MFA EFFECTS ON THE WORLD TRADE OF TEXTILES. ANALYSIS OF CHINESE EXPORTS TO USA AND EU (1995-2017)

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Abstract

The opening of markets along with new technological advances has accelerated the process of globalization in recent decades. These changes have changed the structure of the textile industry. This document analyzes European and US textile imports from China from 1995 to 2017 in which the agreement on textiles and clothing (ATC) is applied. To do this we perform the estimation of a gravity model with panel data in which some of the most determinant factors of textile trade are included. The results support the theory previously described by other authors and also provide empirical evidence that the elimination of the quotas of the Multifibre Arrangement has led to changes in the global structure of production in the textile sector.

Keywords: textile industry, Multifibre Arrangement, imports, gravity model.

JEL classification: C23, F14, L67.

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1. INTRODUCTION

The textile industry has been very important practically since it appeared as such. Europe and the United States were the first regions to face the process of industrialization. Since then, textile products were manufactured in these areas. For this they needed a lot of labor (work), something that some Asian countries, especially China had in abundance. Since the 1960s, the sector had been heavily regulated to prevent countries such as China or India from establishing themselves in international markets. In the 1990s, after the creation of the World Trade Organization (WTO), countries following the path of GATT, continued to open up to the outside world and decided to eliminate impediments to trade.

It was from then on, that China and other Asian countries could begin to exploit their comparative advantage and take off as economic powers. On the other hand, the developed countries had to adapt to the new changes so that the totality of their production would not disappear. The change in geographical pattern has displaced most of the production to Asian emerging countries. At present, China has become the world's leading power in terms of textile production and export, followed by India and Turkey.

The objective of this study is to perform an empirical analysis of the last three decades to examine the most relevant changes in the textile sector. For this, we have divided this work into six parts. The first part contains two sections; the first section provides all the necessary information on the textile sector, both its importance at present and its main characteristics. The second section discuss the evolution of the sector in the last three centuries, providing numerous tables and numerical data and giving an historical approach.

The second part of the work shows numerous studies carried out by other authors in the field of the textile sector. This part offers a perspective of the research methods most used by economists to analyze the trade flows of the textile industry. In the third part, the equation or gravity model is developed, from its initial composition, to incorporate the elements that are used today. This is going to be the analytical instrument that we will use later to study the commercial pattern of the textile sector.

The fourth part provides all the information about the data that we will use in the empirical analysis, as well as the source of the different variables of the model and its description. In addition, a statistical analysis is also presented to observe the behavior and the relationship of the variables before including them in the gravity equation. In the fifth part of the work, the method of specifying the gravity model is discussed by performing different econometric tests. Finally, the sixth part contains the conclusions of the study.

2. TEXTILE SECTOR

2.1 Main characteristics

The textile industry covers the production of fibers, yarns, fabrics and products related to the manufacture of clothing. It is one of the most important industries worldwide because it generates millions of jobs (directly and indirectly) around the world. In addition, it is a very influential sector when deciding an international agreement. This industry is vital for the advancement and development of any society, and therefore is one of the main economic supports in developing countries. The work is carried out in the textile factories, where the activities related to the elaboration of the materials take place.

As the years have passed, the importance of the sector has increased, this is due in large part to the increase in global demand, but also due to globalization. Some of the countries that have traditionally hoarded industrial areas of the textile sector are England, Italy, Spain and Portugal in the European continent and, in turn, the United States in North America. Currently, the textile sector has lost importance in these countries because it has moved mostly to Southeast Asia. World production falls to a great extent in China (the world's leading manufacturer and exporter) due to its low manufacturing costs, its transportation infrastructure and the huge population.

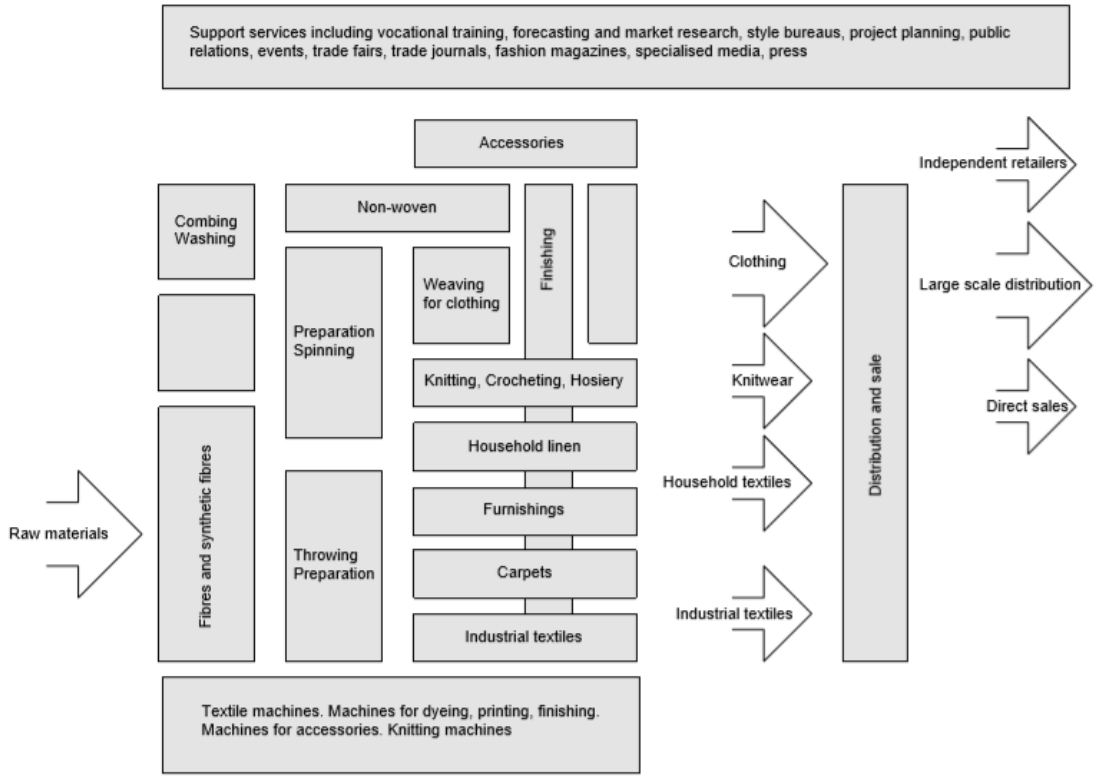
Nowadays, the textile industry is very diverse, in it we can find everything from socks to rugs. In addition, many raw materials are used, either natural fibers (such as cotton or wool) or by artificial or chemical fibers (such as polyester or nylon). It is characterized by being extensive in labor (poorly qualified), which means that the work factor in the country has to be abundant [1]. This industry is a very important part in terms of production and trade, especially in developing countries that are abundant in labour.

