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## **An Augmented Gravity Model: Factors that Affect the U.S. Sugar Imports from Western Hemisphere Countries**

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AN AUGMENTED GRAVITY MODEL: FACTORS THAT AFFECT U.S. SUGAR IMPORTS FROM  
WESTERN HEMISPHERE COUNTRIES

A Thesis

Submitted to the Graduate Faculty of the  
Louisiana State University and  
Agricultural and Mechanical College  
in partial fulfillment of the  
requirements for the degree of  
Master of Science

in

The Department of Agricultural Economics  
and Agribusiness

by  
Katherine Ramirez Hernandez  
B.S Universidad de la Sabana, 2011  
May 2016

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## **ABSTRACT**

This study analyzes the main factors that affect sugar imports to the United States from western hemisphere producing countries. Important variables such as Free Trade Agreements, production capacity levels and the quota imposed by the United States to the imported sugar will be analyzed under the scope of the gravity model.

The estimation of the model is carried out using an OLS analysis. The variables used to create a reliable single-commodity gravity model are: sugar production indicators, distances between the involved countries, population, import quotas, and a set of dummy variables such as FTA (Free Trade Agreements) and border, that augment the model in order to identify and capture the effects of transactional costs and productivity on the sugar industry. The main focus is to assess the extent in which the variables affect sugar imports by the United States. The participation of the United States on international trade makes it essential identifying the FTAs in which they are involved. Some of the FTAs are the North American Free Trade Agreement (NAFTA), The Dominican Republic and Central American Free Trade Agreement (CAFTA-DR), and individual FTAs. On the other hand, the major constraint to U.S. sugar imports are the tariff rate-quotas (TRQ), which are analyzed in order to determine the degree of the effect of this distortion on sugar trade. This research will demonstrate that although the existence of efficient sugar producers and, that FTAs suppose an increase of trade between countries, in the sugar industry, quotas have shown weighting more than any other factor in the U.S. sugar imports.

## CHAPTER 1. INTRODUCTION

Sugar trade has been the center of attention of many international trade agreements. The sugar industry influences developing and developed countries, as well as exporting and importing countries. This industry has been marked for its volatile prices on the free market and for the distortions that governments have put on it. The sugar market is full of quotas, price floors and price ceilings, and subsidies that create an extremely controlled market. Then, why is it so controlled? The importance of this industry is known worldwide. Figure 1 shows that, according to the USDA, the world's sugar consumption for 2013/2014 was of 167 millions metric tons (raw value), while its production in the same period was of 175 millions metric tons (raw value) (USDA, 2016). Also, there is an estimated 60 million farmers who grow sugarcane worldwide on a small-scale and approximately 120 countries around the world produce sugar from cane (sugarcane-solidaridad, 2016). The importance of sugar is based upon the relevance of the industry in terms of consumption and on the amount of people that based their livelihood on sugar production. Since sugar is one of the largest agricultural industries in the United States, negotiations regarding restrictions, barriers to trade and impediments in general make it a very sensitive commodity that is worth to be analyzed. The United States is one of the world's largest sugar producer and consumer. Figure 2 shows the behavior of the U.S. sugar market, where consumption highly exceeds the amount of sugar supplied by the domestic market. Due to this situation, the United States is forced to import the quantity of sugar necessary to satisfy its domestic demand. They use different mechanisms to protect and satisfy their domestic market. The mechanisms used by the United States focus on two different fronts, to encourage and to protect domestic producers: the nonrecourse loan program and the marketing allotments to encourage production, and the tariff-rate quota to protect producers from imports.

An overview analysis of the domestic sugar production in the United States is necessary to understand the behavior of their policies and trade with the western hemisphere countries. The United States has the advantage of producing sugar from cane and from beets. Both industries are large in the country and have invested in research and technology, obtaining important increase in their production and efficiency. Sugar cane accounts for about 45% of the total sugar produced domestically while sugar beets account for the remaining 55%. Sugar cane is grown in Florida, Hawaii, Louisiana and Texas, while sugar beets are grown in California, Colorado, Idaho, Michigan, Minnesota, Montana, Nebraska, North Dakota, Oregon, Washington and Wyoming. In the United States, only Florida, Louisiana and some south areas of Texas have the tropical and semitropical climate condition to grown



sugar cane. On the other hand, sugar beets grow exclusively on temperate climate, which is the main reason to understand why the north western region is the largest sugar beet producing area in the country.

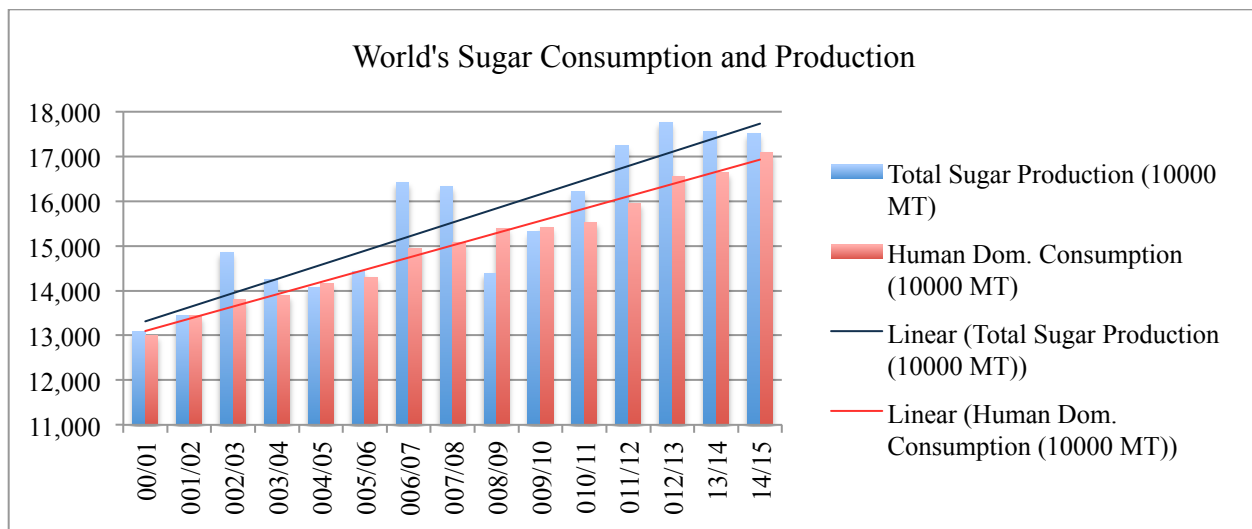


Figure 1. World's Sugar Consumption and Production

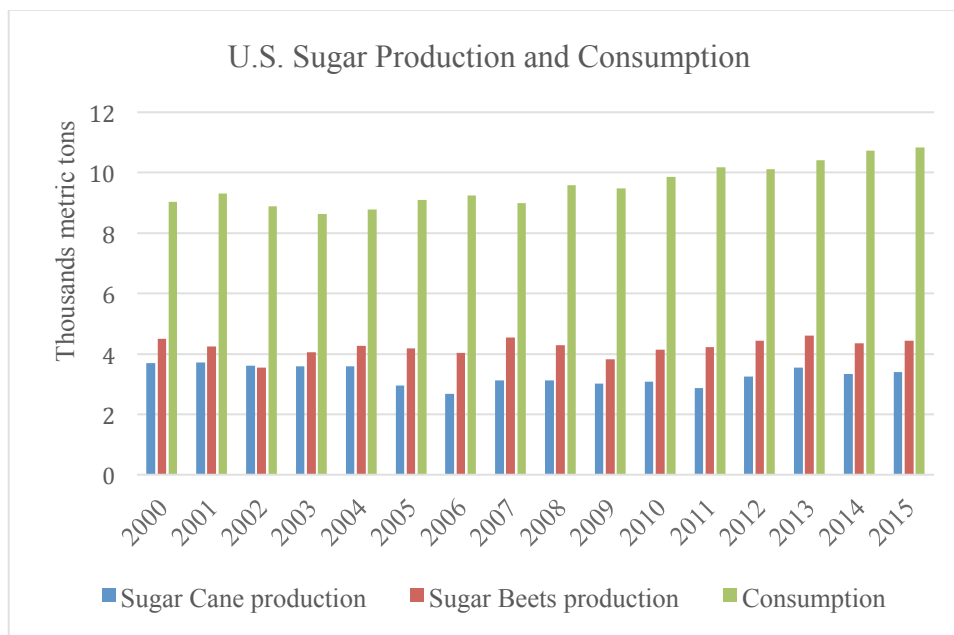


Figure 2. U.S. Sugar Consumption and Production

Figure 3 shows the quantity of sugar cane produced by each of the 4 producing regions in the United States. Given the special climate conditions to grow sugar cane, not many states have the capacity to do so. Louisiana which is the second largest producing state in the U.S., producing 39% of the total amount of U.S. sugar cane production, and the first in acreage harvested, has highly contributed to the State economic development. As

reported by the LSU AgCenter, the contribution of the sugar cane industry is \$2 billion to the Louisiana economy, which constitutes an important contribution not only to the State, but also to sugar cane producers within the state, and to the large demand in the domestic market. (LSU AG Center, 2015). Sugar beets' constant production from 2005 to 2014 can be observed in Figure 4. A relevant fact in the sugar beets industry is that they converted to 100% GMO, which is not totally accepted among consumers, but the industry coordinated an industry-wide conversion to adopt this process, giving consumers not choice but to consume GMO sugar beets or sugar from cane.

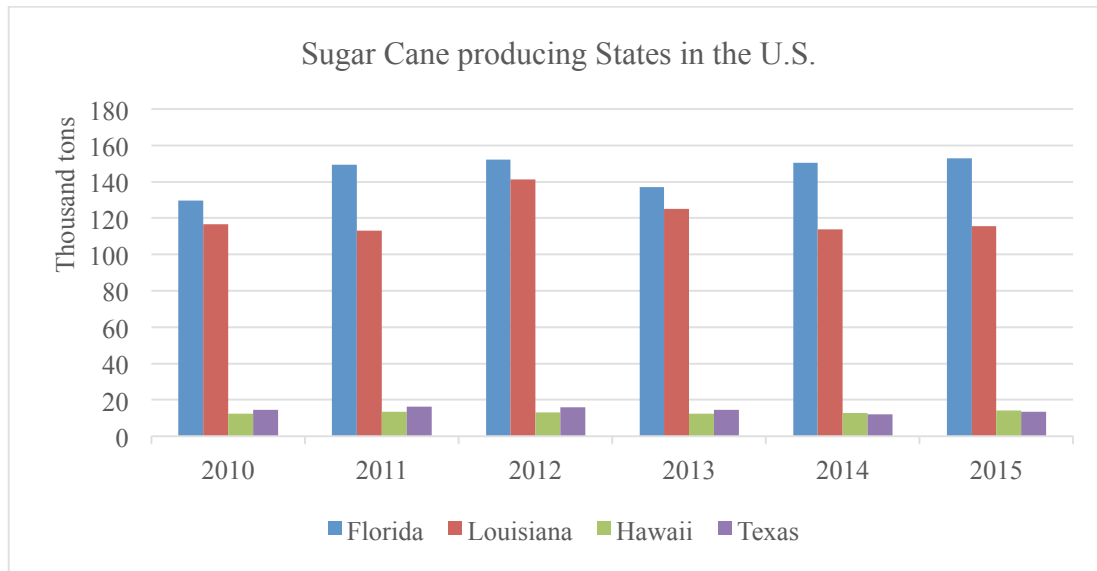


Figure 3. Sugar cane producing states in the U.S.

This research focuses on trade between the United States and some of the western sugar producing countries. Sugar beets industry serves as reference of a substitute from the main commodity in this research, which is sugar cane, but it is not including in the model, since all western countries produce sugar cane and export it to the United States.

The inclusion of FTAs in this scenario makes sugar trade analysis even more interesting because the effects in the market have an additional variable that needs to be measured in order to determine their effects.

The focus of this research is based on the effects of the factors that influence U.S. raw cane sugar imports. The analysis will include the factors that enhance and diminish sugar trade and determine, according to economic theory, how they behave in the sugar industry.

