reduction of these is obtained up to 30%. This is because the regions with higher transport costs are associated with longer routes and worse road conditions.

Another interesting article from Duranton, Morrow and Turner (2013) authors examines the effect caused by road infrastructure in the level and composition of trade in the U.S. cities. We observe that the volume of bilateral trade decreases rapidly with the road distance among cities. A decrease of 1% in travel distance between trading partners increases the value of trade by 1.4% and the total weight by 1.9%. In addition, improvements in the road network produce big changes in the volume of trade and in the longer distances so the effect on trade is larger. Also, improvements on the road network within cities promote the recruitment of workers in sectors of heavy industry which also becomes more specialized. Therefore, improved transport promotes trade in general and in particular, encourages the production and trade of heavy goods.

4. Analytical framework

4.1 Gravity equation

One of the most used models in empirical studies in international trade is the gravity equation. The origin of this equation is well-known since it comes from the popular equation of Newton's law of universal gravitation. In it, the force of attraction between two objects could be described with this simple equation:

$$F = G\frac{m_1 m_2}{d^2}$$

G is the universal gravitational constant, *m1* and *m2* are the masses of the objects and *d* is the distance between them which in the equation is squared.

In recent decades, the gravity model has worked very well by explaining bilateral trade relations from empirical framework. The use of gravity models in international trade goes back to Tinbergen (1962). Tinbergen, in order to explain trade between countries, took into account the gross domestic product (GDP) of the two countries and the amount of trade between them. The gravity equation of trade is equal to:

$$\text{Trade} = B \cdot \frac{\text{PIB } 1 \cdot \text{PIB2}}{\text{Dist}}$$

Dist is the distance between each country and *B* is a constant that indicates the relationship between “the term of gravity" and trade. According to the gravity equation, the larger the countries are or how much smaller the distance between them is, the greater the volume of trade between them. The model implies that larger countries trade more for two reasons: larger countries export more because they produce a greater variety of products and import more because their demand is higher. Therefore, empirical results have been quite significant and largely explain international trade.

The works of Pöyhönen (1963) and Linneman (1966) were performed in this same time and also used gravity models for trade and therefore, they had a great importance in the bilateral trade.

There are various specifications of the gravity model. According to the generalized gravity model of trade, the volume of exports between pairs of countries,X_{ij} depends on income (GDP), their populations, their geographic distance and a series of dummy variables:

$$X_{ij} = \beta_0 Y_i^{\beta_1} Y_j^{\beta_2} N_i^{\beta_3} N_j^{\beta_4} D_{ij}^{\beta_5} A_{ij}^{\beta_6} u_{ij}$$

In this equation, Y_i (Y_j) indicates the income of the exporting country (importer), N_i (N_j) is the population of the exporting country (importer), D_{ij} measures the distance between capitals of both countries, A_{ij} represents any other factor that encourages trade, u_{ij} is the error term. Another alternative is to include income per capita rather than population.

There are other specifications of the gravity equation of trade as that performed by Bergstrand (1989). This is usually used when bilateral exports are estimated for specific sectors. However, in order to estimate the aggregate exports, we use the previous equation.

In addition, some studies show that the gravity model is consistent with the main macroeconomic theories. Anderson's study (1979) shows that the gravity model is consistent with the theory of increasing returns. Another study by Deardorff (1998) shows that the Heckscher-Ohlin theory is consistent with the gravity model and that it is able to incorporate the possibility of trade between developed and developing countries. Another work by Evenett and Keller (2002) also shows that the theories of Heckscher-Ohlin and the increasing returns are consistent with the theoretical foundations of the gravity model.

There are also different studies that have a great popularity and analyze the limitations that exist within the gravity model. The paper of Chen and Wall (1999) shows some limitations of the gravity model. This work shows that the gravity model underestimates the large volume of trade flows and trade flows overestimate low volume. Moreover, in recent years there have been some studies that reveal whether the gravity model measures the real costs of trade. Since the only variable that has been taken into account in most studies to measure transport costs of trade is the distance, and this does not capture all costs associated with trade.

Trade costs are high when you want to include all the costs involved since the goods are transported from producer to final consumer. Therefore, in the study by Anderson and Van Wincoop (2004), the main conclusion is that a better measurement of the costs of trade is beneficial because it can improve the quality of the measures that are used. Estimations based on the structural gravity models and data transport cost could be improved relatively easily. A better understanding of the transportation costs would be reached if we consider extensions of existing gravity models, a better treatment of

endogeneity and aggregation problems, and better estimations of elasticities of substitution. The great importance of the relationship between domestic and international trade costs, market structure and the political economy should be distinguished. It is believed that some trade costs provide benefits and it is likely that the profit would partially explain the costs.

Finally, there are also other studies where the gravity model is extended by adding different dummies as the work of Márquez-Ramos and Martínez-Zarzoso (2005) where the gravity model has been extended with variables representing logistical hardware and software. Another example is the recent work of Jesus Felipe and Utsav Kumar (2012). This work increases the standard gravity model of bilateral trade flows including trade facilitation measures. Here, it is shown that trade facilitation has a positive and statistically significant impact on bilateral trade flows. Furthermore, the results show that the development of infrastructure to provide transport corridors for trade, help to reduce negotiation time and greater integration of the countries of the region and the rest of the world, with special attention to the countries of Central Asia due to its Mediterranean component.