The textile and clothing sector acts as a supply chain in which each party performs a different activity to finish completing the final product. In addition, it goes from obtaining raw materials, through design and production, to the commercialization of the final product. According to Nordås (2004), the supply chain acts as a network where

[1] This coincides with the theory described in the Heckscher-Ohlin model (1919), based on a model with two countries and two factors of production in which each country exports intensive goods in the factor in abundance (in its country) and imports the goods intensive in the scarce factor. In this case, Asian countries such as China or India are abundant in the labor factor and scarce in capital, therefore, following the theory of the model, they must export labor-intensive goods (such as clothing) and import capital-intensive goods (like computers), in the developed countries the exact opposite would happen.

production is divided into specialized activities, and where each activity contributes to add greater added value.

Figure 1. The textile and clothing chain



Source: Dunford (2002).

Figure 1 shows in detail the different activities that make up the supply chain, that after obtaining the different raw materials are linked a series of processes (different depending on the final good to be produced) both manual and made by machines for the preparation of the final product. There are other functions such as project planning or market research that are also very important due to changes in the demand for such items.

The different activities used to be concentrated geographically, but with the liberalization of trade and the relocation of the productive phases, most of the activities have been transferred to Asian developing countries (production and consumption no longer have to go together). To get an idea, in Figure 1 practically all the activities that appear (such as finishing) would have been delocalized except the distribution and sale of the final product. Also, other activities such as obtaining raw materials were already carried out in developing countries.

2.2 Historical evolution

Traditionally, textile production was an artisanal activity that took place in the rural environment in which small groups of artisans participated (many of them women). Throughout the eighteenth century there were several technological innovations that would gradually produce a greater number of textile products. The most famous invention was the flying shuttle[2], which allowed to produce twice as much tissue as craftsmen. However, production remained insignificant and remained concentrated in family households.

This changed with the arrival of the industrial revolution in the early nineteenth century, when the first textile factories began to be created, mainly in the United Kingdom. According to Hudson, Ethridge and Mutuc (2002) the older British colonies in the United States were important suppliers of some raw materials such as cotton until a viable textile industry emerged in the country. In 1830 the railway appeared, which facilitated the transport of raw materials to the industrial centers to be able to exploit the product. Two decades later, in 1850, other European territories and the United States became important centers of production worldwide.

The manufacture of textiles had spread practically to all the developed countries at the end of the 19th century, in which thousands of textile factories were established. In 1930 the factories followed the principles of production of Taylorism[3] Alam *et al.* (2018), what impelled the efficiency in the production and the commerce between the developed countries. Also, the United States and Europe became major exporters worldwide in this period. However, after the Second World War it began the change of geographical pattern to Asian countries, in this case Japan was the first country to re-industrialize and become one of the largest exporters of textiles in the 60s.

At the same time, in countries such as Canada or the United Kingdom the cost of labor increased rapidly and many developing countries such as Taiwan and South Korea took this opportunity to increase the amount of exports to the industrialized countries. The developed countries saw that their national textile industry would be strongly affected as many companies were going to close and to move their production to third world

[2] Created by John Kay in 1733, it is an instrument similar to the sewing machine that facilitated the manufacture of wider fabrics than those manufactured at the time.
[3] The term Taylorism refers to the production method created by Frederick Winslow Taylor in 1911, which consists of dividing tasks within the production process of a factory to increase productivity.

countries. This would automatically provoke unemployment, so protectionist measures were implemented in order to avoid this happening.

Table 1: Evolution of protectionism in textiles

Year	Protectionist measures
1955	United States imposes voluntary restrictions on Japan exports
1959	United Kingdom agrees with Hong Kong, India and Pakistan the voluntary limitation of cotton T&C goods
1960	Short Term Arrangement
1961	Long Term Arrangement
1974	Multifibre Arrangement

Source: Own elaboration based on Spinanger (1999).

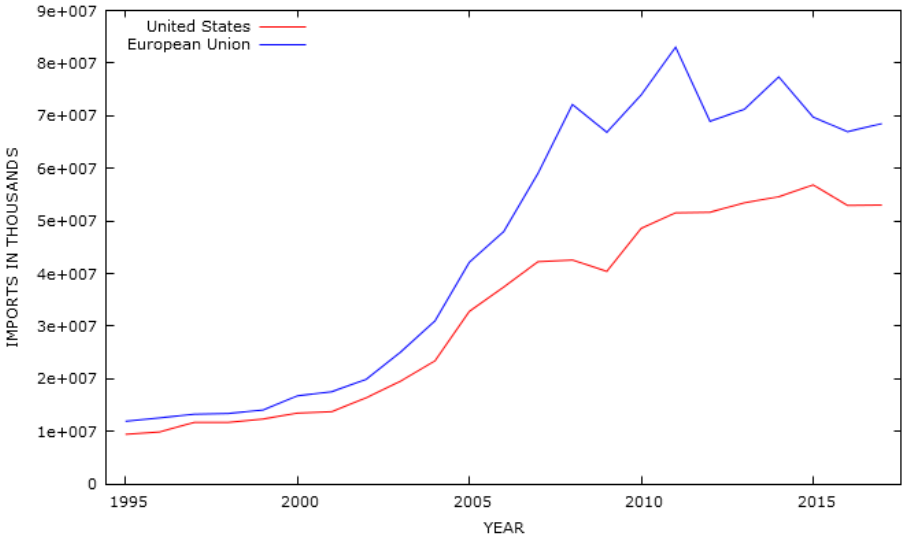
At the end of the 50s, the boom of the textile sector in the Asian continent caused countries like the United States or the European Union to restrict their imports with countries like Japan to try to protect the national industry (Macdonald and Vollrath, 2005). This was just one of many cases, making reference to Spinanger (1999) the United Kingdom also established voluntary restrictions in Hong Kong, India and later in Pakistan. The United States needed a more efficient solution to control its imports, so after a series of discussions under the auspices of the GATT, in 1961 it signed the short-term agreement on international trade in cotton textiles (SPA), which a year it became the long-term agreement (LPA). This agreement had to be renewed on two occasions (in 1967 and 1970) to increase protection.

The growth of the textile sector in the Asian continent did not stop increasing and due to the insufficiency of the previous agreements, in 1974 the importing countries developed another agreement with the objective to regulate the world trade of textiles and clothing, the Multifibre Arrangement (MFA). According to Nordås (2004) the agreement was an order of the restricted markets to avoid "market interruptions". This agreement was of a temporary nature (although it lasted practically 30 years) and included most of the developing countries. It was also very effective, since according to Peltzman (1984) the

total imports of the developed countries during the 1976-1980 period grew to 4.9% annually, while the imports with the countries involved in the agreement only grew to 2.2% year.

In the Uruguay round (1994) the agreement was signed on textiles and clothing (ATC) according to the GATT[4] rules, which eliminated quotas gradually and ended the multifibre arrangement that allowed Asian developing countries to export their textiles and clothing to more developed countries. This process had four phases. According to Brambilla, Khandelwal and Schott (2010), in the first phase (1995), products that represented 16% of import volumes in 1990, in the second phase (1998) 17%, in the third phase (2002) 18% and in the last phase (2005) the remaining 49%.

Figure 2. Textile imports from China.