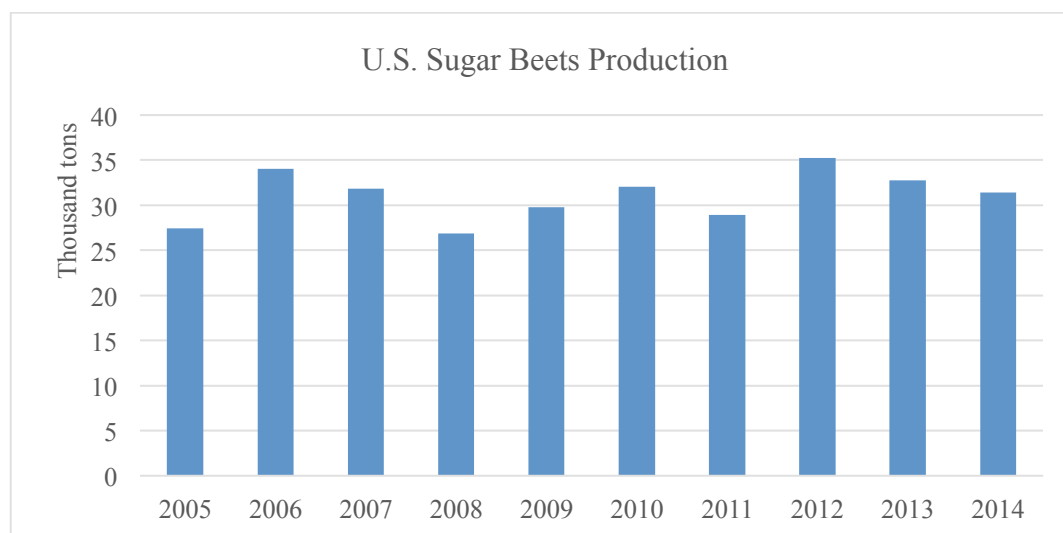


Figure 4. U.S. Sugar Beets Production

### Free Trade Agreements (FTA)

In the last decades, most economies have experienced a marked tendency of getting involved in globalization through bilateral or multilateral agreements that has been mobilized through a series of trade negotiations. According to the World Trade Organization, Regional Trade Agreements have experienced a constant increase. As shown in Figure 5, the growing tendency hasn't stopped since 1991 and it keeps increasing. As of April 7, 2015, the WTO has received 612 notifications of Regional Trade Agreements (WTO, 2015).

Bilateral trade allows the producing countries with a comparative advantage to export their production to countries that don't have the same advantage in producing. In the same sense, they import goods in which they don't have advantages in producing. Each country has the ability to export and import in order to increase its general welfare and it often occurs through agreements that countries sign.

Jacob Viner first introduced the terms of "Trade Creation" and "Trade Diversion", when he was analyzing Custom Unions (CU). Trade creation makes reference to the fall in the production of a good in a country because it is displaced by a lower-cost producing member country because the import of that good is cheaper than producing it at home (Krueger, 1997). On the other hand, trade diversion occurs when countries change imports from a low-cost producing country to a high-cost producing country due to the signature of an agreement. According to Viner (1951), for the country and the world as a whole, reciprocity treaties, even on free-trade grounds, are ordinarily not an amelioration, but on the contrary are an intensification of the evils of customs tariffs. It is important to recall that trade creation and trade diversion effects occur through inter-industry trade and/or intra-industry trade. Inter-

industry trade occurs when a pair of countries has different endowments, leading the country with the greatest advantage to export their products into the other and import what they lack in their market; then it could be trade creating or trade diverting. On the other hand, the intra-industry trade mainly tends to happen between a pair of countries that have similar endowments among them and get to specialize in similar products, which lead them to improve their productive capacity in those specific products; so it is expected more trade creating than trade diverting (Won, Lynn & Skripnitchenko, 2006).

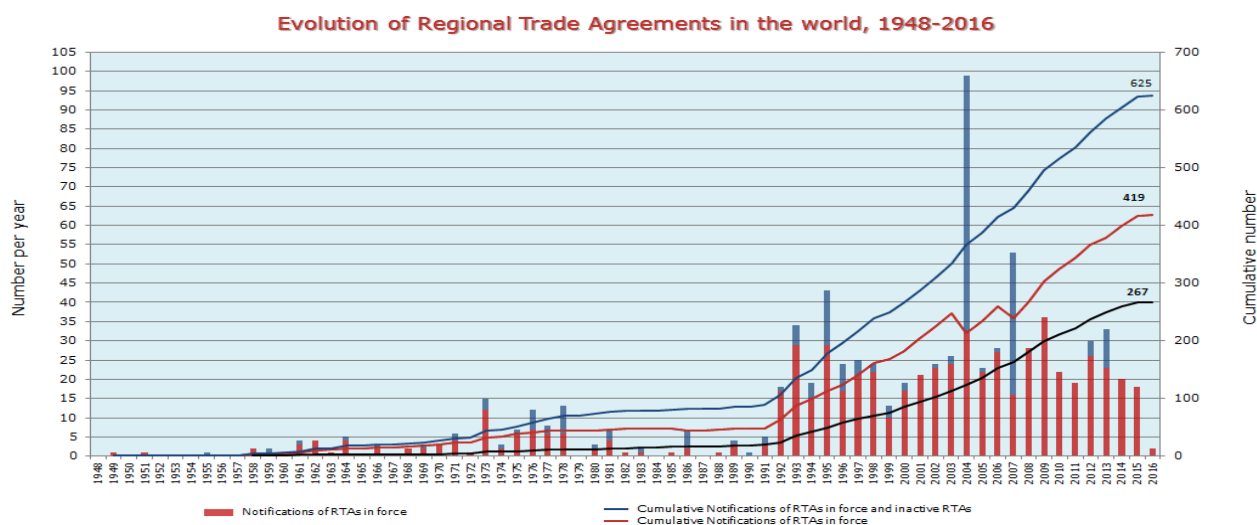


Figure 5. Evolution of Regional Trade Agreement in the world, 1948-2016.

The United States has signed different kind of agreements with various nations. The Trade and Investment Framework Agreements (TIFA) with 51 different countries, it is involved in 41 Bilateral Investment Treaties (BIT), it participates with other 23 economies in the Trade in Services Agreement (TiSA) and it is negotiating with other 13 WTO member countries the Environmental Goods Agreement (EGA). The United States is also involved in Free Trade Agreements (FTAs) with 20 different countries.

Because part of the study in this research is based on the FTAs that the United States has signed with western hemisphere countries, an overview analysis should be made for each FTAs. NAFTA in which Mexico and Canada are involved; CAFTA-DR in which 6 Central American countries are members, and the individual FTAs with Peru and Colombia.

Given Viner's approach, a detailed analysis should be done to determine the cases in which FTAs increase or reduce welfare of nations or in which extent they influence sugar trade among countries. An empirical model is

used in order to analyze the net effect of being part of a FTA, among other important factors, on the total amount of sugar imported in the United States.

### **North American Free Trade Agreement (NAFTA)**

One of the most relevant FTA that the United States has signed is the North American Free Trade Agreement (NAFTA) with Canada and Mexico. Its initial purpose was to reduce the trading costs in order to help North America to be more competitive in the marketplace and to increase business investment among the different industries in the countries members. NAFTA was signed in 1994 and it has increased trade among them in a significant way. The Office of the United States Trade Representative reported that by 2013, imports from Mexico have increased 603% and exports to Mexico have increased by 444% from 1993 (USTR, 2015). The U.S. goods trade deficit with Mexico was \$54 billion in 2013 and the U.S. services trade surplus was \$12 billion. The main products exported by the United States to Mexico are machinery, vehicles and plastic, while the main products exported by Mexico to the United States are vegetable, fruits, beer, wine and snacks.

Under NAFTA, Mexico gained access to the U.S. sugar market. The United States negotiated that if Mexico could become a net sugar exporter for two consecutive years, they could export zero duty free perpetually. By 2008, Mexico met all the requirements in order to export as much as they were able to produce to the U.S. market, which notably changed the historical trend of sugar trade. Figure 6 shows the total sugar exports from Mexico to the United States. The trade tendency changed dramatically in 2008, where exports increased around 225.000 metric tons due to the net exporter status of Mexico. By 2015, due to antidumping and countervailing duty investigations (AD/CVD) beginning in March 2014, sugar imports from Mexico were restricted. Investigations said that sugar imported from Mexico was injuring the domestic industry. According to the USDA, the agreement on the suspension of the investigations was signed between the Department of Commerce and the government of Mexico in December 2014 (USDA, 2016). The agreement contains an Export Limit, which was calculated by the USDA's World Agricultural Supply and Demand Estimates (WASDE). The agreement also included References Prices for all sugar imported from Mexico, which determined the minimums allowed to be shipped from Mexico to the United States.

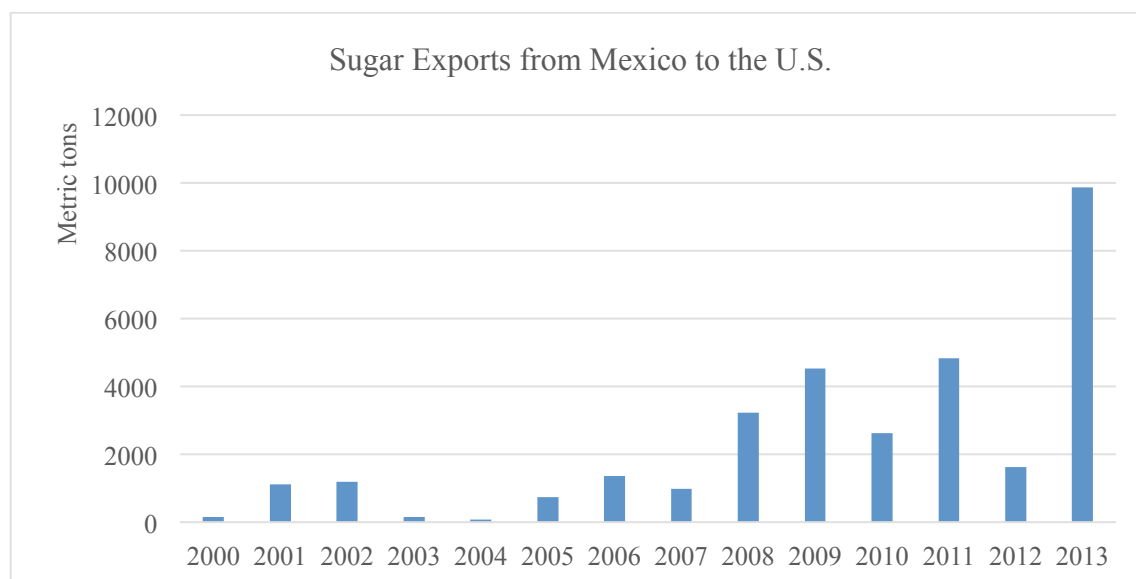


Figure 6. Sugar exports from Mexico to the U.S.

### **The Dominican Republic- Central America Free Trade Agreement (DR-CAFTA)**

CAFTA-DR is the FTA between the United States and 6 developing countries in Central America (Honduras, Guatemala, Nicaragua, Costa Rica, El Salvador and the Dominican Republic). This agreement was signed in 2005 and was originally designed to promote economic development in Central America and the Caribbean islands through private sector initiatives. The main objective of the agreement was to increase the investment on non-traditional sectors through exports, which allow increasing the welfare of different industries among the countries members. The DR-CAFTA member countries have enjoyed some preferences agreed under the FTA, in which the United States increased their assigned TRQ. After the signature of CAFTA, their exports experienced a substantial growth in trade calculated in 71% before CAFTA up until 2013. The sugar industry plays a very important role in this scenario due to the fact that countries as the Dominican Republic, the largest sugar exporter to the United States through TRQs, Guatemala, one of the largest sugar cane producers and Nicaragua one of the countries with the largest sugarcane yield per hectare, are involved in the agreement. Figure 7 shows the total amount of sugar exports from DR-CAFTA to the United States, which from the total sugar imports of the United States, which represents around 3% of the total U.S. sugar imports.

