A STUDY OF THE MEXICAN SUGAR INDUSTRY AND THE IMPACT OF THE NEW SUSPENSION AGREEMENT UNDER DIFFERENT MARKET STRUCTURES

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by

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The undersigned, appointed by the dean of the Graduate School, have examined the thesis entitled

A STUDY OF THE MEXICAN SUGAR INDUSTRY

AND THE IMPACT OF THE NEW SUSPENSION AGREEMENT

UNDER DIFFERENT MARKET STRUCTURES

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and hereby certify that, in their opinion, it is worthy of acceptance.

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Abstract

The aim of this thesis is to investigate the possibility of sugar industry collusion in Mexico, given government policy, and to assess the economic impact of the new trade restrictions on Mexican sugar exports under different market structures.

Government ownership of sugar mills and other policies have led people to believe that there is collusion in the Mexican sugar market. For this reason, the author decided to test for market concentration and the impact of the new trade policy under different market structures.

This thesis first examines the possibility of non-competitive behavior in the sugar industry in Mexico by testing for market integration and pass-through prices. A second analysis uses partial equilibrium models with different market structures, competitive and non-competitive exports.

Time series estimation results support the hypothesis that Mexican sugar market is integrated with international and domestic markets, so these results do not support the hypothesis of collusion. However, evidence is mixed given the different estimates of price penetration among markets and the delays in adjustments to price shocks. Partial equilibrium models show that the effect of the agreement has stronger implications in prices if there is collusion among exporters, leading to larger impacts on sugarcane area, sugar production and consumption in Mexico if there is collusion relative to the competitive market case.

Introduction

Exports of sugar from Mexico to the U.S. have increased since full implementation of the North American Free Trade Agreement (NAFTA) in 2008 (American Sugar Alliance, 2014). Prices in the U.S. decreased in fiscal years 2012 and 2013, triggering the sugar price support program and inducing forfeitures by producers (Beghin and Elobeid, 2014; Congressional Research Service, 2016; USITC, 2015). The American Sugar Coalition filed an anti-dumping (AD) and countervailing duties (CVD) investigation with the U.S. International Trade Commission (USITC) and the Department of Commerce (DOC) to investigate the possible dumping of sugar from Mexican sugar mills, government subsidizing exports and the collusion of the industry in Mexico. Preliminary results from the investigations conducted by the USITC and DOC, found that Mexico was dumping sugar at margins of 40% and 42% and subsidizing exports at rates that varied from 5% to 44% (USITC, 2015). A suspension agreement was reached in December of 2014, where the DOC and USITC suspended investigations and removed all AD and CVD. The agreement set the limit at an estimate of U.S. total needs of sugar and required that Mexican sugar exports be subject to a minimum price when resold in the U.S.

The complaints about Mexico exports rest in part on the view that exports are non-competitive or policy-driven, rather than competitively determined. This claim has not been subject to scientific evaluation and if true, could have important consequences when trying to assess the impact of the agreement on Mexico's sugar trade and domestic market. The sugar industry in Mexico has seen many structural changes, from several rounds of government interventions to market regulations. Historically, the sugar mill sector has had trouble generating positive net returns to stay profitable and as a consequence, the government chose to expropriate sugar mills to prevent the industry to collapse. Government control of many mills, more than half-in 2001, has caused some concern that the market is no longer competitive. Moreover, in Mexico, sugarcane growers and sugar mills are separated industries, but they are interdependent. The government also chose to intervene in this stage of the market, imposing rules on the mechanism for pricing sugarcane. In order to improve payments to sugarcane growers, a price reference formula was developed for the payment of the sugarcane (LDSCA, 2005). This reference price pays sugarcane growers based on their productivity and quality and it is no longer tied to the ability of sugar mills to be more productive and generate sales. However, the price reference is tied to different market prices, for example, the domestic price in Mexico and the sugar price in the U.S.

Since the inception of NAFTA, sugar trade has been subject to restrictions. A debate regarding when Mexico was allowed to export sugar, free of tariff rate quotas (TRQ) to the U.S., in 2001, ended in a side agreement. Under the side agreement, both governments agreed that after 2008, sugar would fully integrate to NAFTA without any TRQ. However, the Mexican government implemented a tax that targeted all beverages using high fructose corn syrup (HFCS) in 2002. The U.S challenged the tax with the World Trade Organization (WTO) by stating that the tax targeted exports of HFCS coming from the U.S. to Mexico. The imposition of the tax increased the price of HFCS in Mexico and reduced imports of HFCS to Mexico almost to zero. However, in 2006, the WTO ruled in favor of the U.S. and imports of HFCS increased. Sugar supplies in Mexico increased, as a result of cheaper HFCS from the U.S. Moreover, an increased in the usage of HFCS in the beverage industry, put pressure on domestic sugar prices, decreasing and reducing margins for sugar mills.