In our study we analyze the bilateral trade to Spain. Our main objective is to see the impact that some variables have in Spanish exports by road to the EU countries. Our gravity equation is:

$$X_{ijt} = GDP_{it} + GDP_{jt} + Dist_{ij} + Border_{ij} \qquad (1)$$

X_{ijt} is our dependent variable and represents exports by road from Spain to the member countries of the EU-27 for each period *t*, in thousands of Euros. The independent variable GDP_{it} represents the GDP per capita of Spain in real terms in each period *t*. The independent variable $+ GDP_{jt}$ represents the GDP per capita in real terms for the EU member countries in each period *t*. Another independent variable is $Dist_{ij}$, which represents the distance in kilometers from Spain to the EU member countries. And finally, the dummy $Border_{ij}$, which is zero when told that Spain has not common border with the country and exported to Spain when one if it has a common border with the country to which exported.

This will be our main model, but we will add some variables to enrich the study and see how Spanish exports by road behave with the introduction of these variables. Once the estimation for this model is done, we will remove the GDP_{it} variable since this variable

only varies temporally and we add dummy variable representing the income per capita in Spain for each of the years. These variables are as follows: *Dyear_1* for GDP per capita of Spain for 2008, *Dyear_2* for GDP per capita of Spain in 2009, *Dyear_3* for GDP per capita of Spain 2010, *Dyear_4* for GDP per capita of Spain for 2011 and *Dyear_5* for GDP per capita of Spain in 2012, but the latter eliminates the estimator to estimate the regression model. Next, we estimate a regression where the variable common border is replaced by two dummy variables to collect separately the effect border with Portugal and France. These variables will be *Border_Francia* which will be worth one for France and zero for other countries; and other variable Bo*rder_Portugal* which will be worth one for Portugal and zero for all other countries. Finally, we add a variable called *CEECs* which will be worth one for the countries of Central and Eastern Europe and zero for all other countries. The term includes all countries CEECs in eastern block west of the border after the Second World War with the former Soviet Union, the independent states of the former and the three Baltic States: Estonia, Latvia, and Lithuania. With this variable, we can see the main results that we provide the countries belonging to the CEECs that are: Estonia, Latvia, Lithuania, Poland, Czech Republic, Slovakia, Hungary, Slovenia, Romania and Bulgaria.

In addition, we also make a small analysis of the most relevant sectors within the road transport in Spain. We analyze each sector separately, observing that influence have the independent variables within the Spanish exports by road to each of the sectors.

$$X_{ijkt} = GDP_{it} + GDP_{jt} + Dist_{ij} + Border_{ij} \qquad (2)$$

X_{ijkt} is our dependent variable and represents exports by road of Spain for each sector of member countries of the EU27 for each period *t*, in thousands of Euros. The sectors that we will analyze are the economic sector of capital goods, durable consumer goods and consumer manufacturing.

4.2 Databases and Data Sources

To create our database, we used different statistical sources. The dependent variable, exports by road from Spain to the EU-27 countries (X_{ijt}) , we have obtained it from the Spanish foreign trade statistics. On the database *DataComex*, and this represents exports for all national territory for all economic sectors together that have been realized by road transport (Annex I). On the other hand, we have the GDP per capita of exporting country as well as the importing country $(GDP_{it} + GDP_{jt})$, which is expressed in real terms and in dollars (Annex II). The source of these data is *The World Bank* and the database used is *World Development Indicators (WDI)*.

Another independent variable that we use in our work is the independent variable of the distance between the exporting and importing country expressed in kilometers ($Dist_{ij}$). This variable is calculated using the latitudes and longitudes of the most important cities or agglomerations (in terms of population). The data source that we used is the *CEPII* and the database used is *dist_cepii* (Annex III). Finally, we have the independent variable common border, which tells us if countries i and j share common border or not. We have also compiled this variable from the database used is *dist_cepii* of the font *CEPII*. We also have the independent variable common border (border ij), which tells us if countries i and j share common border or not. In addition, two individual variables which measure the common border effect in the case of Portugal and France separately. These variables have also been compiled from the database *dist_cepii*, font CEPII. Finally, for the variable named *CEECs* that represents Central and Eastern Europe countries, we have built it through the information available on the OECD website.

For our second study, the independent variables used are the same as the previous model, but we use the exports of three economic sectors separately. Therefore, the dependent variable, exports by road for each sector to Spain of the EU-27 countries (X_{ijkt}), we have obtained it from the Spanish foreign trade statistics, in the *DataComex* data base.

5. Econometric analysis

5.1 Estimation method

In our study, we conduct an analysis of exports from Spain to the distinct member countries of the European Union. We use different variables that could have a significant impact on our study. Our main objective is to study the influence of road transport costs in trade volume.

In order to accomplish our goal we use an econometric model. Econometric is based on the development of statistical methods for estimating economic relations and contrasting economic theories. Econometric has been developed as a distinct discipline of mathematical statistics as it focuses on the problems related to the collection and analysis of non-experimental data. Econometric methods are relevant to almost all branches of applied economics. Through empirical analysis using data we contrast a theory or estimate a relation. In our work we make an empirical analysis using various economic data.