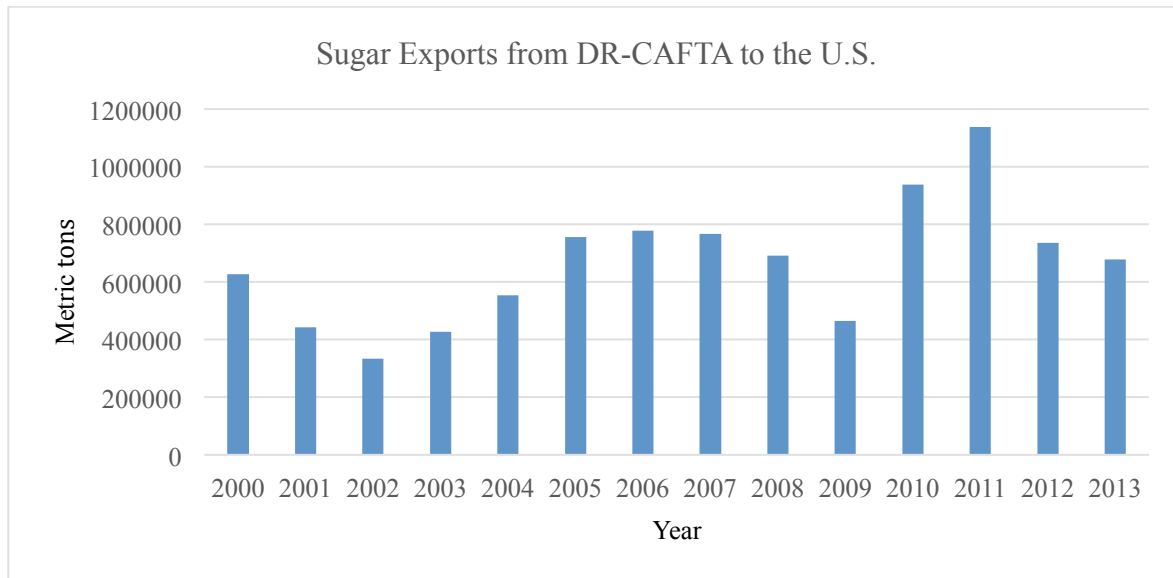


Figure 7. Sugar exports from DR-CAFTA to the U.S.

#### **The United States – Colombia Trade Promotion Agreement (CTPA)**

By 2013, the U.S. goods trade deficit with Colombia was of \$3.0 billions. The FTA with Colombia was a key movement of the United States in their strategy to advance free trade with other western hemisphere countries. After the FTA was signed almost 70% of the U.S. current trade received zero duty free implementation. The FTA eliminated the price band system that Colombia had, which protected their domestic production from imports and hadn't permitted more than 150 U.S. products to reach that market. The main goods that Colombia exports to the United States are agricultural-based products such as coffee, tea, fruits and nuts, or nonrenewable goods such as mineral fuel, oil and precious stones. On the other hand, U.S.'s main exports to Colombia are vehicles, electric machinery and organic chemicals. In May 2012, the United States and Colombia signed the FTA in order to remove tariffs and barriers to trade. It was a continuation to the previous trade preference that Colombia had with the United States known as the Andean Trade Promotion and Drug Eradication Act (ATPDEA), in which the United States granted duty-free access to a sort of imports from Colombia, Bolivia, Ecuador and Peru until 2011. Negotiations in terms of sugar were not easy since Colombia is an efficient-low cost producer that could eventually represent a threat to the U.S. sugar producers. The general volume of Colombian sugar exports is an evidence of their specialization in the sugar production. Colombia has also enjoyed some benefits due to their sugarcane yield that allows them to have enough capacity to export at a competitive cost. The FTA signed agreed to increase Colombia's

sugar quota from 30,760MT in 2007 to 50,000MT after the signature of the agreement with an increase by 750MT per year. Figure 8 shows sugar exports from Colombia to the United States from 2000 to 2013.

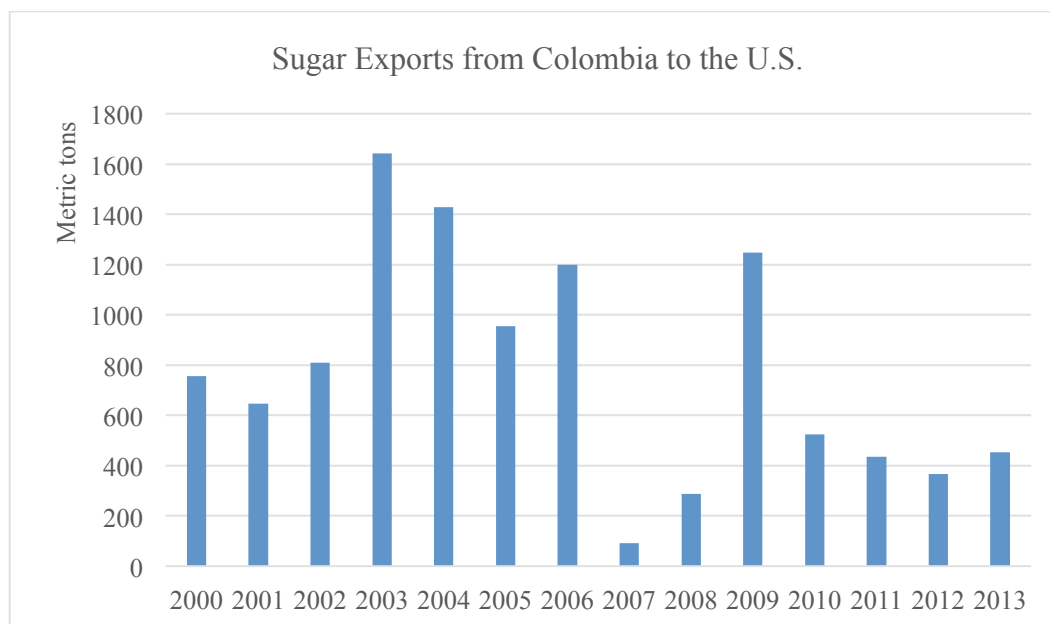


Figure 8. Sugar exports from Colombia to the U.S.

### **The United States – Peru Trade Promotion Agreement (PTPA)**

Parallel to the Colombian's negotiations of the FTA, in February 2009, the United States and Peru signed the promotion agreement. The main objectives were to increase the access to good and services for both countries and to remove tariff and barriers to trade. The U.S. goods trade surplus with Peru was \$1.9 billions in 2013 in which the main exports to Peru were plastic, mineral fuel and oil, and electrical machinery, while the main exports to the United States from Peru are knit apparel, vegetables, precious stones and fruits.

The negotiation terms were the same as those with Colombia since Peru was also part of the ATPDEA. Due to the APTDEA's expiration in 2011, Peru was interested to sign the FTA with the United States to keep all the trade benefits they had enjoyed since 2002. As in Colombia, sugar was a very controversial topic in the negotiations because Peru is a large sugar producer. In 2011, Peru was at the top of the largest sugarcane yield worldwide with 1'234.552 hg/ha, which made them very competitive in the international market. Figure 9 shows Peru's sugar exports to the United States.



A basic requirement for these countries in order to export sugar to the United States is that they become “net sugar exporters”, if this requirement is not fulfilled, then they are not allowed to export under the FTAs (USTR, 2015).

This study is focused on the effects of FTAs in the sugar market between the United States and some western hemisphere countries. Since the main restriction to sugar trade with the United States is the TRQ, the FTAs and the TRQs are going to be separately evaluated, having as premise that TRQs are always included in the negotiations of the FTAs.

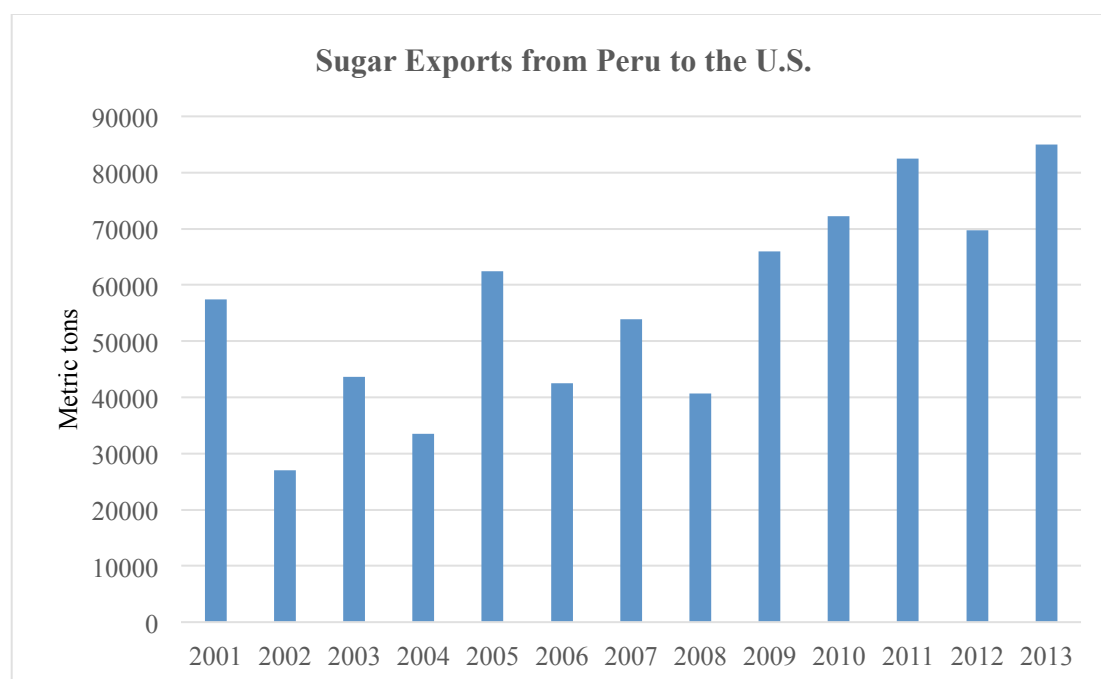


Figure 9. Sugar exports from Peru to the U.S.

### **Tariff Rate Quotas (TRQ)**

As required in the 2002 Farm Security and Rural Investment (FSRI), the U.S. government employs several tools to operate the U.S. sugar program at no net cost to taxpayers. Those tools include a non-recourse loan program, TRQs and domestic marketing allotments. The actual 2014-2015 crop national sugar loan rate is 18.75 cents per pound for raw cane sugar and 24.09 cents per pound for refined beet sugar (USDA, 2015).

As mentioned before, the most relevant constraint to the U.S. sugar imports are the so-called TRQ that as its name indicates is a quota that the United States applies to sugar imports at a low or zero duty. The United States Trade Representatives annually establishes it according to the obligations that the United States has with the WTO.

The current obligation is 1,117,195 tons of raw sugar and 22,000 of refined sugar (USTR, 2015). Figure 10 shows the TRQ % allocation in 2014 for the western hemisphere countries included in this research. Around 54% of the total TRQ allocation is given to western hemisphere countries.