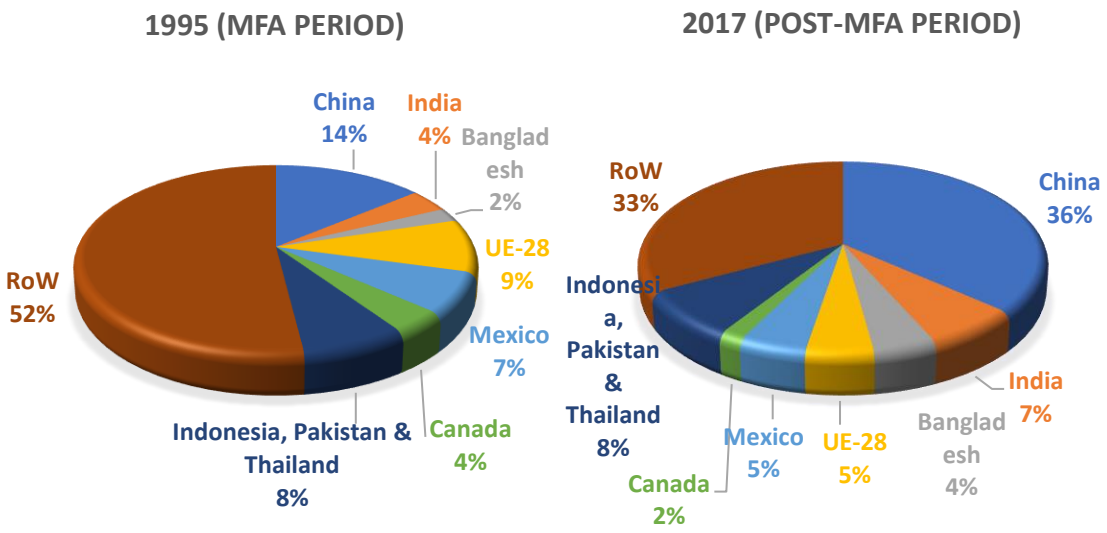
Source: Own elaboration based on UNCTAD data.

The total abolition of quotas took place in 2005, and the outcome has clearly been positive for developing countries such as China or India. Figure 2 shows the effect of the complete elimination of the Multifibre Agreement, in which time European and US imports reach the maximum growth (2005-2008 period). Subsequently, the growth is reduced due to the impact of the financial crisis, although the level of imports is much higher than what existed with the quotas.

[4] Agreement created in 1947 to set trade patterns and reduce tariffs, was the forerunner of the WTO.

The opening of the markets generated a movement called "offshoring"; in which most of the companies from the developed countries transfer their production to the developing countries, where the remuneration of the labour factor is much lower. This movement has not only occurred in the manufacture of goods, but also in different areas as for instance, the marketing concept has changed as well as some company departments. The relationship between low wage costs and the speeding up of transport have increased the profits of companies that have chosen to separate production from sales.

Figure 3. Percentage of E.E.U.U textile and clothing imports



Source: Own elaboration based on UNCTAD data.

Figure 3 clearly shows the change in the pattern of imports from developed countries, in this case from the United States. China, which in 1995 exported a tenth of its total imports to the United States, now accounts for more than a third of the total. India and Bangladesh have also increased their share of exports with the United States (and with developed countries), but to a lesser extent than China. Finally, the countries that have reduced their level of textile exports, as expected, are the developed regions such as the European Union or Canada. Mexico has been one of the most benefited countries of the Multifibre Arrangement, as it has lower labour cost than in United States and its geographical situation bordering the US makes it easily accessible with low transport costs.

This change in trend has been led by China, which emerged suddenly after a long period of isolation. According to Eichengreen, Rhee and Tong (2007) in recent years, China has

grown at an annual rate of almost 10% thanks to the expansion of the industrial sector, oriented towards exports. Much of this "evolution" of the Chinese economy was made possible by the reforms introduced by the government in the 1970s. These reforms led to the entry of China into the WTO in 2001[5] and a change in the employment model that changed to be agricultural to industrial in just a decade. In addition, the creation of free trade agreements (such as SAFTA) in the region has also encouraged the growth of trade flows between the different Asian countries.

The negative effects such as the disinvestment of the textile industry and the increase in unemployment (table 2) in this sector have been palpable in countries such as the United States, Canada or the European Union (where SMEs are dependent on the sector). However, not all textile production in these countries has been reduced, since a small part of the sector (high-quality clothing) is still produced in developed countries. The liberalization of the sector has caused that Europe cannot compete with Asian countries so the employment in Europe has drastically decreased and has been reduced by practically one third.

Table 2. Employment in manufacturing sector (thousands)

Year	*1995*	*2005*	*2015*
Country			
Germany	9.072	8.003	7.876
United Kingdom	4.931	3.848	3.068
Spain	2.483	3.188	2.236
Italy	5.020	4.878	4.014
France	4.409	4.253	3.337
United States	21.101	17.922	16.641
Canada	1.949	2.258	1.759

Source: Own elaboration, based on ILOSTAT data.

[5] China applied to enter the GATT in 1986, but the request was rejected until 2001.

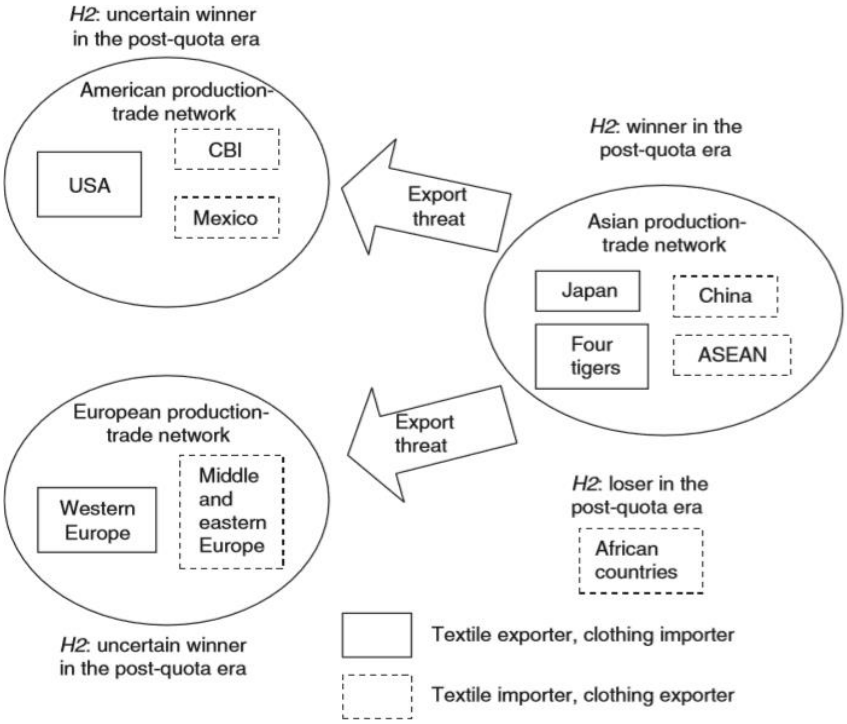
Nowadays, products manufactured in Europe are relatively different from those exported by Asian countries because they tend to be innovative and / or high-quality products. In this market segment of higher quality, designers can produce totally different products, but they also adapt to the tastes of consumers. The different varieties of a product change every 6 months or so, so companies are forced to quickly adapt the product to the new needs of consumers. The market is characterized by seasonal fluctuations such as the summer season or the winter season.