The group of economic data can be of different kinds. In our case we create one database panel or also called database longitudinal. The group panel data are time series observations about a sample of time units. That is, a group of individuals are observed at different moments in time. For a variable y_{it} have $i = 1, \dots, N$ cross-sectional observations y $t = 1, \dots, T$ time-series observations. We call Micropanel if the information to be analyzed corresponds to individual agents. In general, there are a very large number of individuals and few temporal observations for each. We call Macropanel if the information to be analyzed corresponds to other units of analysis (countries, regions, sectors, etc.) for which we have many corresponding temporal observations for few individuals. The data panel provides very valid information of individuals following them through time, which provides a more complete picture of the problem, performing better the dynamics of change. Therefore, they let us study more complex models of behavior. Also, they eliminate bias specification that have time series models that take into account the unobservable characteristics of individuals that may be conditioning their behavior or latent effects in each time period that can alter the behavior of the same individual at different points in time. Besides, these provide us additional degrees of freedom due to the union of the temporal and individual dimension. As well, these data provide information that allows lessen or reduce co-linearity problems regarding time series models. A problem of these data is that it requires that the same units are repeated over time, so they are more difficult to obtain than other types of data.

To estimate the panel data model various situations can be presented according to the relationship that can be present between one or more independent variables with individual effects or unobserved heterogeneity α_i. The individual effect includes all unobservable factors that do not change over time but affect the independent variable. The simple model is as follows:

$$y_{it} = \beta o + \alpha_i + X_{it}\beta_1 + u_{it} \qquad (3)$$

If we consider that Cov $(X_{it}, \alpha_i) \neq 0$, that is, unobserved heterogeneity is correlated with each of the independent variables, it is convenient to make the estimation by fixed effects. The fixed effects model adds dummy variables in cross-sectional units, allowing to vary the intercept of the regression in each unit. When α_i this arbitrarily correlated X_{it} is not possible to distinguish the observed effects of unobserved, therefore, it is necessary to make a transformation of fixed effects.

When we consider that Cov $(X_{it}, \alpha_i) = 0$, that is, the fixed effect is uncorrelated with each of the independent variables, we may have several options: estimation by pooled OLS or random effects.

Pooled OLS is an appropriate estimation method when no observed effect $\alpha_i = \alpha$, that is, there are no differences between groups or units of cross-section. In this sense, a single constant will exist. It is important to note that not presenting a relationship between $X_{it}\ y\ \alpha_i$, the individual effect can be incorporated into the error term to make the estimation, that is α_i is considered as a specific group error, then the model takes the form:

$$y_{it} = \beta o + X_{it}\beta_1 + \nu_{it} \quad (4)$$

βo is the constant term in the model and the random part ν_{it} formed as follows:

$$\nu_{it} = \alpha_i + u_{it} \quad (5)$$

On the other hand, the random effects model decomposes the residual variance into two parts, a specific part of the unit cross-section or group (σ_α^2) and the other associated with a particular observation (σ_u^2) . The estimation method recommended here is generalized least square (GLS), which creates unbiased and efficient estimators

To study our data use pooled OLS estimator since it is the best adjustment to our data. We believe that our groups (countries) are relatively similar or homogeneous. This estimation is obtained by random sampling of a population at different times. Furthermore, it assumes that the observations are not identically distributed over time. This model is simply to "merge" the data from the 26 countries that export to Spain and estimate the model by ordinary least square (OLS). Thus, we estimate a regression model that measures us the effect of different variables that change over time in Spain exports by road to the EU countries. One drawback that can suppose this estimator is that it does not take into account the heterogeneity of each country, which moves to u_{it}, which can lead to problems of specification.

To create our database, we create in Excel and export it to Gretl. The program Gretl is econometric free software. This gives access to very large data bases of both public bodies such as the Bank of Spain, as examples in econometrics texts. With this program you can make estimations of all kinds. In our case, we introduce the panel database to create and we estimate by OLS. Thus, we obtain our estimations of pooled OLS.

5.2 Results of the estimation

In this section we will make different estimations in order to observe and to analyze the different results. As we have developed along the work, international trade among countries is very important for the economy of a country. Therefore we want to see the impacts of the road transport costs in international trade that is why we analyze the EU area. Our analysis focuses on the costs of road transport so we analyze trade among the countries of Europe, as it is the most used way of transport of goods within the EU. We use exports by road from Spain to the member countries of the EU for a number of years. In this study, it will be from 2008 to 2012. Here, we will resort to the distance variable as a proxy for the road transport costs. Besides, this variable is also positively correlated when increasing distance from one country to another that causes an increase in transport costs.

As we have previously explained, to estimate our regression model we will use pooled OLS, as this is the best estimator that adaptes our data. Our data is formed by 130 observations and 26 cross-sectional units, corresponding to the 26 countries over Spain in the EU-27.