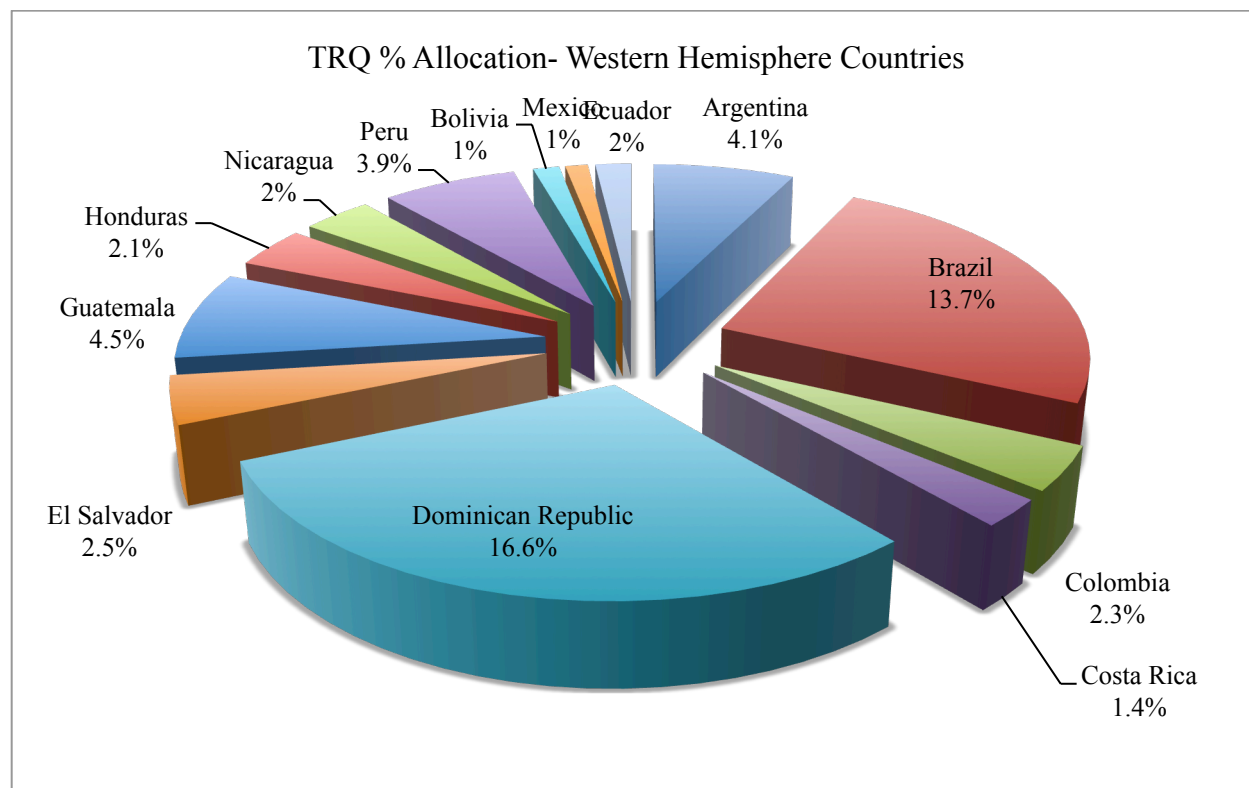


Figure 10. TRQ % Allocation for Western Hemisphere Countries

However, if a country decides to export more than the amount allowed by the allotted TRQ, that country faces a second-tier tariff that is a way higher tariff. According to the USDA, the in-quota tariff is equal to 0.625 cents per pound, but the over-quota tariff is 15.36 cents per pound for raw sugar and 16.21 cents per pound for refined sugar. Other U.S. initiatives to support the sugar industry are the Nonrecourse Loan Program and the Marketing Allotments. The Nonrecourse Loan program is a domestic price support that gives sugar cane and sugar beets producers a loan that guarantee a minimum price regardless of the market conditions. (Sugarcane.org, 2016). Loans are given generally for 9 month, and at the end of that period, producers decide whether to sell it to the government, as a way to pay the loan back, or sell it in the market if prices are favorable. The loan rate is US \$18.75 cents per pound for raw cane sugar and US \$24.09 cents per pound for refined beet sugar. Marketing allotments are domestic market controls that the USDA allocates annually, which define the amount of sugar each producer is allowed to sell in the market for each year. The allotments are assigned according to the State's and producers'

production history. Both initiatives define the amount of sugar produced in the United States which in turn influence the allocation of the TRQ, which is based on the U.S. demand each year. Although, intrinsically these measures define the total amount of the main variable in this research, they are not included in the model, but they are used as reference and starting point of definition of the TRQ.

## **Historical Background**

Since 1985 when the United States signed its first FTA with Israel, many countries expressed their desire to negotiate trade agreements with them. One of the main motivations was to introduce their products into one of the world's largest markets. However, it is also known that due to the advantage in terms of relative endowments, inexpensive labor force and growing economies that some of the western hemisphere countries are experimenting, the United States has observed these countries as an opportunity to increase their economic power in the world.

According to Anderson and Martin (2005) the Doha Round of trade negotiations in the World Trade Organization (WTO) has been labeled as the "development round", a key part was increasing developing countries' access developed-country markets. The Doha Round involved topics related to tariff reductions on agricultural products mainly because most of the developing countries are major agricultural exporters, in which agriculture has a large share on their GDP (Sexton et al, 2007). While it is true that many advances were made and most of the tariffs and distortions to trade in industrial goods were diminished during the five rounds of the WTO negotiations, the barriers in terms of agricultural goods stayed the same, and the complexity of the agricultural negotiations has been way more difficult than it is for other goods. Gibson et al. (2001) estimated that the average tariff on agriculture at the end of the Uruguay Round implementation period was about 60 percent (about 12 times the average tariff on industrial goods). There are still multiple barriers that each country adopts to protect their domestic production that finally impedes free trade of agricultural goods. When western hemisphere countries began negotiations with the United States, the rural sector and most of the people depending on agriculture reacted negatively and insisted being actively involved in the whole negotiation rounds. The main reason for their reaction is that the U.S. government supports, through different mechanisms, most of the agricultural products that make them more competitive in price in the world market and assuring them a fair pay for their production.

On the other hand, since 2002, when the ATPDEA was enacted, a preferential treatment was given to Colombia, Peru and Ecuador. The main objective of the agreement was boosting economic development through the supporting to legal crops as an alternative to peasants who were involved in illegal crops. The ATPDEA helped to

lighten the disastrous economic, political and social effects that arose in the 90s because of the proliferation of illegal crops in the member countries.

In terms of TRQs, since 1934, the United States established the first sugar quota in order to regulate their domestic supply. The department of agriculture made the allocation based on the market shares of 1925-1933. The system has only changed because of the independence of the Philippines, the Cuban Revolution and the Hawaiian statehood, among other facts that made a new allocation of the tariff. By 1974, when the sugar world prices were extremely high, the United States opened their market and allowed free trade. In 1982, the United States imposed again the sugar quota and based on trade between 1975 and 1981 (the so called “Olympic Market Share”), the United States ensured direct quotas for 40 countries without any substantial changes up until now (Andersen & Watson, 2011). In 1994, the TRQs were officially established during the Uruguay Round in the agreement on Agriculture in an effort from the United States to accomplish the obligations acquired with the General Agreement on Tariffs and Trade (GATT).

### **Problem Statement**

Efficient and low-cost sugar producers located in the western hemisphere in their relationship with the United States, experience the effects of a policy that prevent them to export as their productivity levels and costs allow them. A TRQ that is set by the United States based on trade history instead of productivity capacity is also affecting the countries that are receiving the benefits of the import quota. In a free trade scenario, without any barriers to trade, the panorama would be quite different: the countries with the largest sugar yield, that enjoy economies of scale due to their specialization would have the largest TRQ assigned. Added to this scheme, the United States has signed several FTAs that contain increments to the TRQs for each country.

Through the research of obtaining data on sugar imports, special features, certain characteristics and other singularities have been identified in order to further explain the U.S. sugar import's behavior. Once the factors have been identified, it is possible to quantify the effects of each of them on the total amount of sugar imports of the United States. A proper identification of the factors, plus a correct estimation of the effects on sugar imports, will contribute to future investigations in terms of analysis of trade of a particular commodity. This research attempts to identify the factors that affect the U.S. sugar imports and qualitatively analyze the consequences of the inefficiency of the TRQ.

## **Justification**

The impact of FTAs, productivity levels and sugar TRQs in trade between the United States and some western hemisphere countries are important for several reasons. These countries that strongly rely their economies on agriculture have been affected in their internal economies by the barriers to trade (mainly TRQs), plus the FTAs that the United States has signed with various countries around the world. Theoretically, FTAs increase the welfare of the member countries, since they are acquiring a more diverse amount of products at better prices, and they are also exporting their production, in which they have a comparative advantage, to most expanded markets. However, this is not a constant in all agreements, so in order to analyze trade patterns a deep research on factors that outweigh the effect of FTAs must be done.

On the other hand, an analysis of the effect of TRQs imposed for sugar imports to the United States is relevant because it has some sort of similar effect as the FTAs. The identification of the effect of FTAs plus the inclusion of the main barrier to sugar trade in the analysis is pertinent to see the real impact on trade flows on a specific-product research.

There are multiple sources of information and analysis regarding trade creation and trade diversion in many of the FTAs that have been signed during the last years. The FTAs have been deeply studied for each case and from different perspectives the impact and effect of FTAs vary in each case. The empirical work related to trade creation and trade diversion has given insights of possible factors affecting trade positively or negatively depending on the countries and some externalities; therefore, there is not a proven answer for each of the cases. Anderson and Wincoop (2003) affirmed that the key factor in the theoretical gravity equation is that trade between regions is determined by relative trade barriers and that those trade barriers depend on the bilateral barriers between them relative to average trade barriers that both regions face with all their trading partners.

This study exclusively concentrates on the FTAs of the United States with some western hemisphere countries. The FTAs are NAFTA, CAFTA-DR and the FTAs with Colombia and Peru. The objective to choose these countries and their respective FTAs is to understand how trade has been affected in terms of sugar between the United States and the selected countries and how a barrier such as a TRQ, (which mainly marks the U.S. sugar trade with the rest of the world) affects trade and captures almost all the effects of FTAs.

The selection of the countries was based on their production capacity and in their participation on the TRQs assigned by the United States.

It is relevant to make a study in this topic, since there are only few researches in gravity model applying to a single commodity and there are no studies in the special case of sugar. The variables used in this model are different, adapted to the specific case of sugar; however, the standard interpretation of trade of the gravity model still the same.

### **Study objective**

The objective of this study is to identify the impact on U.S. sugar imports, that different factors as the basic ones in the gravity model, TRQs and FTAs, among others, influence in the relationship of the United States and some western hemisphere countries. By identifying the degree in which each of the factors affect the amount of U.S. sugar imports; give some insights in the main forces that control this trade.

The main barrier to sugar trade, the TRQs, is going to be deeply analyzed, since its effect captures almost all the influence of other important variables that normally help to explain international trade.

### **Thesis organization**

This research will have four chapters divided as following: Chapter 1 includes the introduction, the problem statement, justification of the research and the objectives of the study. Chapter two introduces the theoretical and empirical model for international trade in the gravity model. Chapter three contains the applied methodology and an overall description of the economic theory that explains the model. Chapter four focuses on the variables used and the interpretation of each factor in the model and Chapter five finishes with the summary of the research, the conclusion and further studies to be done.

## CHAPTER 2. LITERATURE REVIEW

Regarding the relevance of trade among countries and the importance of the analysis of the different trade agreements between economies around the world, poses a very important question to analyze in order to know the impact of trade. It is important to clarify that there is not a formula that could determine the effects of trade in general; it will always change according to the countries' economics, politics, history and other more characteristics. Srivastava and Green (1986) concluded in their study that several factors are statistically significant related to the intensity of trade flows between nations; therefore it is a multidimensional phenomenon. One of the three questions made by Eichengreen and Irwin (1998) was about the degree of the impact and general welfare of trade liberalization on the different interest groups, such as the countries directly involved in regional agreements and the rest of the world.

From Jacob Viner (1951) who described how the welfare effects of a regional trade agreement (RTA) depended on the trade creation and trade diversion, economists have been interested in estimating these two effects (Magee, 2008). An important result from his analysis is that trade between countries would be beneficial or harmful to them depending upon the preferences that the agreements generate.

### The Standard Gravity Model

As the name of the model implies, the gravity model adapts the main principles of Newton's law of universal gravitation, in which two masses in the universe attract each other with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

In its most elementary and basic form, the gravity model could be expressed as

$$T_{ij} = C \frac{M_i^{\beta_1} M_j^{\beta_2}}{d_{ij}^{\beta_3}}$$

where  $T_{ij}$  is the trade flow between countries  $i$  and  $j$ ,  $C$  is a constant,  $M_i$  is the mass of the country of origin  $i$  (in bilateral trade flows, it is common to use the GDP of each country),  $M_j$  is the mass of the country of destination  $j$ ,  $d_{ij}$  is the distance between the countries  $i$  and  $j$ ;  $\beta_1$  is the potential to generate flows,  $\beta_2$  is the potential to attract flows and  $\beta_3$  represents impediments to trade due to the distance costs.