Finally, after analyzing the most important effects of the sectoral restructuring of the textile industry, we only need to know what has been the role of each region (which countries have come out winning with these changes and which, for their part, have lost). The MFA was applied to benefit the most developed regions (Europe and North America) but also helped many countries to develop their textile industry, allowing them to access their markets. In Africa, countries like Cambodia took advantage of this opportunity to introduce their garments in the European markets and in America, as I mentioned earlier, Mexico exploited its proximity to the United States to export its textile products.

When the ATC came into force and quotas began to be eliminated, giving way to the free market, competitive gaps emerged. Few countries could be more competitive than Asian countries, especially China (the most abundant country in the labor factor). The developed countries went from being exporters to importers [6], but it was the African countries (figure 4) that saw almost all of their exports replaced by those of the Asian developing countries as they were much more competitive (they offer higher prices). low).

[6] However, as we have seen previously, they retained a market segment (high quality clothing).

Figure 4. Geographic location of clothing exporters



Source: (Lu, 2012).

Mexico and some countries of the Caribbean also suffered the effects of the abolition of quotas, however, its geographic location with respect to the United States and Canada have allowed it to maintain a part of its industry. In addition, free trade agreements such as NAFTA have encouraged trade flows in these areas. The developed countries have managed to restructure the textile production to specialize in niche markets and the application of new technologies. The winners (emerging Asian countries) have managed to increase production and the degree of industrialization that in some countries was zero previous years[7]. Wages have increased considerably, and poverty has been reduced from low-income to low-middle income or middle-income countries.

3. LITERATURE REVIEW

Due to the importance of the textile sector worldwide there are numerous studies carried out by economists either to explain the behavior of the sector or to try to predict such behavior in the future. In the case of the Multifibre Agreement, it has also been a topic that has been widely examined by various authors due to the impact that quotas have

[7] Some Asian countries were dedicated exclusively to agriculture and the textile industry has been the first phase of industrialization.

on trade (the effect is more harmful than in the case of tariffs or non-tariff barriers). Below, some of these works are presented as they can help us to focus our analysis.

The economist Lu (2012) investigates the impact of the elimination of Multifiber Arrangement quotas by performing a multivariate analysis of variance (MANOVA), including 51 garment exporting countries from 2000 to 2009. This study concludes that each country responds differently to the elimination of quotas depending on the region in which it is located. It also suggests that European countries were achieving greater growth of exports in the period analyzed, compared to the United States.

China's export performance in the textile sector has been a surprising phenomenon that many authors have tried to explain. By expanding the export equation in the panel data frame Baiardi and Bianchi (2019) show that China displaces most of its competitors from the market due to the combination of low price policies and other non-price factors that stimulate export volumes. However, the dynamics of Chinese exports in recent years has clearly worsened, making China's business prospects worse.

One of the most used tools in the field of the textile sector is the gravity model. The work of Ernst, Hernández Ferrer and Zult (2005) tries to forecast, through the gravity model, changes in trade and employment after the abolition of the MFA. To collect the impact of the quotas create a quota indicator, which distinguishes between textiles and clothing, captures the power of relative restriction of quotas and takes into account the number of quotas established. In the case of employment, it is necessary to define a relationship between the same employment and exports, estimating the labor elasticity of production (assuming that the country's demand remains constant over time).

The results reinforce the theory, countries like Italy, Portugal or Canada would lose more than 15,000 jobs in the sector, while China, the country most benefited would generate more than 2 million jobs. Overall, the gain or loss is not fully defined, since in the study they only have employment data for half of the countries.

Another author who analyzes the effect of the quotas imposed in the Multifibre Agreement is Baleix (2005), which adds an indicator for non-tariff barriers that includes 20 categories of clothing products using data from 1996 (cross-section data, only having a period of time). Subsequently, this indicator is used as an endogenous variable using the variable "QR" as an instrument; quantitative restrictions. The results show that the gradual reduction of quantitative restrictions should be reflected in European imports (20% on average).

In the case of the Indian textile industry, Chan, Au and Sarkar (2008) they use the increased gravity model implementing variables to capture the effect of the rupee exchange rate, the effect of the implementation of the euro in Europe and the fact of being a member of the WTO. Even under quota restrictions, Indian exports increase when the rupee depreciates and decrease when appreciated. This implies that the real exchange rate has an influence on Indian trade. The introduction of the euro has a slightly negative effect by increasing restrictions on non-eurozone countries.

Free trade agreements or the creation of customs unions can also be analyzed through the gravity equation. The aim of Tsang and Au (2008) was to examine the impact of the creation of the North American Free Trade Agreement (NAFTA) on textile exports of Asian countries through the application of the gravity model. As expected, the application of the treaty increased the number of regional exchanges within North America. However, as the share percentage of the MFA decreased, intra-North American trade began to fall due to increased competition from Asian countries.

On a more disaggregated level, Lau and Bilgin (2010) have managed to use the gravity model to estimate the elasticity of Chinese cotton garments in the US market. In their case, they create the long-term import demand function by incorporating price elasticity and income elasticity into the equation. The main conclusion of this study states that the existing trade mechanism supports a unique long-term equilibrium between the import price and the per capita GDP of the United States. The price and income elasticities are significant (at 5%) and with the expected signs, which is why Chinese companies are expected to obtain higher long-term income. Finally, it should also be noted that, through an error correction analysis, it is obtained that the increase in Chinese exports will only negatively affect its neighboring countries temporarily in the short term.

Finally, it is worth mentioning the work carried out by Chi and Kilduff (2010), which estimated the gravity equation including in its model 18 variables that capture both regional agreements such as NAFTA or the language spoken by each country. The biggest driver of US export growth is the growth of the US GDP itself. Distance on the other hand affects negatively, which coincides with the theory described by the gravity model. Other elements such as the literacy rate or the level of infrastructure of the exporting country also generate a positive impact.

4. EMPIRICAL ANALYSIS: A NOTE ON THE GRAVITY EQUATION

In the previous section, we have observed how most of the works elaborated by economists in the field of the textile sector use the equation of gravity with the aim of obtaining clear conclusions about the events that took place in the sector. In this section we will expose the basic fundamentals of the gravity equation to apply later in our study.

The equation or model of gravity is based on the "law of universal gravitation" exposed by the physicist and mathematician Isaac Newton in 1687. This law establishes that the force of gravity between two objects depends on the product of its masses and the square of the existing distance between them.

$$F_{ij} = G\frac{M_i M_j}{D_{ij}^2} \tag{1}$$

Where, F_{ij} is the force of attraction; G is a gravitational constant that depends on the units of mass and force measurement; M_i and M_j are the masses of the bodies and D_{ij} is the distance between the bodies.