Table 1: Estimation results. Total trade by road

Model / Variable	1	2	3	4
log(GDPj)	0.426 *** (0.10)	0.422 *** (0.10)	0.274** (0.12)	0.167 (0.25)
log(GDPi)	-0.622 (4.50)			
log (Dist)	-2.01*** (0.30)	-2.02*** (0.31)	-2.55*** (0.37)	-2.01*** (0.31)
Border	1.20*** (0.41)	1.20*** (0.42)		1.06** (0.41)
Dyear_2		-0.176 (0.30)	-0.185 (0.31)	-0.192 (0.29)
Dyear_3		-0.087 (0.34)	-0.095 (0.33)	-0.10 (0.33)
Dyear_4		0.038 (0.34)	0.033 (0.32)	0.030 (0.33)
Dyear_5		0.086 (0.35)	0.081 (0.32)	0.077 (0.34)
Border_France			1.86 *** (0.34)	
Border_Portugal			-0.471 (0.61)	

CEECs				-0.506 (0.37)
R²	0.455	0.458	0.485	0.465
Number of observations	130	130	130	130

All models that we have been made are logarithmic, so the coefficient of the independent variable is the elasticity estimated of the dependent variable with respect to the independent variable. The first regression model estimated provides important results. In this model, all variables are statistically significant except the variable that represents the GDP per capita of Spain. The GDP per capita of the importing country is statistically significant since the p-value (0.00015) is less than the significance level, both when $\alpha = 0.05$ and $\alpha = 0.01$. This variable indicates that an increase of 1% in GDP per capita of the importing country provides to an increase of 0.42% of Spanish exports by road. This variable coincides with economic theory since it represents that an improvement of income of the importing country encourages the importation of goods because it has higher incomes and thus, trade between the importing country and other countries is encouraged.

The distance variable is also statistically significant, with p-value (0.00001) less than the significance level (0.05 even 0.01). This gives us a very important idea that it is adapted with economic theory: the increase in distance causes a decrease in trade among countries and, indirectly this represents an increase in the road transport costs due to an increase in the distance that also would suppose a decrease in trade between Spain and other EU countries. Countries that trade and are more distant from each other support higher time costs in transporting goods, higher fuel costs for the vehicle and also higher costs relative to wear vehicle. This increases the road transport costs and therefore, it discourages trade between countries. In the case of Spain, this variable indicates that an increase of 1% in the kilometers distance causes a decrease of 2.01% of Spanish exports by road.

The common border variable is also significant, since its p-value (0.0045) is less than the significance level. Interpreting this variable, we observe that countries sharing a common border benefit from Spanish increased exports. This is the "border effect" which argues that neighbor countries have more incentive to trade among them due to the smaller geographical distance. This idea is also in contrast to the case of Spanish

exports by road. The coefficient represents that Spain has a road exports 1.20% higher for countries sharing a common border that is Portugal and France.

On the coefficient of determination, we can say that the independent variables explained 45.5% of the exports of Spain by road. Finally, we have the variable of GDP per capita of Spain which is not significant, because the p-value (0.89) is greater than the different significance levels. To get a better understanding of this, we will create a dummy variable for each of the years and we can analyze the increase or decrease in the income for each of the years. These results are obtained in the second model.

As we have said in the second model, we included four variables of time, one of them is eliminated to create the model. The variables included in the second model represent for example; the increase or decrease of GDP per capita of Spain for 2009 (Dyear_2) compared to 2008, the increase or decrease of GDP per capita of Spain for 2010 (Dyear_3) on 2008, etc. To analyze these variables representing Spain's GDP per capita for each of the years we have to consider two important ideas. The first is the periods studied that represent a few years where Spain is immersed in a serious economic crisis period. This can affect both to this variable and to all data collected and cause some distortions or different behaviors of the variables.

The second idea to consider is that the coefficient of GDP per capita in Spain is negative in the first years. According to economic theory, country's exports are positively correlated with GDP per capita of the country. That is, an increase in income per capita would increase exports to a particular country. If we analyze the history of the Spanish economy, we can observer that in a certain period this theoretical phenomenon is not performed. In the years in which the Spanish economy began its first expansion and economic growth, we see that Spanish income grows but exports do not accompany this growth. This occurred because in the early years when the Spanish economy grew, expanded and developed, an important part of the income per capita of the country was invested in this process of economic growth. These caused the companies, at the time of the economy extend, to resort to domestic trade and they spent more resources in their expansion and development than growing internationally and therefore, they exported to other countries. For this period analyzed, we can argue that it has the opposite effect. Due to the great economic crisis that undergoes Spain, GDP per capita of Spain has decreased over the period, yet exports have been increasing (Annex IV). Companies have reduced prices as much as possible, reduced wages, and definitely, they have reduced the cost per unit of production to export outside Spain. Mainly, this is caused due to Spanish very low domestic demand, as

well as consumption and investment and therefore the Spanish GDP per capita. The companies have exported their goods to other countries as a solution to increase their profits, and not suffer the situation of lack of internal demand in our country. This is a possible explanation for the effect produced by the GDP per capita of Spain in the Spanish exports. We could, perhaps, talk about an “inverse” absorption effect in the behavior of our economy.

In this model we did not observe significant changes in the coefficients of the variables. If it is observed that the constant is significant in this model with respect to the first, but this is not a change that give us great ideas.

In the third and fourth model we have included and eliminated some variables to see what other effects this may involve in changing variables. In the third model, we eliminated the variable common border and we have added two dummies: one for the border of France and the other for the border of Portugal. These new variables collect separately the border effect, as only Spain shares borders with these two countries. The objective is to see if there is any difference between the border with a country and another. The coefficient for the variable common border with France (1.86) has the expected positive sign and is statistically significant. The main idea is to increase exports of Spain when Spain trades with France due to the "border effect". However, we cannot say the same for the dummy in the case of Portugal, since this is not statistically significant. Furthermore, the coefficient of the variable is negative which does not coincide with economic theory and it has not economic sense. Generally, with the introduction of these variables is not observed any significant change. If we observe that there is a slightly decrease in the coefficient of the variable that belongs to the GDP per capita of the importing country and a slightly increase in the coefficient belonging to the variable measuring the distance between countries.