The gravity model has performed remarkably well as an empirical framework for measuring the impact of regional integration arrangements (Grant & Lambert, 2005). Researches have proved to show reliable results and a

considerable amount of studies have accepted the importance of the gravity model in order to identify the main factors that affect international trade.

The first adaptation of Newton's law in the international trade field was independently made by Tinbergen (1962) and Pöyhönen (1963). They concluded that the amount of trade between a pair of countries increases as their income increases and decreases by their geographical distance. By the same time, Pulliainen (1963) included more variables that could affect positively or negatively the trade flow model. After these two studies the model was officially known as the Gravity Model.

Later on, Linnemann (1966) enriched the model by adding key variables, such as population, relative factor endowments, resistance factors to trade, economic distance and trade preferences. His study was based on trading patterns on 80 nations in which no communist country was included. The variables that he used to explain trade were population, GNP (in order to include an economic measure), distance between the trading countries and a preferential trade variable. For the dummy preferential trade variable he used the information related to the former colonial ties and found that all the variables contributed to explain both import and export volumes. Further in his study, he contemplated an additional variable that considered the commodity composition of trade. His conclusion on this topic was that homogeneous productions among countries prevent trade, while differentiated production enhance trade between nations. Another important contribution from Linneman was the importance of having similar cultural backgrounds, which resulted to be positively related to trade; which indicates that differences in culture among countries inhibit trade between them. The Linneman's model was used by Aitken (1973); Geraci and Prewo (1977), who found that common language and preferential trading group membership have a significant impact on trade; and Kolhagen (1978), who included the negative effect on trade because of the inclusion of the volatility of the exchange rate; Anderson (1979) made the first attempt to assume product differentiation (the Armington assumption); Abrams (1980) and Sapir (1981), enriched the model as well. Srivastava and Green (1986) evaluated different aspects that could influence trade among countries, so in a real case study in which they included 45 exporter countries and 82 importing countries they used the same basic variables of the standard gravity model and added three more variables in an attempt to capture cultural similarities. The new variables that they included were political instability, cultural similarities (such as religion, language and colonial heritage) and membership in a particular economic union. The result was that political instability influenced on exports but not on imports; while the cultural similarities appeared to have greater effects on bilateral trade than it was to have a membership on an



economic union. It is important to notice that given that they were one of the first to provide independent measures for individual product categories (an extension of Linneman analysis), their research showed that the variables included have greater explanatory power on manufactured goods than on food and raw materials.

Thursby & Thursby (1987) replaced the total population of the member countries, to the absolute per capita income, and Rebecca (1989), in her study about the U.S. bilateral trade included economic and political variables and she excluded price and exchange rate variables.

### **A Gravity Model in Agricultural Trade**

Today, the inclusion of agricultural products on international trade, which each day takes a larger importance in the world's economy, has been influenced by national agricultural policies, which is increasing in output, import protection, and export expansion (Dascal et al, 2002). Taking into account that in the agricultural field there is a combination of economic forces from the origin and from the destination and other forces that help to enhance or prevent trading from the origin to the destination, a gravity model is appropriate to make a proper analysis.

Since 1990 some empirical contributions have been made, the real effects of the FTAs on agri-food products has not been rigorously investigated. Srivastava & Green (1986) made an extension to Linneman's analysis in which they provided further analysis on product differentiation by giving independent measures for individual product categories, which was a first approach to individually evaluate each products or sector. Their study was able to account for the commodity composition of trade between nations and it extended the gravity model by determining whether the identified factors are better at explaining trade flows in some categories than in others (Srivastava & Green, 1986).

One important contribution in terms of agricultural trade flows is what Koo et al. (2006) focused on. They utilized the gravity model on international trade but directly applied to agricultural trade, which include some important variables that affect agricultural trade flows. They included the basic gravity variables, GDP, distance between the economic centers and a set of dummy variable that captures the trade creation effects (when both countries are members of a FTA), another one for the trade diversion effects (when only one country is member of an FTA and the other is not), sharing of a common border, colonial ties, common language, relative factor of endowments and other variables related to monetary factors. An important contribution to the agricultural field in terms of enriching the gravity model is remarkable since the GDP (income) and the FTAs (all the dummy variables

related to FTAs) don't depend at all on the volume of agricultural trade flows, hence it is not expected endogeneity in the model. The final result of their research is that overall FTAs have a positive effect (trade creation) on the member countries, and to a lesser extent to no-member countries.

The gravity model they suggested has the following form:

$$X_{ij} = a_1 + a_2y_i + a_3y_j + a_4d_{ij} + a_5PTAc_{ij} + a_6PTAd_{ij} + a_7S_{ij} + e_{ij}$$

in which the bilateral trade flow between countries i and j is the dependent variable and is explained by the following independent variables:  $y_i$  country's i GDP;  $y_j$  country's j GDP;  $d_{ij}$ , which is the distance between country i and country j;  $PTAc_{ij}$  is a dummy for the trade creation effect and  $PTAd_{ij}$  is the dummy for the trade diversion effect (when one of the countries is not a member of the economic union);  $S_{ij}$  is a variable that includes other factors that may affect trade flow between a pair of countries; and  $e_{ij}$  is the error term.

Grant & Lambert (2008) demonstrated that FTAs effects on members' trade depend fundamentally on whether the analysis focuses on agricultural or non-agricultural sectors, on the particular agreement analyzed, and on the length of the phase-in period that characterized almost all FTAs. Their conclusion is relevant to this research, since sugar is the core agricultural product to be analyzed under the scope of the international trade and the FTAs. Lambert & McKoy (2009) showed through analyzing the effects of various FTAs in different periods of time, that membership in FTAs generally increases agricultural and food trade between countries. It is also true that it is necessary not only to evaluate the pair of countries that are going to be studied and their current political, financial and historical backgrounds, but also it is needful to evaluate what kind of product is including in the research because it will let to add, remove or reorganize the variables according to their specific requirement or status.

### **A Single-Commodity Gravity Model**

Since this research is based on sugar cane, a commodity-specific gravity model is use to evaluate trade flows between a pair of trade partners. Unlike the gravity model of aggregate goods trade, the single-commodity gravity model can include precise factors and characteristics attained to the specific commodity, which makes the variable's interpretation clearer.

Almost every study has been made related to trade flow between economic blocs and in a macro-level way in which they don't make a special distinction on commodities. However, empirical literature has demonstrated that the gravity model can be precisely applied to a single commodity study. Phren & Brümmer (2011) established that

single commodity gravity trade model is in the focus of interest in the analysis of gravity models, since the economic effects of policies have their primarily effects on specific commodities. Therefore, they suggested that it is statistically more appropriate to disaggregate data and then to aggregate it again in the corresponding micro-level results than to do the analysis based on an aggregate macro-level. However, little research has been conducted concerning the applicability of a real commodity under the gravity model, and under the author's knowledge, none has been made in terms of sugar cane. A research evaluating the trade creation and the trade diversion of sugar imports from Mexico under NAFTA was made by Devadoss et al, (1995), in which they predicted the potential effects of sugar trade reforms on production, consumption and prices and the resulting implications of U.S. sugar imports from Mexico and other countries. Instead of using a gravity model to evaluate the trade creation and diversion effects, they quantified them through a theoretical analysis of economic integration, in which they suggested the benefits and detriments for producers and consumers in both countries.

Koo et al, (1994), showed a particular commodity gravity model with meat trade in which a panel data was used and concluded that trade policies must be a variable included in every single commodity gravity model and that the exchange rate are one of the most important factors affecting trade flows. Dascal et al, (2002) made an analysis regarding wine trade in the EU and proved that the gravity model is the best theoretical framework to combine all the variables that they introduced in the model. Eita & Jordaan (2007) based their research on South African wood's exports capacity showed that distance was not significant in their model, that not all trade agreements encourage trade flows between the member countries and that language promotes wood exports. Another research was made by Tamini et al, (2010) in which they included a processed commodity such as the bovine meat and a primary one such as cattle and created a theoretical model accounting for vertical linkage between both products. They also proposed different policy simulations in order to analyze the possible effects on beef and cattle market.

## CHAPTER 3. METHODOLOGY

### Gravity Model Form and Function

The log-linear form is the most utilized functional form for the gravity model. Anderson (1979) proposed the log-linear specification, which allows interpreting the coefficients as elasticities. Later on, additional contributions showed up to improve the model, which resulted in significant variables to the basic form of the gravity model. Some of later contributions came from Bergstrand (1989) who associated the gravity equation with simple monopolistic competition model; Eichengreen & Irwin (1998) concluded that countries with a trading history with each other –whether for reasons related to politics, policies, or other factors- generally continue doing so; Deardorff (1998) showed that the gravity model could be justified from standard trade theories such as the Ricardian and Heckscher-Ohlin models; and Anderson & Wincoop (2001) included multilateral resistance variables.

The gravity model has been used to explain different effects on international trade and to measure the impact of the variables that affect trade between countries. Some of the variables that have been included in the gravity model in order to explain trade between a pair of countries are the barriers to trade, such as the TRQs, and the participation on FTAs. Wall (1999) provided estimates of the effect of the U.S. protectionism on trade and included an interpretation of the general welfare effect; Soloaga & Winters (1999) specifically examined the effects of the Preferential Trade Area (PTA) on trade. Breuss & Egger (1999) and Egger (2000) contributed in the improvement of the econometric specification of the model and, Lião & Venables (1999) promoted the amelioration of the gravity model by contributing to a better calculation of the distance variable.

The gravity equation indicates that the volume of exports of one country to another is a function of their incomes (GDPs), the population, the distance between their economical centers and a set of dummy variables.

The gravity model has the following specification:

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

where  $X_{ij}$  is the amount of trade flow from country  $i$  to country  $j$ , which is a function of  $Y_i$  and  $Y_j$  that represent the GDP of the importer / exporter country;  $D_{ij}$  which measures the distance between the main economic centers of the countries;  $N_i$  and  $N_j$  that represent the population of the importer / exporter country;  $F_{ij}$  includes all the other factors that enhance or prevent trade; and  $e$  is the error term.

Summary (1989) and McCallum (1995), among other authors used GDP in their gravity model in order to represent the income of the exporting and importing countries. The GDP represents the productivity capacity of the exporting country and the acquisitive capacity of the importing country (Dascal et al, 2002). Bougheas et al (1999), affirmed that a higher level of income in the exporting country indicates a higher level of production which increases the availability of products for export, while a high level of income in the importing country suggests higher imports. The expected relation between trade and income is positive, since the larger the productivity and acquisitive capacity, the larger the trade between the pair of countries.

Bergstrand (1989), Sanso et al. (1993), and Tamirisa (1999), among other authors employed the GDP per capita. Linder (1961) suggested that a pair of countries with similar GDPs per capita would have similar demands; and Gross & Gociarz (1996) affirmed that per capita output is used to take into account the idea that as income increases, the share of tradables in overall income might increase; i.e., for a given overall income a country with a higher income per capita would trade more intensively than a poorer country.

The inclusion and variation on distance  $D_{ij}$  in the gravity model has been object of some debate. Geraci & Prewo (1977) considered that the distance has some limitations and was not recommended being included in the model; and more recently Bougheas (1999) demonstrated that transport costs are a function not only of distance but also of public infrastructure.

Population of both countries represented by the variable  $N_i$  and  $N_j$ . The economic theory says that the greater the population, the greater will be the demand for food and services. In such case we expected that population is positively related to trade; however, this coefficient also tend to be negative since it is a measure of a country's size, and it is also true that the larger the countries, the greater their capacity to diversify their activities in different ways, therefore, they tend to be more protective of their domestic production.

Other factors, represented by the coefficient  $F_{ij}$ , contain other possible variables that may affect trade between the pair of countries. It will include some dummy variables that have been proposed by different authors described above that will augments and enriches the model.