More than two centuries later, Tinbergen (1962) and later Pöyhönen (1963) extended this famous equation to the field of economics:

$$X_{ij} = K\frac{Y_i^{\alpha} Y_j^{\beta}}{T_{ij}^{\theta}} \tag{2}$$

In this case, X_{ij} represents the trade flows from "i" to "j" in year t. Y_i and Y_j are the economic size of each country or block, usually measured with GDP. Finally, T_{ij} is "The cost of interaction" or the distance between the two countries or blocks.

Now that we have a clear relationship between the different variables that represent the gravity equation, we will have to estimate it. Because the multiplicative nature of that equation, we can obtain a linear relationship (Head, 2003). So, it's more simplified form can be estimated by the traditional ordinary least squares method:

$$ln\, X_{ij} = \alpha\, ln\, Y_i + \beta\, ln\, Y_j - \theta\, ln\, T_{ij} + \varepsilon_{it} \tag{3}$$

Where, ε_{it} is the term of random disturbance or error term (commonly known). It includes those factors not included in the regression that affect the dependent variable. Just for the sake of reviewing, it can be recalled that OLS estimates to be statistically useful, they must meet three basic requirements:

1. Errors must have a mean of zero and should not be correlated with each of the explanatory variables (assumption of null conditioned average).

2. Errors must be extracted independently (random sampling) from a normal distribution (to be able to make inference) with a fixed variance (assumption of homoscedasticity).

3. None of the explanatory variables can be a linear combination of another explanatory variable (assumption of multicollinearity or perfect collinearity).

Under these assumptions, the OLS estimators will be consistent, efficient and unbiased since our method minimizes the standard errors and the coefficient of the sample estimates does not differ from the population values.

The gravity equation has "grown" over time as economists included new variables in the model. This model with new variables is called "increased gravity model" and the included variables have less theoretical justification than the distance or mass of a country, but they enrich the model. Some of these variables are:

Income per capita or GDP per capita: countries with higher incomes tend to trade more in general because they have better infrastructures, in addition they usually have lower tariffs.

Adjacency: it consists of including a dummy variable to collect the effect in the countries that share the border. According to Head (2003) the estimated coefficient for this variable is close to 0.5, which indicates that trade with an adjoining country is 50% higher.

Population growth: has a direct relationship with consumption in importing countries, so it influences trade flows.

Common language: countries that use the same language eliminate transaction costs due to the inability to communicate and cultural differences. They also tend to have greater trade flows between them.

Colonies: this variable is related to the previous one, since many countries use the same language because one of them has been formerly a colony of the other. As expected, the relationship with trade flows is also positive.

Political risk or corruption: some authors incorporate indicators such as the corruption perception index, especially in developing countries (they have higher rates). The greater the political instability within a country, the lower its capacity to maintain relations abroad, and therefore it is expected to trade less.

Gravity models have changed so much in recent years, that they are no longer just a way of explaining the commercial relationship with size and distance. The new variety of gravity models provides firmer microeconomic foundations. The gravity equation is a very useful tool for analyzing trade flows between different regions and has been used profusely in the last years. In addition, there are more and more regional agreements such as NAFTA, created to form customs unions or free trade agreements and thereby expand the market of goods and services with partners.

In this area, the gravity equation is the preferred instrument of economists to analyze its effects. For example, Soloaga and Winters (2001) they use the augmented gravity equation including dummies to capture the effect of the Preferential Trade Agreements (PTAs) in both intra-block and extra-block trade. The result shows that intra-bloc trade has not been favorably affected by the growing regionalism. On the other hand, only for the EU and EFTA there is evidence of trade diversion.

The study made by Ekanayake, Mukherjee and Veeramacheneni (2012) implements the augmented gravity equation including the similarity index, which aims to reflect that the similarities with respect to GDP per capita in the different countries have a positive effect on trade. For this, they use data from 19 Asian countries divided into four periods: 1980-2009, 1980-1989, 1990-1999, and 2000-2009. The estimates coincide with economic theory and agree with previous studies of Asian trade flows.

Other authors such as Yang and Martínez Zarzoso (2014) analyze the effects of the creation of the ASEAN-China Free Trade Area (ACFTA) using the equation of increased severity with three different sets of dummy variables. To do this, they divide the products into different categories such as manufacturing goods and agricultural goods. The conclusion is that ACFTA favors both the growth of the region and intraregional development. In addition, the reduction and abolition of tariffs, especially for agricultural products that is still slow.

Another study that measures the impact of a free trade area is the one carried out by Kar (2018) , in this case focusing on the creation of the South Asia Free Trade Area (SAFTA). For this purpose, it uses the increased gravity equation including the variable "TAR_{jt}", which represents the value of the most favored[8] nation tariff imposed by the importing countries. In addition, it includes three binary variables ($SAFTA1_{ijt}$, $SAFTA2_{ijt}$ and

[8] The most favored nation assumption is implemented through the framework of the WTO and establishes that each of the countries that intervene in this agreement must grant conditions that are as favorable to their partner country as those offered to third countries.

$SAFTA3_{ijt}$) to measure the specific trade effects of the free trade area. The results reflect once again the growth of intra-block and extra-block trade flows. In addition, the variable "$SAFTA3_{ijt}$, shows that if a SAFTA member country imports from a non-member country, the export has little or no impact.

Focusing on the Asian continent, especially in China, Eichengreen, Rhee and Tong (2007) They have analyzed the impact of China's growth on exports from other Asian countries. For this, it has included instrumental variables taking into account the endogeneity of Chinese exports in a gravity model. The particularity of this model is that it has been estimated by adding temporary fixed effects, that is, a binary variable has been created for each year (not including the first year of the sample to avoid multicollinearity), to capture multilateral resistance to trade of a country. The "exclusion" effect of China mainly affects consumer goods, and therefore less developed Asian countries.

Now that we have clear the basic fundamentals of the equation and we know what variables we can incorporate into it. Our equation will be given in the following way:

$$ln\ imports_{ijt} = \beta_0 + \beta_1\ ln\ GDP\_imp_{it} + \beta_2\ ln\ GDP\_exp_{jt} - \beta_3\ ln\ Dist_{ij} + \beta_4\ PopGrowth_{it} + \beta_5\ EURO - \beta_6\ ATC + \varepsilon_{ijt} \quad (4)$$

5. DATA AND STATISTICAL ANALYSIS

To perform the econometric analysis, we extracted a sample of imports of textile fibers, yarns and clothing (SITC classification in revision 1, in two-digit codes: 26, 65 and 84) of the UNCTAD database. In addition, we have considered a period of 23 years, from the year 1995 (the beginning of the abolition of the MFA) until 2017 (the latest data available) in order to evaluate the effect of the decrease in quotas. For this analytical exercise, we will use a set of panel data including as importing countries the 28 countries of the European Union and the United States and as exporters to China.

Before estimating the gravity equation, we should make explicit the variables that we want to include in our model. Table 3 shows all the variables that we will include, the magnitude in which they are expressed and the source from which they were extracted.