On the other hand, in the fourth model we have introduced a dummy representing the countries of Central and Eastern Europe (CEECs) in order to analyze the influence on Spanish exports by road from the countries of Central and Eastern Europe over the other countries. Generally, we note that the coefficients of the independent variables do not suffer a significant change with the introduction of this variable. Nevertheless, it is observed that the coefficient of variable GDP of the importing country decreases and causes that the coefficient is not statistically significant. This input variable is not significant which gives us a fundamental idea. The countries of Central and Eastern Europe are countries that have most recently joined the EU and therefore, they can be considered that are less established within the framework of the EU with respect to the

other member countries which are longer attached and whose economical structure is more consolidated. Therefore sing negative coefficient can be interpreted as that Spain traded less with countries in Central and Eastern Europe.

But this variable is not significant, demonstrating that it is possible that this trend has already disappeared and today these countries are totally adhered within the EU and their economic structures are similar to the other member countries.

On the other way, we have made a short analysis of Spanish exports by road to EU countries for three different sectors. The objective is to analyze the economic sectors that are generally transported by road. We have three regression models corresponding to the three economic sectors we want to study. The estimation models are the same as the two models previously estimated but for each of the sectors individually.

Table 2: Estimation results. Road trade by sectors

Model / Variable	Capital goods	Durable consumer good	Consumer manufacturing sector
log(GDPj)	0.402 (0.35)	0.498 (0.35)	0.317 (0.315)
log (Dist)	-1.73** (0.79)	-1.67** (0.82)	-1.87*** (0.70)
Border	1.34 (1.14)	1.80 (1.11)	1.58 (1.01)
Dyear_2	-0.269*** (0.54)	-0.508*** (0.09)	-0.045 (0.02)
Dyear_3	-0.260*** (0.05)	-0.494*** (0.15)	-0.019 (0.03)
Dyear_4	-0.091* (0.04)	-0.37** (0.17)	-0.194*** (0.04)
Dyear_5	-0.043 (0.05)	-0.436*** (0.16)	-0.252*** (0.05)
R^2	0.40	0.44	0.48
Number of observations	130	130	130

Comparing with the regression model two, the main differences that we see when we look at each sector separately are seen in the distance variable. The coefficient of this variable has decreased compared to the other model. The other variables represent a

change but not significant. Nevertheless, we observe that the variable representing the GDP per capita in the importing country is not significant in any of the three sectors.

Observing the estimation of each model separately we observe some differences according to the economical sector. For the distance variable we see that the consumer manufacturing sector has a higher and statistically significant coefficient. A 1% increase in kilometers of distance would decrease Spanish exports of consumer manufacturing sector by 1.87%. Regarding the variable that represents the common border we note that durable consumer goods sector represents the highest coefficient. This indicates that Spain has some exports in the durable consumer goods sector 1.8% higher in countries sharing a common border. We note that there are not big differences regarding other sectors since in the capital goods sector it would be 1.34% higher and in the consumer manufacturing sector 1.58% higher.

Finally, if we look at the variable that represents the GDP per capita in Spain some significant differences can be observed. The negative sign tells us that income has decreased compared to 2008 for each of the importing countries. For capital goods sector we can see that the decrease in income is significant for 2009 and 2010 compared to 2008. Nevertheless, consumer manufacturing sector can see that the decrease of income in Spain is significant for 2011 and 2012. But, for the durable consumer goods sector we can see that the decrease in income is significant for all the years from 2008 which is the base year. This difference may be because in the years where the variable is significant there has been a further decline in the income of the importing country.

6. Conclusions

World trade in recent decades has experienced a great growth and this has a positive impact on the world economy. World trade is affected by many factors that influence both, positively and negatively. Transport costs are very important for the growth of trade flows. Thus, in recent years there have been more studies that help us to understand the relevance of transport costs in international trade. These studies analyze the factors of transport costs and are shown as they depend for example on geographical factors and the state of infrastructure, among others. Many authors do it through the gravity model which is one of the most used models in empirical studies in international trade. During several decades various authors have applied the gravity

equation for bilateral trade and they have shown that the gravity model is consistent with the main macroeconomic theories.

Globally referring to freight transport, the maritime transport is one of the most used way of transport in the global freight and also road transport, but to a lesser extent. A great advantage of road transport is that it allows transport goods to the exact destination, thus facilitating trade flows. In the context of the European Union, 33% of freight transport of long distance is carried out by road. The main geographic area of network freight transport in the EU where greater volume of goods are transported is Germany, France, Poland, Spain and Italy. One of the problems that Europe has been suffering for two decades is the phenomenon of congestion affecting trade flows of the EU member states. To reduce these costs the EU needs more efficient transport and logistics, infrastructure improvement and optimization of capacity use.