### **Theoretical between Economic Theory and the Gravity Model**

Economic theories have tried to explain the main factors that affect trade among countries. Beginning with the Adam Smith's model in which the absolute advantage was the way for a country to be competitive in the international market; following by David Ricardo's theory that identified industry specialization and the differences

in technology and natural resources as the main factor of trade advantages; continuing with the Heckscher-Ohlin model that developed the theory in which the international trade is determined by the relative in their factors of endowments; among other theories.

The gravity model attempts to estimate the pattern of international trade by the utilization of determinant factors such as income (measured by the GDP's of both countries), transaction cost (defined by the dummies variables that are used as proxies of transportation cost, cultural differences and distance between both countries), population and FTAs between both economies. Countries that have higher income tends to trade more, which means that stronger economies tend to trade more than disparate economies and it happens also among countries with similarities in other aspects, such as language and common borders. Distance, which is other of the important variables that is taking into account in the gravity model shows that to the extent that the countries are far to each other, an increasing in transportation cost will be notable and will decrease trade among countries. In terms of Regional Trade Agreements, they facilitate trade because it will reduce the transaction costs that trade may carry. A decrease on duties, a decrease on tariffs and the agreement of trade on the main commodities for each of the countries notably reduce trade transaction costs. The effects of FTAs could be evaluated in the short-run and in the long run. In the short-run the benefits are immediate and evident; however, in the long run the effects have to be determined by the degree in which the diversion effects outweigh more or less than the trade creation effects.

An important way to understand the effects of some of the important factors, such as income and transaction cost, is explained by the economic under the framework of the partial equilibrium model. The impact of income on trade has to be evaluated from two different perspectives: From the importing country and for the exporting country.

### **Impact of Income on Trade (Importing Country)**

Figure 11 shows the effects that a change in income produces in an importing country evaluated in the framework of the partial equilibrium model. Assuming we are evaluating a small country, the world price,  $P_w$ , is fixed and it results to be equal to  $ES_w$ , which means the world's excess supply. As income is increased on the importing country, its demand will move from  $D_0$  to  $D_1$  and at the same time it moves the excess of demand curve from  $ED_0$  to  $ED_1$ . As a result of this change in income and the shifts of the curves, the quantity demanded increases, provoking an increase of the quantity supplied by the world from  $Q_{world0}$  to  $Q_{world1}$ , while the quantity consumed in the importing country increased from  $Q_0$  to  $Q_1$ .

On the other hand, if income is decreased on the importing country, the demand curve will move from  $D_0$  to  $D_2$  and it will cause a shift in the excess of demand curve from  $ED_0$  to  $ED_2$ . Due to the decrease in income, the importing country decreases their consumption from  $Q_0$  to  $Q_2$  and the amount supplied by the world will also fall from  $Q_{world0}$  to  $Q_{world2}$ .

In conclusion, when income on an importing country increases, the quantity demanded in the country and the quantity supplied by the world increase. In contrast, when income on the importing country decreases, the quantity demanded in the country and the quantity supplied by the world decreases as well.

The application of this principle into the Gravity Model is that an increase in the factor that counts for income should be positive, showing that as income increase in the importing country, the more trade will exist among both countries. If a decrease on income in the importing country occurs, there will be a notable decrease on trade between both countries due to the decrease in purchasing power of the importing country.

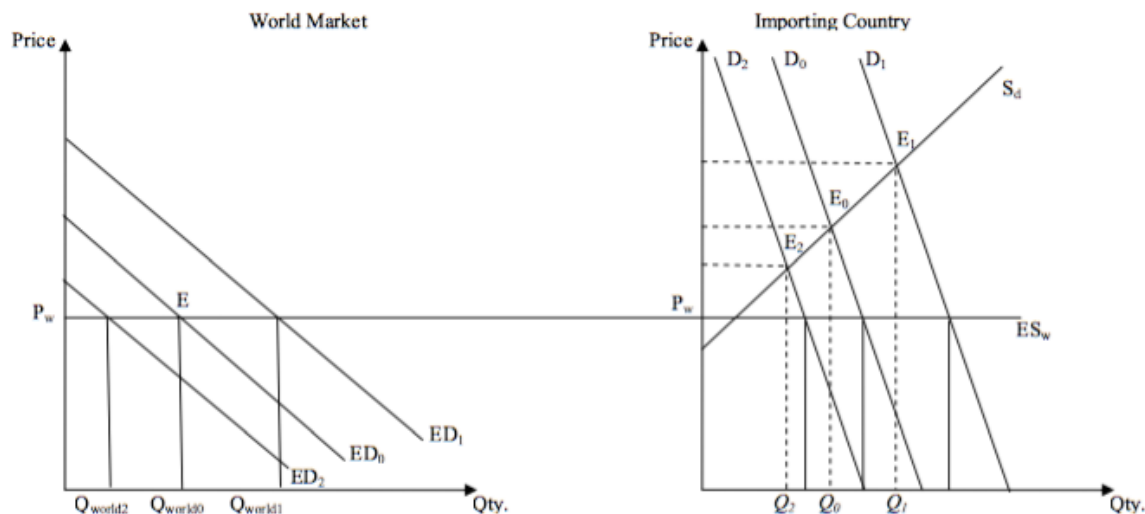


Figure 11. Impact of Income on Trade (Importing Country)

#### Impact of Income on Trade (Exporting Country)

In Figure 12 it is possible to observe the effects of an increase and a decrease on income of a exporting country on the domestic and the world market. The initial point will be on the equilibrium point  $E_0$  and  $Q_{world0}$  in the world market. When a rise on income occurs, the demand curve  $D_0$  moves to the right to  $D_1$ , showing an increase in the quantity of domestic demand  $Q_0$  to  $Q_1$ . Due to this increase in income the excess supply curve moves to the left from  $ES_0$  to  $ES_1$ , since there is less amount of quantity supplied by the exporter from  $Q_{world0}$  to  $Q_{world1}$ .

If the situation is of a decrease on the exporter income, the demand will move to the left from  $D_0$  to  $D_2$ , but will move to the right the excess supply curve from  $ES_0$  to  $ES_2$  since the domestic market is consuming less, there is

more quantity disposed for world consumption. The quantity supplied for the rest of the world moves from  $Q_{\text{world0}}$  to  $Q_{\text{world2}}$ .

The application to the gravity model of this principle is that as the exporting country increases its income, it results in an increase in demand of the country. An increase of the demand in the domestic market increments the price and leads to an increase of the price in the world market. When exporters perceive higher revenues for their production (due to higher prices), they tend to increase their production of the specified commodity. The increase of production that arises from the increase on income of the exporter country will increase the bilateral trade between both countries. Due to the increase of the price for the domestic market, this will demand less and will result in a larger excess of demand that means greater amount of quantity supplied to the world.

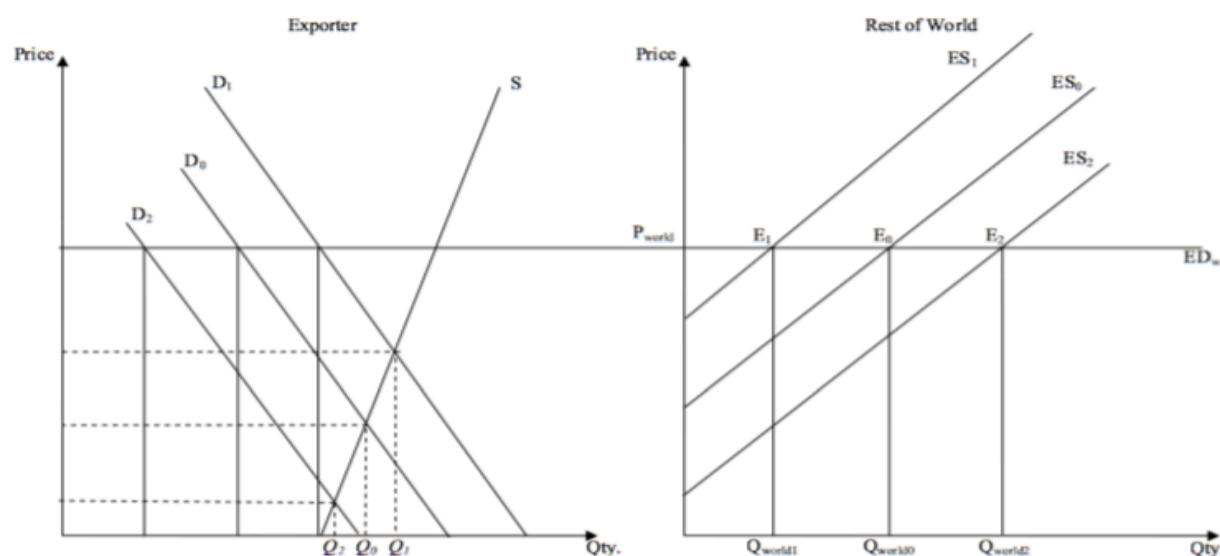


Figure 12. Impact of Income on Trade (Exporting Country)

### Effects of Transaction Costs on Trade

When using the term “transaction costs” in the framework of the gravity model, it refers to all the costs that are associated with transportation, colonial ties, language and other variables that may interfere in trade among countries. Transactional costs might significantly make a difference in the decision process of a country to trade with another. Greater distance among countries will definitely increase the cost of trade; likewise, shorter distance decreases these costs. Figure 13 shows the leftward shift on the excess supply curve from  $ES_0$  to  $ES_1$  for the rest of the world. In terms of quantity, the increase in prices due to the increase in transactional costs lead to a decrease in quantity demanded from the world from  $Q_{\text{world0}}$  to  $Q_{\text{world2}}$ , which at the end means reduction on trade. In Figure 13



it is possible to notice the shift on the excess supply  $ES_0$  to  $ES_2$ , showing a decrease of prices due to a decrease in transactional cost from a decrease in distance between the countries. The world quantity demanded increases due to the decrease in prices leaded by the decrease in transactional costs, moving the demand from  $Q_{wld0}$  to  $Q_{wld1}$ . Given this relationship between the transaction costs and the excess supply and the quantity demanded, a negative sign is expected in the distance variable ( $D_{ij}$ ) of the gravity model, in which an increase in distance leads to lowered the amount of trade among countries.

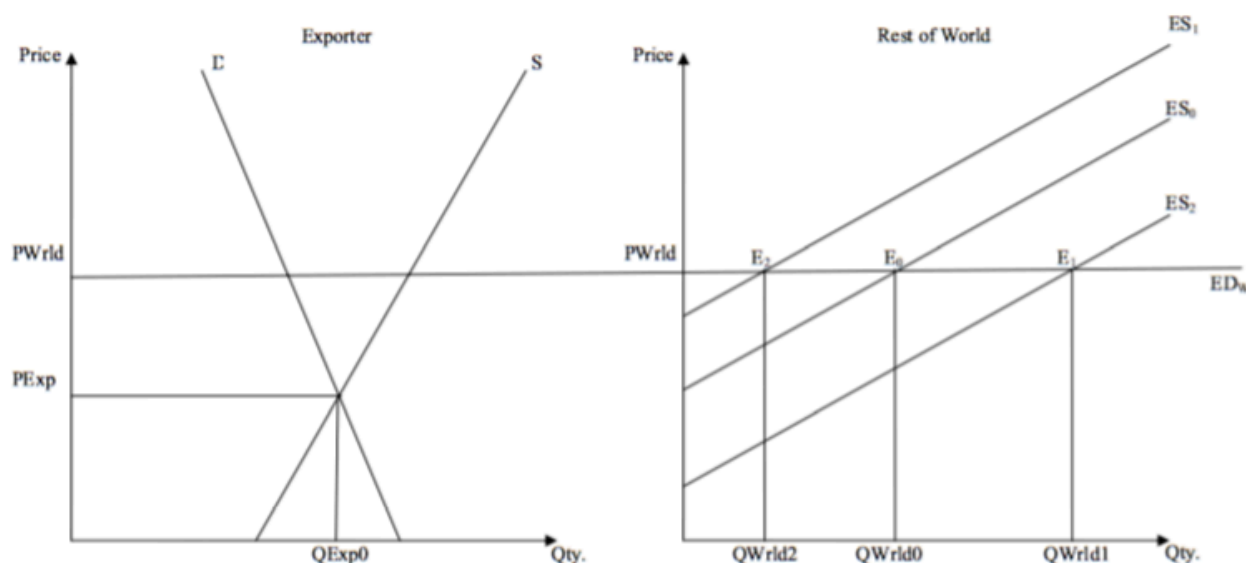


Figure 13. Effects of Transaction Costs on Trade

#### Effects of Economic Integration: Trade creation and Diversion Effects

Viner (1951) pointed out that regional trade agreements could be beneficial or harmful to the participating countries because the preferential nature of these trade deals generates both trade creation and trade diversion. Economic integration means preferential agreements, through the lowering of transactional costs among member countries as opposed to nonmember countries. International trade is constantly changing and its dynamic requires recurrent and individual evaluation of the agreements, the member countries, preference within them and the trade creation or diversion effects. When a pair of countries are in the same preferential agreement they are enjoying the benefits of moving toward free trade (trade creation); however, nonmember countries suffer the diversion effects of trade agreements because although their costs are lower, the external tariff makes them having higher total costs. As Viner (1951) defined, trade creation happens when the domestic production of a particular commodity is outsourced

to a member that is able to produce it at a lower cost. The movement that occurs in the production process enhances the welfare effects to the members of the agreements. On the other hand, trade diversion occurs when the shift on production is away from a nonmember country to a member producing one, whose production costs are higher to those of the nonmember producing country. This kind of shifts could reduce welfare since it represents a movement away of an efficient free-trade allocation.