Table 3. Gravity model variables

VARIABLE	DESCRIPTION	DATA SOURCE
ln(Imports)	Logarithm of textile imports in thousands of United States Dollars from China to trading partners	UNCTAD
ln(GDP_imp)	Logarithm of GDP of importers in current United States dollars	WORLD BANK DATA
ln(GDP_exp)	Logarithm of GDP of China in current United States dollars	WORLD BANK DATA
ln(Dist)	Logarithm of the geographical distance in kilometres between China and importers	CEPII
PopGrowth	Population growth rate (annual percentage) of importers	WORLD BANK DATA
EURO	Dummy variable equal to 1 if the importer country uses the Euro	
ATC	Percentage of quotas remaining since the entry into force of the ATC	TRAINS DATABASE

Source: Own elaboration.

In order to identify the main determinants of European and US imports we have considered some factors such as the growth rate of the population of importing countries, an important element that can affect the demand for textile products, the introduction of the Euro (which produced in 1999[9]), since a large part of the exports of Chinese textiles are directed to this region and the percentage of quotas remaining with the entry of the ATC in 1995. The rest of the variables that make up the standard gravity model have already been described previously in the section "gravity equation".

[9] In 1999 the euro was inserted into international markets as a financial currency, but coins and notes did not enter circulation until 2002. At first, only 12 countries used it, but with the entry of new members to the European Union, they joined more countries to make up the current euro zone of 19 members.

Table 4. Descriptive statistics on textile sector

Variable	Obs.	Mean	Std. Dev.	Min	Max
Imports	667	2,240.725	6198.656	270.213	4.87×10^{7}
GDP_imp	667	9.46×10^{11}	2.55×10^{12}	3.44×10^{9}	1.94×10^{13}
GDP_exp	667	4.67×10^{12}	3.93×10^{12}	7.35×10^{11}	1.22×10^{13}
Dist	667	7,708.186	985.358	6,326.875	10,993.68
PopGrowth	667	0.244	0.805	-3.820	2.951
EURO	667	0.419	0.493	0	1
ATC	667	0.29	0.342	0	0.84

Source: Own elaboration.

Table 4 presents the main statistics of each variable. The ATC variable is the most homogeneous since it has less variability compared to the rest (its standard deviation is lower). We must bear in mind that we have a complete panel because we have data for all observations. In addition, it is a short panel, since the number of cross-section observations is greater than the number of periods.

Table 5. Correlation matrix

Variable	*GDP_imp*	*GDP_exp*	*Dist*	*PopGrowth*	*EURO*	*ATC*
GDP_imp	1.000					
GDP_exp	0.083	1.000				
Dist	0.654	0.000	1.000			
PopGrowth	0.176	0.012	0.381	1.000		
EURO	-0.068	0.333	0.177	0.305	1.000	
ATC	-0.090	-0.755	0.000	-0.037	-0.361	1.000

Source: Own elaboration.

As we can see in table 5, the correlation is very low among the explanatory variables (practically below 50%). Note the variable ATC, which has a negative correlation with all variables, especially with China's GDP, which makes us think that the elimination of

import quotas (market liberalization) has led to Chinese growth in economic terms. In order to observe the relationship between the variables and the imports, in Annex A several graphs of points are presented that can help to observe the behavior of some variables.

6. ESTIMATION OF THE GRAVITY MODEL

The analysis of panel data has been growing rapidly in recent years due to its enormous advantages. This approach provides information on each individual over time, which helps us better interpret the dynamics of change. In addition, it allows to reduce the multicollinearity problems that appear in the time series. Now that we have the variables that we will include in the gravity model, we have to estimate it as shown in equation (3) by pooled OLS. Considering this, the model of increased gravity that we will use in our empirical exercise is given by:

$$ln\ imports_{ijt} = \beta_0 + \beta_1\ ln\ GDP\_imp_{it} + \beta_2\ ln\ GDP\_exp_{jt} - \beta_3\ ln\ Dist_{ij} + \beta_4\ PopGrowth_{it} + \beta_5\ EURO - \beta_6\ ATC + \varepsilon_{ijt} \quad (4)$$

This approach allows us to estimate the independent effect of each variable, keeping the effects of the other variables constant (Ceteris Paribus). However, if the effect of multicollinearity appears between the independent variables and the heterogeneity related to time, our estimators would be biased. For the estimation to be consistent, we must assume that the fixed effect not observed is not correlated with any of the explanatory variables. A possible solution to avoid this problem and to cancel the effect of the unobserved variables would be to use the econometric approach of the estimation by fixed effects or random effects.

The estimation by fixed effects assumes that the factors of export and import, as well as the geographical factors considered in the equation are not random, without depending on the specific characteristics of each country. This estimate also helps us to add other factors, such as political or geographical factors, which are not random, since they depend on the characteristics of each country. However, the problem of this estimate appears when we introduce a variable that is constant within a group (as it happens with the distance to be constant between partner countries), so this variable will be excluded from the estimate. Now the equation is given by:

$$\ln imports_{ijt} = \alpha_i + \beta_1 \ln GDP\_imp_{it} + \beta_2 \ln GDP\_exp_{jt} - \beta_3\ \ln Dist_{ij} + \beta_4\ PopGrowth_{it} + \beta_5\ EURO - \beta_6\ ATC + \delta_t + \pi_{ij} + \varepsilon_{ijt} \quad (5)$$

The random effects estimate, unlike the fixed effects estimate, assumes that the individual effects are not independent of each other, but are randomly distributed around a value. This estimate measures both the impact of the explanatory variables and the characteristics of each country (which are different). According to Yang and Martínez Zarzoso (2014) the estimation by fixed effects tends to provide better results than the estimation by random effects within the framework of the gravity model and that is why it has been chosen in most of the studies. The equation would be:

$$\ln imports_{ijt} = \alpha_i + \beta_1 \ln GDP\_imp_{it} + \beta_2 \ln GDP\_exp_{jt} - \beta_3 \ln Dist_{ij} + \beta_4 PopGrowth_{it} + \beta_5 EURO - \beta_6 ATC + \delta_t + v_{ij} + \varepsilon_{ijt} \quad (6)$$

The main difference with the fixed-effect model is that here we assume that the coefficient is common for each individual and over time, plus the random variable (v_{ij}) that varies among individuals, but not in time.

Table 6. Panel data gravity estimations

Dependent Variable: ln(Imports)			
	Pooled OLS (4)	*Fixed effects (5)*	*Random effects (6)*
ln(GDP_{imp})	1.087*** (0.018)	1.217*** (0.091)	1.124*** (0.049)
ln(GDP_{exp})	0.184*** (0.054)	0.147*** (0.042)	0.162*** (0.040)
ln(Dist)	-1.128*** (0.241)	----	-1.286 (0.867)
PopGrowth	0.142*** (0.039)	0.049 (0.038)	0.062* (0.037)
EURO	-0.004 (0.048)	0.100* (0.060)	0.086 (0.058)
ATC	-0.916*** (0.145)	-0.815*** (0.131)	-0.889*** (0.116)
Constant	-10.587*** (2.355)	-23.009*** (2.310)	-9.521 (7.417)
N	667	667	667
R^2	0.924	0.919	0.923

Note: Pooled OLS has been estimated by the robust errors to the HTC.