Referring to the estimations, we have made several ideas that coincide with the macroeconomic theories and they report us relevant information. In the case of GDP per capita of the importing country, we can say that this has a positive effect on exports and so, when this experiences an increase it causes an increase in trade flows. The GDP per capita of Spain also gives us some important ideas. Due to the great economic crisis in Spain the GDP per capita of Spain has decreased during this period, yet exports have been increasing. Companies have reduced the cost per unit of production to export outside Spain. The companies have exported their goods to other countries as a solution to increase their profits and not suffer the situation of lack of internal demand in our country.

The distance analysis also gives us some important conclusions. The increase in kilometers of distance causes an increase of transport costs due to higher fuel, travel time, etc… This increase in transport costs has a negative influence on bilateral trade between countries.

On the other hand, the called "neighbors effect" has also been demonstrated in the model estimation, neighboring countries have more incentives to trade with each other. For the specific case of France, it represents 1.86% higher exports. Therefore this is indirectly related to transport costs since countries that share borders have less distance between them and less transport costs and therefore, they have more incentives to trade. Referring to the countries of Central and Eastern Europe, it can be interpreted that Spain traded less with them due to their recent entry into the EU. But this trend may have disappeared and today these countries are fully bonded within the EU and therefore, they trade with Spain in the same magnitude.

Finally, if we look at the variable that represents the GDP per capita in Spain some significant differences can be observed when analyzing the sectors separately. The capital goods sector has a more significant decrease of income in 2009 and 2010, for the consumer manufacturing sector in 2011 and 2012. Nevertheless, in the field of consumer durables diminution of income is significant for every year from 2008.

7. References

ANDERSON, J. (1979): «The Theoretical Foundation for the Gravity Equation», *American Economic Review*, 69, pp.106-116.

ANDERSON, J. and VAN WINCOOP, E. (2004): «Trade Costs», *NBER Working Paper 10480.*

ANDERSON, J.; JAMES and VAN WINCOOP, E. (2003). «Gravity with Gravitas: a solution to the border puzzle». *American Economic Review*, 93, pp. 170-192.

BERGSTRAND, J. H. (1985): «The gravity equation in international trade: Some micro-economic foundations and empirical evidence», *The Review of Economics and Statistics,* 67, pp. 474-481.

BERGSTRAND, J. H. (1989). «The generalized gravity equation, monopolistic competition, and the factor-proportions theory in international trade». *The Review of Economics and Statistics*, 71, pp. 143-15.

BLYDE, J. (2010): «Paving the road to export: the trade impacts of domestic transport costs and road quality», *Inter-American Development Bank*, 3, August, United States.

CHEN, I-H. and WALL, H. J. (1999): «Controlling for Heterogeneity in Gravity Models of Trade», *Federal Reserve Bank of St. Louis Working paper 99-010A.*

COCA CASTAÑO, P.; MÁRQUEZ-RAMOS, L. y MARTÍNEZ-ZARZOSO, I. (2005): «Infraestructuras, Costos de Transporte y Flujos de Comercio», *Revista de Análisis Económico,* 20, pp. 3-22.

DEARDORFF, A. V. (1995). «Determinants of bilateral trade: Does gravity work in a Neo-classical word? », *NBER Working Paper 5377.*

DEARDORFF, A.V (1998): «Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World? » *NBER Chapters, in: The Regionalization of the World Economy, National Bureau of Economic Research*, pp. 7-32.

DURATON, G.; MARROW, P. AND TURNER, M. (2013): « Roads and Trade: Evidence from the US», *Review of Economic Studies*, July.

EVENETT, S. J. and KELLER, W. (2002): «On theories explaining the success of the gravity equation», *Journal of Political Economy*, 110, pp. 281-316.

HUMMELS, D. (1998b): «*Towards a Geography of Transport Costs*», University of Chicago, mimeo.

JESUS FELIPE and UTSAV KUMAR (2012): «The Role of trade facilitation in central Asia. A gravity model», *Eastern European Economics*, 20, pp. 5-20.

LIMÃO, N. y VENABLES, A. J. (2001): «Infrastructure, Geographical Disadvantage and Transport Costs», W*orld Bank Economic Review,* 15, pp. 451-479.

LINNEMAN, H. (1966): « *An Econometric Model of International trade flows»*, Amsterdam: North Holland Publishing Co.

MÁRQUEZ-RAMOS, L.; MARTÍNEZ-ZARZOSO, I.; PÉREZ-GARCÍA, E. y WILMSMEIER, G. (2007): « Determinantes de los costes de transporte marítimos. El caso de las exportaciones españolas», *Información comercial española. Revista de economía*, 834, enero-febrero, pp. 79-93, Madrid.

MÁRQUEZ-RAMOS, L.; MARTÍNEZ-ZARZOSO, I.; SUÁREZ-BURGUET, C. (2011)**:** « Trade Policy versus Trade Facilitation: An Application Using "Good Old" OLS », *Economics: The Open-Access, Open-Assessment E-Journal*, 6, September, Germany.

MARTÍNEZ-ZARZOSO, I. and NOWAK-LEHMANN, F. (2005): « Is distance a good proxy for transport costs? The case of competing transport modes», *The Journal of International Trade & Economic Development*, 16, pp. 411-434.

MARTÍNEZ-ZARZOSO, I. and WILMSMEIER, G (2008): « Determinants of maritime transport costs. A panel data analysis for Latin American trade », *Ibero-America Institute for Economic Research*, 172, May, Germany.