Figures 14 and 15 represent the effects of trade creation and trade diversion of RTAs and the subsequent effects on trade flows. Initially, before any integration, the price of the good in country j was  $P_j(P_i + \text{tariff})$ . When the integration between countries i and j happens, the tariff is removed and country j is now able to import (Qty4-Qty1), different from (Qty3-Qty2) from country i. In this scenario Qty4-Qty3 represents the increase in consumption while Q2-Q1 reflects the displacement of the domestic production. In general, trade creation increases the welfare of the member countries by decreasing the prices of the item/commodity since there are more cost-efficient producing countries. The trade effect could be seen as the sum of areas b and d.

Before the integration of country j with country i, j has an import tariff for a good. The price of the good in country j was  $P_j = P_k(1+t)$ , where  $P_k$  represents country K's tariff. When integration hasn't happened yet, country j imported from country k (Q3-Q2). When country j and country i began integration, country j imported (Q4-Q1) with no tariffs from country B. In this case, integration between country j and i diverted trade and relegating country K's production. In the case of trade diversion, the trade effect could be seen by the area b and d, due to the decrease in price for country's j customers and area e, which represents the lost tariff revenues from country A that is not perceived any more from its consumers. There are many consequences of free trade that affect domestic producers: Since there are more imports with competitive prices, there is a contraction in production that leads to a decrease in the price of their products, that will reduce the producer surplus, and this decline discourage production that will reflect a decrease in profit and in employment rates. Such situation allows the opportunity for domestic producers to find ways to compete through different mechanisms, such as specialization, innovation and by generating new ways to effectively reduce costs. Monopoly tends to be reduced because of the new competitive environment and also firms are encouraged to export their production to new markets. The possibility of specialization could also generate economies of scale in specific goods. Some other benefits of free trade are related to the mobilization of capital (investments), people and services. Greater investments in foreign countries, more specialized work force and the facility of trade flow of multiple commodities are only few of the advantages of free trade. The ability of moving

goods or services from places in which there is excess of certain good to places in which that same good is scarce, is definitely a sign of better economic situation and a general welfare effect for consumers.

Some other effects of integration are related to innovation on the internal infrastructure. An economy that wants to competitively face a FTA must have the means to ensure to exporters, importers and domestic producers, transportation for their production from the plants to their final destiny within the country. A country must invest in technology to update their management systems, in machineries and in all the processes that international trade imposed in an economy.

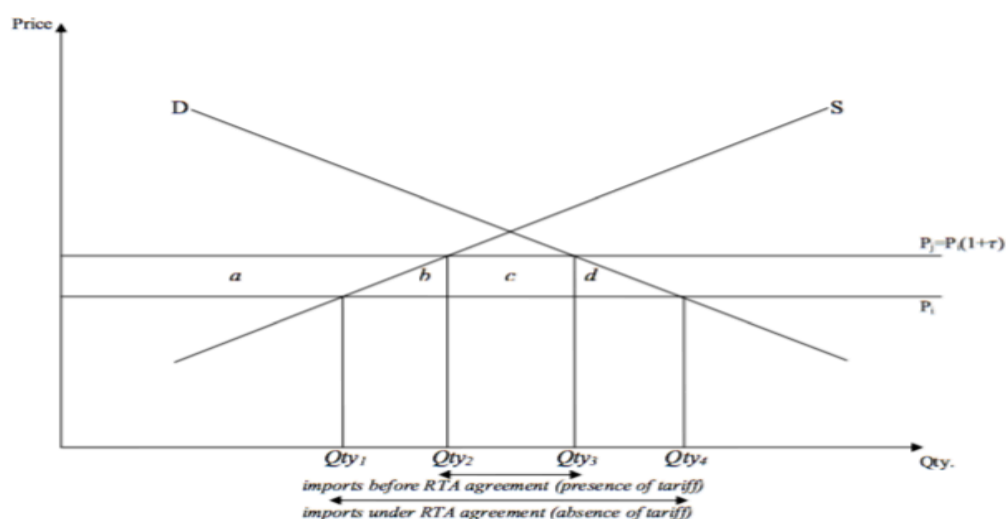


Figure 14. Effects of Trade Creation

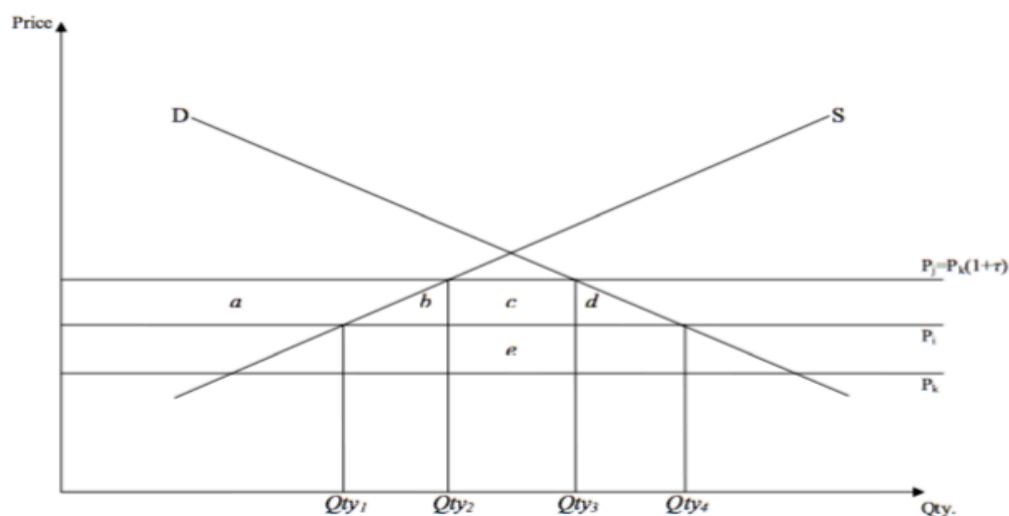


Figure 15. Effects of Trade Diversion

## CHAPTER 4. EMPIRICAL ANALYSIS

### Estimation Techniques

According to the theoretical literature regarding the gravity model, the model employed in this study will have the log - log form, using the OLS regression analysis. The augmented gravity model is the general model with additional variables such as a dummy variable for borders (1=if share borders, 0 otherwise) and distance (using the “great circle” calculations between capital cities). In order to analyze the effects of the FTAs on sugar trade between the United States and some western hemisphere countries, a dummy variable that accounts for it is included (1=if FTA with the United States, 0 otherwise). Random effects in a panel data is used since it involves frequently measurements that vary over time.

### Gravity Model Equation

The gravity model for the specific case of raw cane sugar imports from the United States and some western hemisphere countries has the following form:

$$\ln X_{ij} = \alpha_i + \beta_1 \ln SsizeProd_{ij} + \beta_2 Endow_{ij} + \beta_3 \ln Yield_i + \beta_4 \ln TRQ_i + \beta_5 \ln Dist_{ij} + \beta_6 Border_{ij} + \beta_7 FTA_{ij} + e_{ij}$$

where  $\ln X_{ij}$  represents the imports from country  $i$  to  $j$ ,  $\alpha_i$  is the intercept term,  $\ln(SsizeProd_{ij})$ , the log for the proxy in similarity of production size,  $Endow$ , accounts for relative factor endowments, production per capita,  $\ln(Yield_i)$ , the log of country's  $i$  sugar yield,  $\ln(TRQ)$ , the log of the tariff rate quota that is assigned to each country,  $\ln(Dist_{ij})$  is the log of the distance between countries  $i$  and  $j$ ,  $Border$  is a dummy variable that accounts if country  $i$  and  $j$  share borders (1=share borders, 0 otherwise),  $FTA$  is a dummy variable accounting for free trade agreements between countries  $i$  and  $j$  (1=if there is an FTA and 0 otherwise), and  $e_{ij}$  is the normally distributed error terms.

### The Data

The empirical analysis for this study contains information from 1986 to 2013, a balanced panel of annual observations covers 13 western hemisphere countries (Argentina, Bolivia, Brazil, Colombia, Costa Rica, the Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Peru), which were chosen according to their sugar trading relevance with the United States. The dataset consists of 364 observations. The data related to imports and sugar yield was obtained from the statistic division of the Food and Agriculture Organization of the United Nations (FAOSTAT). The GDP was obtained from the World Bank database and the

population from the U.S. Census Bureau. The TRQ was taken from the Office of the United States Trade Representative (USTR) database and distance was taken from a web page that shows the great circle distance between economic centers of each country. Although not specifically included as variables, four FTAs were analyzed and the information regarding the signature of them and the countries included were obtained from the USTR.

### The Variables

The logarithmic form for total raw sugar imports, given in tons, from the United States is the dependent variable in this study. The main explanatory variables are:

- *SsizeProd*: shows a measure of sugar's production similarities between a pair of countries. The values will be among  $-\infty$ , which will represent perfect dissimilarity, to  $-0.69$ , which exhibits perfect similarity. It is defined as:

$$SsizeProd_{ij} = \ln \left( 1 - \left( \frac{Prod_i}{Prod_i + Prod_j} \right)^2 - \left( \frac{Prod_j}{Prod_i + Prod_j} \right)^2 \right)$$

- a). An example of perfect similarities in overall production levels would be:

$$SsizeProd_{ij} = \ln \left( 1 - \left( \frac{5,000}{10,000} \right)^2 - \left( \frac{5,000}{10,000} \right)^2 \right)$$

$$SsizeProd_{ij} = \ln \left( 1 - \left( \frac{1}{4} \right)^2 - \left( \frac{1}{4} \right)^2 \right)$$

$$SsizeProd_{ij} = \ln \left( \frac{1}{2} \right)$$

$$SsizeProd_{ij} = -0.69$$

- b). An example of dissimilarities in which country i is larger producer than j would be:

$$SsizeProd_{ij} = \ln \left( 1 - \left( \frac{10,000}{14,000} \right)^2 - \left( \frac{4,000}{14,000} \right)^2 \right)$$

$$SsizeProd_{ij} = \ln(0.409)$$

$$SsizeProd_{ij} = -0.89.$$

In the case that country j's production is larger, the coefficient will also tend to  $-\infty$ . The closer to  $-0.69$ , the more similar the country's production capacities are, the farther from  $-0.69$ , the more different both countries are.