Source: Own elaboration and estimated with STATA.

Table 6 shows the results provided by each estimate (pooled OLS, fixed effects and random effects). Comparing the three estimates we can see how the results are quite similar. The coefficient of determination (R^2) it hardly differs between the three models and is very high in all three cases, which indicates that we have a good adjustment to explain the behavior of textile imports. To know which of the three estimates best fits our model of gravity we have to perform several tests. The first of these is the Hausman test (see Annex B), through which we have obtained that the random effects estimation is better adapted to our model.

Although studies such as those mentioned above suggest that the estimation of the gravity model increased by pooled OLS could be biased, we will use the test Breusch-Pagan[10] o Multiplier of Lagrange to confirm that the random effects specification is more appropriate than the pooled OLS. The results shown in Annex C confirm that the best method for estimating the augmented gravity equation is the random effects specification.

All the variables show the expected signs before the estimate. The GDP of the importing countries (the size economically speaking of each country) reflects a large impact on imports since, keeping the remaining factors, an increase of 1% of the GDP of the importing country will mean an increase of 1.124% in imports Chinese from that country. For its part, China's GDP also influences its textile exports, although to a lesser extent than the GDP of the importing countries. Distance negatively affects commercial flows, as expected, but it is not a relevant variable in our model (less statistically significant than a 90%).

The population growth rate has a positive coefficient and statistically significant at 90%, which indicates that it has a positive effect on trade flows between countries. The study made by (Brada, J.C. and Mendez, 1983) supports this assumption by arguing that countries with higher population growth rates tend to have a higher value of imports. The EURO dummy variable also presents a positive coefficient, which leads us to believe that the launch of the euro has streamlined transactions (not only intra-Europe, but also extra-europe). However, this variable lack significance, so we will not take it too much into account.

The variable ATC represents a crucial role in our gravity equation since it shows that a 1% decrease in the level of quotas imposed by the United States and Europe to China,

[10] Do not confuse it with the Breusch-Pagan Heteroscedasticity test for the regression of ordinary least squares.

causes an increase in the amount of imports from those countries in a 0.88%. This reflects the importance and impact in economic terms of this agreement that ended decades of protectionism in the textile and clothing sector. Hence, in 2005, when 50% of the remaining quotas were eliminated, Chinese exports grew with greater intensity than in previous years.

7. CONCLUDING REMARKS

The gravity model is one of the best tools to analyze trade flows, which is why it is one of the most used among economists applied in this field. Using a sample with panel data, using 29 countries over 23 years, this study supports the theory of the gravity model and provides empirical evidence that the elimination of quotas of the Multifibre Arrangement has led to changes in the global structure in the textile sector that is concerned.

On the one hand, we have observed how China has benefited due to the increase of its exports linked to the increase in world demand, but above all due to the liberation of the market. The abundance of low skilled labor in the region together with the opening to markets has created the perfect environment for China to become the leading exporting power in the textile and clothing sector (thus taking advantage of its comparative advantage). On the other hand, the importing countries (mainly United States and the European Union) have lost several thousand jobs in the sector, since a large part of the industry has been transferred to emerging countries. However, consumers and large companies increase welfare, since production has become more efficient and final prices are more competitive.

As in many other works that use the gravity model, distance has a negative coefficient, however, in our model it lacks relevance. There are several factors that directly or indirectly can explain that. The reduction in transport costs due to the process of containerization or the creation of new commercial routes. The incorporation of a single currency in Europe (the euro) has not had a great effect, rather the effect is practically negligible despite having stabilized the exchange rates. It should also be noted that the period of the financial crisis has slightly slowed Chinese export growth in line to drastic fail in trade experienced in the world economy.

This study shows an overview of the global textile landscape. To continue and deepen this line of research would be interesting to take into account other Asian countries such as Bangladesh or India to include them as exporting countries in our equation, this would not only allow us to analyze the impact of quotas in these countries, but also possible agreements established between them. It would also be interesting to examine the evolution of the prices of textile products before and after the abolition of quotas. Another

way of approaching the elimination of quotas would be by adding an exogenous instrument for the variable ATC and thus be able to approach the problem through instrumental variables. In addition, an analysis of temporary fixed effects could also be included to try to capture common events such as the financial crisis.

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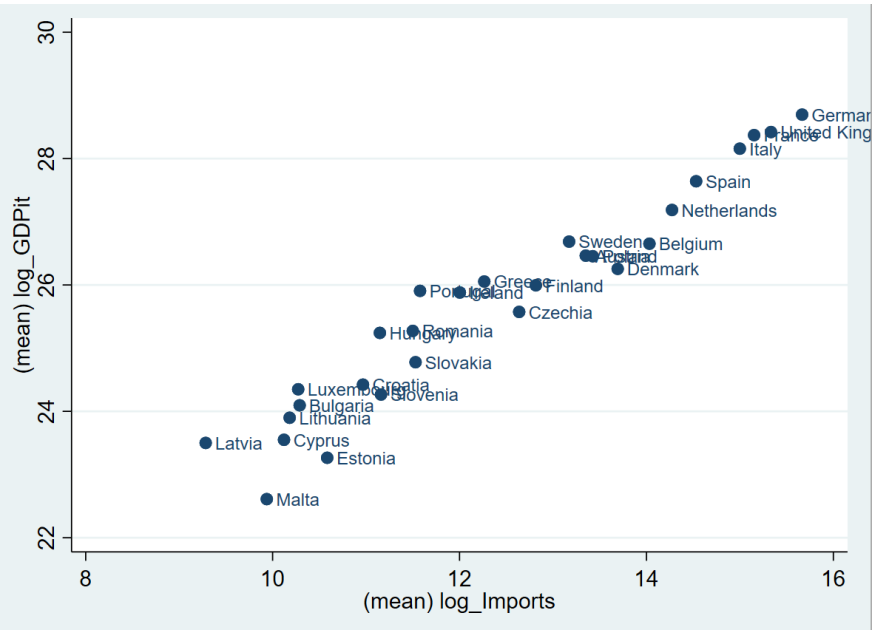
ANNEX A. POINTS DISTRIBUTION CHARTS

In this section, we show different distribution charts of points including the GDP_imp, Dist and PopGrowth variables on the ordinate axis and Imports on the abscissa axis. This type of graphs are very useful to evaluate and compare the distributions of data in the sample and to analyze the relationship between the variables represented. In our sample, each point represents the temporal average of the values of each European country. The objective is to observe the relationship between our dependent variable (Imports) and the independent variables.