MARTÍNEZ-ZARZOSO, I. y HOFFMANN, J. (2007): « Costes de transporte y conectividad en el comercio internacional entre la Unión Europea y Latinoamérica », *Información comercial española. Revista de economía*, 834, enero-febrero, pp. 45-59, Madrid.

MONETA, C. (1959), «The Estimation of Transport Costs in International Trade», *Journal of Political Economy,* 67, pp. 41-58

PÖYHÖNEN, P. (1963): «A Tentative Model for the Volume of Trade between Countries», *Weltwirtschaftliches Archiv*, 90, pp. 93-100.

TINBERGEN, JAN (1962): «An Analysis of World Trade Flows», *in Shaping the World Economy, Twentieth Century Fund World Bank Economic Review,* 15, pp. 451-479, New York.

Statistics sources

CEPII. Available from: *http://www.cepii.fr/*

EUROPEAN COMMISSION. Available from: *http://ec.europa.eu/index_en.htm*

EUROSTAT. Available from: *http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/*

MINISTERIO DE ECONOMIA Y COMPETITIVIDAD. SECRETARIA DE ESTADO DE COMERCIO. Available from: *http://datacomex.comercio.es/*

THE WORLD BANK. Available from: *http://www.worldbank.org/*

UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT (UNCTAD). Available from: *http://unctad.org/en/Pages/Home.aspx*

Annex I

This table shows the data used to create the variable representing the Spanish exports by road to the EU countries (thousands of Euros). To do this, we utilized the database *DataComex*.

Spanish exports to the EU countries (2008-2012)

Year / *Country*	**2008**	**2009**	**2010**	**2011**	**2012**
Austria	1157207.65	1098736.13	1322158.34	1684974.22	1729373.25
Belgium	4076232.48	3294916.72	3481384.33	4004952.76	4239348.39
Bulgaria	247388.12	233168.71	208222.99	238461.31	266874.43
Cyprus	140536.93	147970.41	109578.50	110981.41	167452.12
Czech Republic	1364478.56	1185716.83	1449149.78	1544735.71	1472870.90
Germany	17352320.77	15005556.01	16804540.49	18714216.49	20601369.03
Denmark	1290653.79	817948.27	841456.58	957373.59	960376.09
Estonia	77159.20	56682.12	63111.51	79885.13	101650.09
Finland	424698.62	302791.98	365168.89	407111.12	401812.77
France	26425996.82	24318395.34	26969390.21	29814530.01	29368660.34
United Kingdom	8868280.81	6609677.90	7394541.68	8300858.15	8875323.32
Greece	1476551.55	1074375.27	959932.58	952729.56	869877.89
Hungary	741403.19	630506.56	712711.01	1049190.00	963588.77
Ireland	534144.86	398818.13	514079.40	441851.94	519657.31
Italy	12539168.09	10434009.17	13140502.51	13936159.94	13469368.61
Lithuania	172833.53	128020.60	151851.88	186935.05	221910.08
Luxembourg	229002.03	192030.59	151138.26	163738.03	146398.11
Latvia	89571.10	66865.03	68079.20	95523.61	131333.97
Malta	61318.70	55170.56	69573.31	72348.40	78286.04
Netherlands	4180261.50	3546121.76	4113149.05	4634253.11	4757591.43
Poland	2392073.76	2070551.38	2451834.65	2836295.44	3003510.89
Portugal	15492359.90	13733926.91	15124560.32	16083391.23	14229497.12
Romania	844749.28	636845.06	741292.20	1051874.55	1081555.37
Slovakia	442874.87	384556.56	450686.98	585942.99	599321.46
Slovenia	384689.85	310518.85	366252.92	357707.54	330971.50
Sweden	1272624.61	894285.50	1108101.50	1389036.94	1312023.48

Annex II

This table shows the data used to create the variable representing the GDP per capita for countries UE and the GDP per capita for Spain. The source of these data is *The World Bank* and the database used is *World Development Indicators (WDI)*.

GDP per capita (constant 2005 US$)

Year / Country	**2008**	**2009**	**2010**	**2011**	**2012**
Austria	39895.11	38240.33	38803.24	39825.14	40058.38
Belgium	37582.66	36237.39	36742.01	36877.02	36560.39
Bulgaria	4640.98	4414.07	4461	4570.51	4633.83
Cyprus	24312.9	23700.44	23156.54	22663.48	21552.03
Czech Republic	14610.63	13872.84	14174.05	14402.01	14235.02
Germany	36468.96	34680.21	36127.05	37321.82	38219.83
Denmark	48878.44	45862.77	46292.74	46596.41	46254.89
Estonia	11766.32	10120.8	10392.91	11402.79	11902.29
Finland	40642.72	36995.04	38064.65	38921.73	38416.74
France	34759.15	33492.6	33898.27	34405.27	34239.78
United Kingdom	39629.7	37299.99	37611.4	37723.82	37608.92
Greece	23288.12	22466.36	21308.96	20122.75	18891.95
Hungary	11533.82	10766.34	10926.47	11132.79	11000.2
Ireland	48892.69	45308.64	44583.34	45384.62	45355.77
Italy	30666.04	28807.55	29163.15	29186.37	29012.7
Lithuania	9897.44	8532.6	8829.32	9572.86	10061.09
Luxembourg	85529.8	79295.54	80276.01	80007.07	77971.3
Latvia	8708.14	7263.53	7390.82	7925.53	8425.67
Malta	16252.97	15703.01	16049.81	16269.62	16307.47
Netherlands	42467.27	40699.9	41110.28	41305.47	40639.65
Poland	9505.84	9651.39	10035.85	10387.38	10575.78
Portugal	18868.13	18301.92	18647.76	18441.68	17919.41
Romania	6016.82	5654.66	5634.89	5793.43	5834.42
Slovakia	14433.55	13703.47	14263.38	14672.35	14911.05
Slovenia	20706.67	18877.11	19054.26	19147.82	18629.96
Sweden	43045.55	40534.54	42825.67	43749.94	43830.57
Spain	**26737.51**	**25486.09**	**25317.96**	**25240.85**	**24816.67**