- *Endow*: Is a measure of the endowments of each country. The proxy utilized is sugar production per capita. According to Martinez & Nowak (2003) this variable attempts to find a possible Linder effect associated with sugar production, instead of country's income. The variable is defined as:

$$Endow_{ij} = \left( \ln \frac{Prod_i}{Pop_i} - \ln \frac{Prod_j}{Pop_j} \right)$$

a). An example in which country i represents larger production per capita:

$$\begin{aligned} Endow_{ij} &= \left( \ln \frac{1,160}{31,145} - \ln \frac{2,845}{240,133} \right) \\ Endow_{ij} &= (\ln (0,037) - \ln (0,011)) \\ Endow_{ij} &= (-3,29 - (-4,50)) \\ Endow_{ij} &= 1,21 \end{aligned}$$

b). An example in which country j represents larger production per capita:

$$\begin{aligned} Endow_{ij} &= \left( \ln \frac{2,845}{240,133} - \ln \frac{1,160}{31,145} \right) \\ Endow_{ij} &= (\ln (0,011) - \ln (0,037)) \\ Endow_{ij} &= (-4,50 - (-3,29)) \\ Endow_{ij} &= -1,21 \end{aligned}$$

c). An example in which both country have similar production per capita:

$$\begin{aligned} Endow_{ij} &= \left( \ln \frac{2,845}{240,133} - \ln \frac{3,000}{245,000} \right) \\ Endow_{ij} &= (\ln (0,011) - \ln (0,012)) \\ Endow_{ij} &= (-4,50 - (-4,42)) \\ Endow_{ij} &= -0,08 \end{aligned}$$

When there are similarities among endowments of a pair of countries, the coefficient tends to get closer to zero. When there are a lot of dissimilarities among them, the coefficient tends to be different from zero and the analysis goes in terms of the sign. If the sign were positive, it would suggest inter-industry structure; however, if the sign is negative it would suggest intra-industry structure.

Other variables that explain the amount of sugar imports will depend on the production capacity of each of the exporter countries. The variables are measured as follow: sugar yield is given in hg/ha, production is given in tons, the sugar TRQ assigned to each country is measured in metric tons (MTRV) and the distance between economic centers in each country is given in miles. The two dummy variables that accounts for *FTA* and *Border* were previously described. For the variable that accounts for distance, the capital cities selected where (Washington, Buenos Aires, La Paz, Sao Paulo, Bogota, San Salvador, Quito, Guatemala City, Managua, San Jose, Lima, Mexico City, Tegucigalpa and Santo Domingo).

Table 1 summarizes the description of each variable, the expected sign and the source from which each of the variables was taken.

Table 1. Variable's Definition and Data Source

Variable	Description	Expected sign	Source
$\ln X_{ij}$	The logarithm of sugar imports to the U.S.		FAOSTAT
$a_i$	Intercept term	(+/-)	
$\ln S_{sizeProd_{ij}}$	The logarithm of sugar production similarities	(+/-)	FAOSTAT
$Endow_i$	Sugar production per capita / endowment	(+/-)	FAOSTAT/ U.S. Census Bureau
$\ln Yield_i$	The logarithm of sugar yield of country i	(+)	FAOSTAT
$\ln TRQ_i$	The logarithm of the sugar import quota of the U.S.	(+)	USTR
$\ln Dist_{ij}$	The logarithm of distance between countries.	(-)	Web page. <a href="http://www.timeanddate.com">www.timeanddate.com</a>
$Border_{ij}$	A dummy variable that accounts for border sharing	(+)	CIA World Factbook
$FTA_{ij}$	A dummy variable that accounts for FTA between a pair of countries.	(+)	USTR

## Results

The main objective of this thesis is to analyze and to estimate the extent in which certain factors affect sugar trade between the United States and some western hemisphere producing countries. The factors that the gravity model includes in order to have a better approach to understand international trade, and the inclusion of more variables for the study of a specific commodity, are the basis to analyze the results of the present thesis. This section analyzes the gravity model, the variables included to augment the model and the influence of each of them on the total amount of imported sugar in the United States. The method applied to analyze the model is the Ordinary Least Square Regression, using STATA as the software mechanism.

Countries with larger productions tend to trade more among them, even more; countries that have similarities in their production capacity and in factor composition with the United States have shown exporting more to the US. Being part of a FTA and sharing a border with the United States were not found to be significant in the model. As it was expected, distance has a negative effect on sugar imports and the TRQ positively affects sugar trade with the United States.

The estimated OLS augmented gravity model is as follow:

$$\ln Imports_{ij} = -4.253 + 0.3250 \ln(S_{sizeProd_{ij}}) + 0.7096 Endow + 0.5653 \ln(Yield) + 0.8731 \ln(TRQ)$$

(S.E)      (2.06)      (0.20)      (0.16)      (0.13)      (0.04)

$$\begin{array}{ccc} -0.3896 \ln(\text{Dist}) & +0.7143 \text{ Border} & + 0.0504 \text{ FTA}_{ij} + e_{ij} \\ (0.22) & (0.57) & (0.18) \end{array}$$

Table 2 shows statistical information on the parameters. The results presented in this study were first tested for heteroskedasticity (Breusch-Pagan / Cook-Weisberg test), which was corrected by applying the robust standard errors. A Hausman test was applied in order to identify if the panel data was using either, fixed effects or random effects. Random effects were selected since the variation was assumed to be uncorrelated with the independent variables and also in order to keep the relevance of the time invariant variables.

The coefficients had the expected signs that go according to the economic theory and to the gravity model basis. U.S. sugar imports are positively affected by SsizeProd, which suggests that similarities in production levels increase trade; however it is not significant in the model. The coefficient *endow* is significant and has the expected sign, which suggests that similarities in the factors composition in the sugar production process enhance U.S. imports. As Krugman (1982) stated, that as countries become more similar, the trade between them will tend to become intra-industry in character. As it was stated before this variable is showing a possible Linder effect by demonstrating that similarities (in this specific case in terms of sugar production) induce both countries to trade more intensively with one another (Hallak, 2010). Since the sign is positive, it is showing the presence of an inter-industry trade structure, which suggests that the country with the greatest advantage exports the production in which they have advantages and import what they lack in their market. Sugar yield is statistically significant and its sign is the expected one. As sugar yield of the western hemisphere producing countries increases by 1%, the sugar imports increase by 0.56%. Distance had the expected sign but it is not significant in the model, which in this case is showing that the transactional costs related to transport costs are not affecting the amount of sugar imports to the United States. This result was somehow expected, since the TRQ was assigned independently of the location of the countries. Another variable that accounts as proxy for transactional costs is border, which has the expected positive sign, but it is not significant to explain the model. Many factors may interfere in this result, such as the relevance of other variables such as the TRQ and sugar yield. Even though, sharing border with a trading partner may decrease costs, it is also truth that in the special case of sugar, other factors that enhance and reduce trade proved to be weighted more in the model. Besides that, the only country included in this study that shares a border with the United States is Mexico. The FTAs normally supposed an increase on trade and in the model it generates a positive sign as it was expected, but turned to be not significant ( $p > 0.174$ ). An explanation for this result is given by the existence of the TRQ imposed by the United States years ago that limits sugar imports. During the negotiation rounds of FTAs with



the United States, sugar is one of the most delicate commodities and in the negotiations the most they can do is to gradually increase the TRQ for member countries within a FTA. Under this scenario, the effects of the FTAs are not seen as significant in the sugar industry in this study. The variable that accounts to measure the impact of the TRQs on sugar imports is significant and positive as expected. As the TRQ increases by 10%, the sugar import increases by 2.5%, holding all else constant. For what has been exposed before, related to the importance and relevance for sugar trade, the TRQ is the main variable in the U.S. sugar imports model.

Table 2. Coefficient Estimation

Variable	Estimate	S.E	t-value	p-value
Intercept	-4.25	2.064	-2.06	0.04*
ln(TRQ)	0.87	0.046	19.12	0,000***
Simsizeprod	0.33	0.207	1.57	0.117
Endow	0.71	0.165	4.3	0,000***
ln(SugarYield)	0.57	0.136	4.15	0,000***
ln(Distance)	-0.39	0.224	-1.74	0.083
Border	0.71	0.575	1.24	0.215
FTA	0.25	0.184	1.36	0.174
# of Obs.	364	*p<0.05		
R <sup>2</sup>	0.4925	**p<0.01		
F-value	0.00	***p<0.001		

## **CHAPTER 5. SUMMARY AND CONCLUSIONS**

### **Summary**

Sugar trade with the United States is extremely complicated due to the U.S. domestic producers demands and the internal policies they use to protect internal production. Some of the exporting countries are located in the western hemisphere and are efficient sugar producers that have exceptional production capacity and are relatively close to the U.S. market. However, other factors, such as the TRQ, have changed the sugar market trade. The distortion in this market is given if an efficient and large producing country is not included in the list of 40 countries that are allowed to export sugar through TRQs, and they have to face an over-quota tariff in order to export to the United States. For this specific case, the countries included are large sugar producers located in the western hemisphere.

The main objective of the study was accomplished in the sense of understanding the effects that the variables included in the proposed model have on the total amount of sugar imports to the United States. It is important to clarify that not all the quantity of sugar trade imported by the United States is captured by the variable that accounts for the TRQ, since countries are also allowed to export above the TRQ level. The more similar a country's sugar production capacity per capita is to the United States, the more trade will exist between them. Distance doesn't show to be significant in the model, demonstrating that transactional costs, in this case transportation costs, don't influence the final amount of sugar imports. The effects of trade creation and trade diversion effects on the sugar industry, in which there is an annual definition of the amount to be received in imports, make it very difficult to determine these effects. Given the latter policy, it is not possible to transfer the TRQ from one country to another. Under this scenario the effects of trade creation and diversion were not quantitatively analyzed in the model developed in this research. Results showed the expected positive sign for FTAs; however, the variable is not significant and doesn't help to explain the model. This result was not at all surprising, since the presence of TRQ in the sugar market evaporates trade gains from the FTAs.

### **Conclusions**

The factors that affect the U.S. sugar imports, according to the augmented gravity model used in this study, rely mostly on the production capacity of the exporters, the TRQ associated and similarities in production levels with the United States. The United States tends to trade more with countries that have similar sugar production per capita capacity, which generates a positive impact on total sugar imports. Sugar yield of the exporter is a determinant factor that increases sugar imports to the United States. According to the research, the TRQ plays a

major role. The model shows consistency with the theory and even more, the TRQ was the factor that weighted the most in explaining the total amount of sugar imports to the United States. The distance between the exporting countries and the United States, in this study, were not found to be significant in explaining the quantity of sugar imported by the United States. Overall, the results suggest that production capacity and TRQ are the variables that better explain the amount of sugar imports to the United States. Factors such as sharing borders, having a similar overall sugar production and having a FTA with the United States were not significant in explaining the model.

The gravity model in this paper correctly performs the objective of this study of evaluate and analyze the factors that affect U.S. sugar imports.

### **Further Study**

By analyzing and defining the main factors that affect imports from a specific country on a specific commodity, it would be useful to see if the addition of other variables that will augment the model. Also, with the time frame used, most of the FTAs had come into effect for less than 2 or 6 years, which didn't let the variable captures the real effect of trade preferences. Further studies could be done with additional data that captures the FTA's effects on imports. Another important analysis would be related to the special case of Mexico and its role of exporting all their sugar production capacity to the United States.

The importance of empirically evaluate trade of a specific commodity that shows trade barriers and internal protection, and adapts additional variables that may affect trade among economies is a good approach to deeply understand the interaction of the commodity on international markets.

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## **VITA**

Katherine Ramirez is originally from Bogota, Colombia. In 2011 she received her Bachelor in Science in Business Management. After receiving her degree, she worked as an intern in the commercial office of the Colombian Embassy located in Guatemala City, in which she was responsible of coordinating business meetings. She later accepted another internship position in Colombia at Siemens in the Human Resources Department and she ended up being the coordinator of the training department. She coordinated the trainings for the employees and she designed, along with other members of the department, the best courses that potentiate the employee's skills according to the company's vision and mission. She worked at Siemens for 3 years and later on, she decided to work on the agricultural business. She worked with the rural community in one of the most important agricultural areas in Colombia. Her job consisted in coordinating the agricultural workers that were not receiving a fair payment for their production, due to the lack of specific certifications, and advice them in order to get them. In 2014 she obtained an assistantship at LSU to pursue her Master of Science Degree in Agricultural Economics. She is a candidate to receive her master's degree on May 2016 and plans to begin work on her doctorate upon graduation.