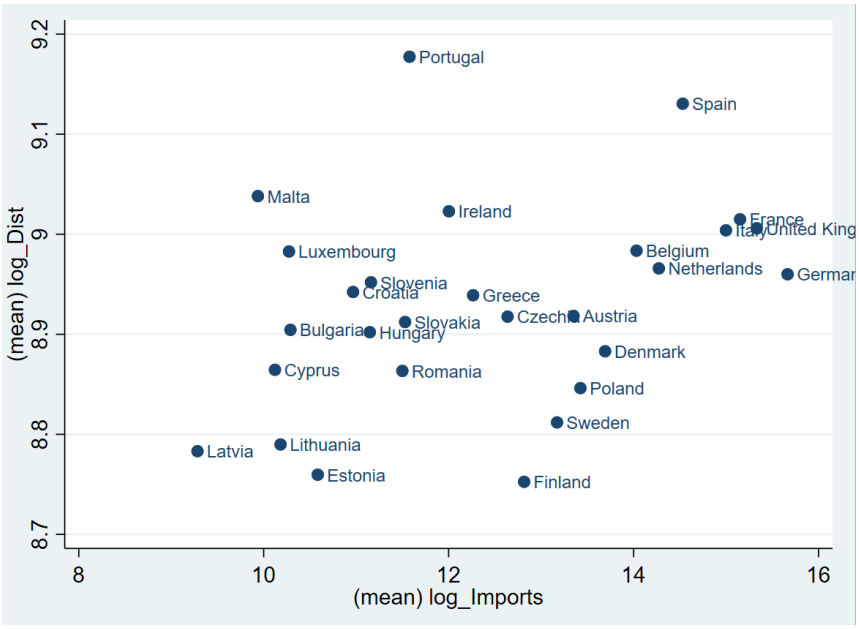
Figure A1. ln(GDP_imp) distribution by Country



Source: Own elaboration.

The distribution of the GDP of the importing countries in relation to the quantity imported clearly shows a positive correlation. Economically more powerful countries such as Germany or the United Kingdom are the ones that import more textiles from China, while smaller countries like Latvia or Malta import less textiles (in absolute terms). This is also related to the population of the countries, since the countries with the greatest number of inhabitants tend to consume more than the most depopulated countries.

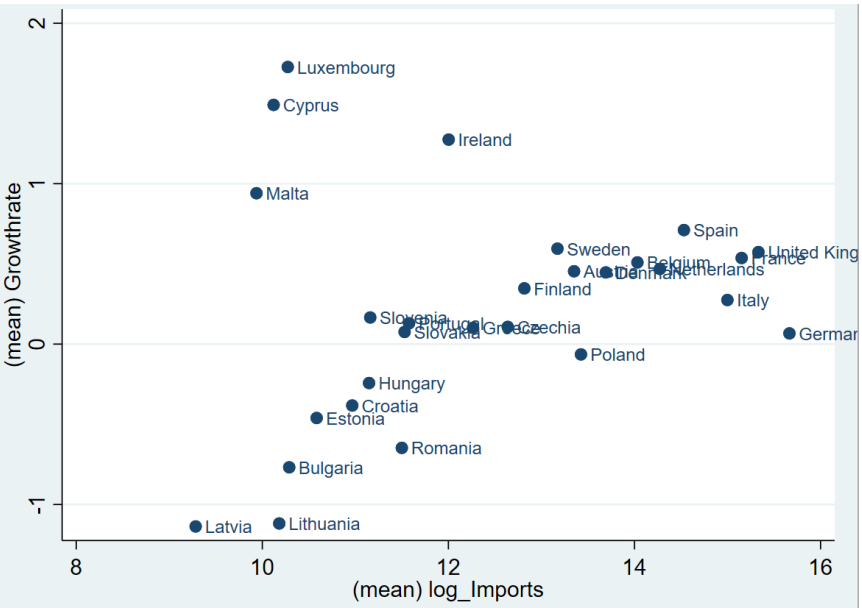
Figure A2. ln(Dist) distribution by Country.



Source: Own elaboration.

We know that the distance negatively affects trade flows because it is always cheaper to import products from closer regions (transport costs are lower, operating with the same currency facilitates transactions...), however, as we can see in figure 5, there is a very dispersed distribution, so that distance stops being the biggest impediment to trade. This may be due to the new established commercial routes, to the reduction of the cost of freight transport ...

Figure A3. PopGrowth distribution by Country



Source: Own elaboration.

The population growth rate shows a more uniform distribution than the distance between the importing and exporting countries, but even so, its correlation is not as marked as in the case of the GDP of the importing countries. The figures of the different growth rates oscillate between very close values (almost all are between -1 and 1), although, despite this it seems that the growth rates that are positive tend to be the countries that import more textiles.

ANNEX B. HAUSMAN TEST

Jerry Allen Hausman, professor of economics at the Massachusetts Institute of Technology showed that the difference between the coefficients obtained from fixed and random effects can be used to test the null hypothesis that the error (ε_i) and the independent variables are not correlated.

Therefore, the null hypothesis of the Hausman test (H_0) indicates that the estimators of fixed and random effects do not differ significantly. On the other hand, the alternative hypothesis (H_1) suggests that the estimators do differ and the estimation by fixed effects is more appropriate.

$$H_0: \beta_A = \beta_B$$

$$H_1: \beta_A \neq \beta_B$$

Where, β_A are the coefficients of the estimate by fixed effects and β_B are the coefficients of the random effects estimation.

Table B1. Hausman test

Variable	**Fixed ($\boldsymbol{\beta_A}$)**	**Random ($\boldsymbol{\beta_B}$)**	**Difference ($\boldsymbol{\beta_A}$)- ($\boldsymbol{\beta_B}$)**	**Standard error**
ln(GDP_{imp})	*1.217*	1.124	0.927	0.763
ln(GDP_{exp})	0.147	0.162	-0.015	0.117
PopGrowth	0.049	0.062	-0.012	0.010
EURO	0.100	0.086	0.013	0.014
ATC	-0.815	-0.889	0.073	0.061
chi2 (5)	**2.31**			
Prob>chi2	**0.804**			

Source: Own elaboration.

Given that the p-value (0.804) is greater than 5%, we have enough evidence at 95% of significance (and 99% as well) to not reject the null hypothesis (H_0). The parameters of the two estimates do not differ, therefore, we prefer to estimate the model by means of random versus fixed effects.

ANNEX C. BREUSCH-PAGAN TEST

The Breusch-Pagan or Lagrange Multiplier test consists of performing an auxiliary regression including the compound error (v_i) and considering that the null hypothesis of the variance of this error is equal to zero:

$$H_0: Var(v_i) = 0$$

$$H_1: Var(v_i) \neq 0$$

In this case, if we reject the null hypothesis (H_0) we consider that there is an unobservable component of the variance associated with each individual and we prefer to estimate the model by random effects.

Table C1. Breusch-Pagan estimated results

	Var	**Sd=sqrt(Var)**
ln(Imports)	5.007	2.237
e	0.178	0.422
v	0.237	0.487
chibar2(01)	**2003.36**	
Prob > chibar2	**0.000**	

Source: *Own elaboration.*

The value of the test is high (the p-value is less than 0.05) so we have enough evidence (practically at any level of significance) to reject the null hypothesis (H_0). As expected, it is preferable to estimate the model by random effects.