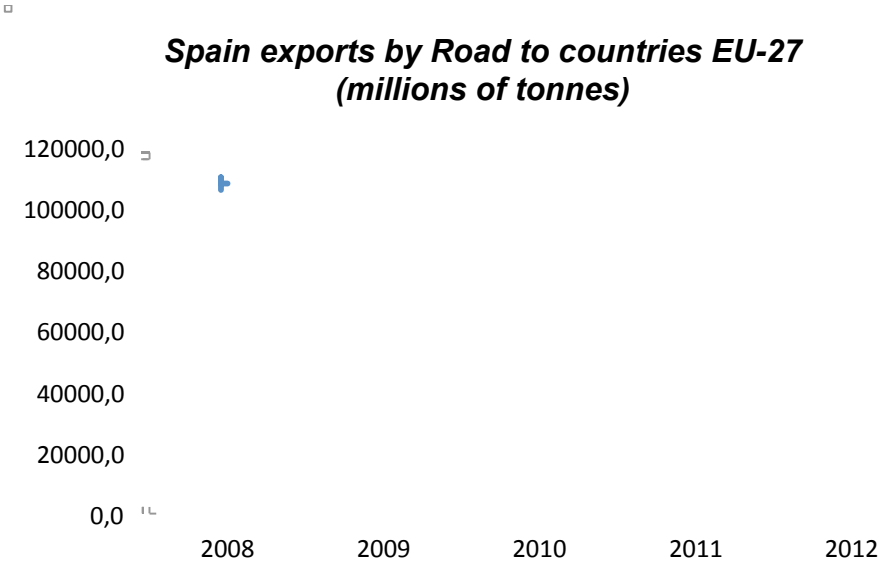
Annex III

This table shows the data used to create the variable representing the dist among Spain and countries of EU-27 (kilometers). This variable is calculated using the latitudes and longitudes of the most important cities or agglomerations (in terms of population). The data source that we used is the *CEPII* and the database used is *dist_cepii.*

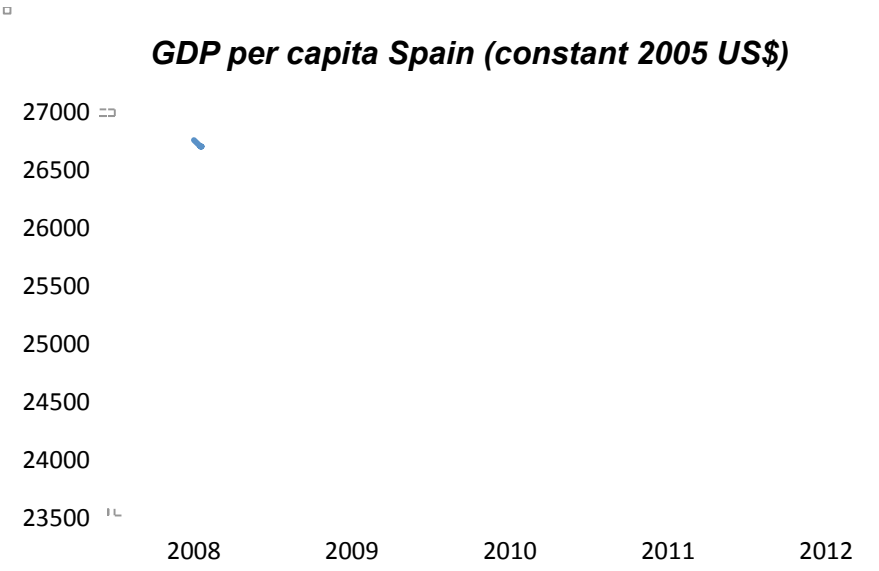
Distance from Spain to countries EU-27

Country	Dist
Austria	1812.00
Belgium	1316.64
Bulgaria	2254.80
Cyprus	3288.07
Czech Republic	1776.35
Germany	1479.33
Denmark	2074.98
Estonia	2895.38
Finland	2952.20
France	1054.66
United Kingdom	1263.38
Greece	2372.90
Hungary	1977.71
Ireland	1450.24
Italy	1366.76
Lithuania	2666.38
Luxembourg	1281.23
Latvia	2715.85
Malta	1670.80
Netherlands	1481.37
Poland	2293.01
Portugal	500.92
Romania	2477.15
Slovakia	1865.66
Slovenia	1600.56
Sweden	2596.91

Annex IV



Source: Ministerio de economía y competitividad de España. Datacomex



Source: The World Bank. World Development Indicators (WDI).