Price transmission analysis is commonly used to understand how integrated markets are at different levels of the supply chain and internationally. Using price transmission analysis, helps determine if price shocks are passed through different stages of the production chain. When prices are not fully transmitted among different stages of the supply chain, there could be non-competitive behavior in the market, policies that prevent the prices being fully passed through or high transaction costs. Moreover, import restrictions or non-tariff trade barriers can also reduce the level of transmission from international markets.

Price transmission models can be extended to assess the elasticity of price transmission and to conduct co-integration tests. Price transmission elasticities measure the level of responsiveness of different agents through the supply chain and from changes in the international prices. A co-integration test is used to see if two markets tend to move together, regardless of how big or small elasticities are. In addition to price transmission elasticities and co-integration tests, an asymmetric price transmission model is commonly used to find any deviations from the long run equilibrium between prices. Within a co-integrated market, prices can be asymmetrically transmitted from different stages in the supply chain or from international markets. Thus, when non-competitive behavior is present, agents might price discriminate.

A second method used to analyze policy impact and market concentration is to apply a partial equilibrium model approach. Partial equilibrium models aid economist in analyzing the impacts on price, supply, demand or policy and the effects at different stages of a market. Here, three models are generated to compare effects under different export structures, differentiated by the treatment of exports. These models are used to estimate how the agreement signed in December 2014 affects the Mexico sugar market.

The main objective of this study is to estimate the impact of the new export policy, taking into account the claims that Mexican sugar mills collude. In this manner, we use one method that looks at non-competitive behavior. This question is explored through price transmission analysis, specifically looking at pass through of different prices in the domestic market. In a second analysis, the impact of the agreement recently signed between Mexico and the U.S. on the domestic Mexican sugar market is estimated using partial equilibrium models with different export market representation.

We find that the Mexican raw sugar market is co-integrated to the refined sugar market in Mexico U.S. and international markets. However, price elasticities vary from market to market. For example, Mexican domestic prices respond little to world price changes, but the domestic price in Mexico is more responsive to U.S. prices. This is partly due to TRQ from Mexican imports of sugar from the rest of the world that Mexican prices respond slower to world price changes

The agreement has a larger trade impact in the non-competitive case when compared to the competitive case. Consequently, the agreement to limit trade has a higher impact on sugarcane area planted and sugar production in the non-competitive case when compared to the competitive baseline. However, the price reduction associated with the trade agreement does not appear dramatic compared to historical prices. For example, the average price over the ten-year projection in the non-competitive case does not go lower than the average price from 2008 to 2015.

The thesis consists of eight sections. The second section gives a background on the sugar industry in Mexico. The third section looks at the literature review on NAFTA, voluntary export restraints (VER) and finally in non-competitive behavior. Fourth section gives a brief description of data. Moreover, fifth section describes the data used for export representation. Section six goes through the theoretical description of price transmission, price transmission elasticities, asymmetric price transmission and the theoretical partial equilibrium model. The seventh section talks about results. Finally, the eighth section summarizes and concludes.

Industry Background

History

Mexico has become one of the major producers of sugar in the world. Currently, it is the sixth largest producer of sugar after Brazil, India, EU-27, China, and the U.S. (FIRA, 2015). The government has created laws and policies, such as the law of sustainable development for sugarcane, that have led to changes in the structure of the industry (LDSCA, 2005).

Singelmann (2013) states that land reforms were undertaken so people that worked land for agricultural purposes could be able to own their own piece of land, after the Mexican revolution in 1910. Because of the land reforms, ejidos were created. Ejidos are communal lands that are divided into parcels so members of the community share and work a piece of land. Moreover, Singelmann finds that, due to these reforms, sugar production was divided in two, sugar cane growers and sugar mills. Sugar haciendas ceased controlling the whole chain of production. The government created a rural bank that would channel funds to the industry for technology investment and modernization of sugar mills (Singelmann, 2003).

Unable to sustain the burden of the debt, in 1982, the government stepped in and expropriated the sugar mills. The high level of debt by sugar mills and the low productivity of land to produce sugarcane, due to low prices of sugarcane and lack of incentives provided to cane growers, caused the industry to go bankrupt (Singelmann, 2003). In 1988, the industry was privatized.

However, in 2001, sugar mills had difficulties repaying government loans, and were unable to pay sugarcane growers for past harvests. After weeks of protest and complaints from sugarcane growers, the government decided to step in and buy 27 out of the 51 sugar mills, controlling nearly 50% of the total production of sugar (Martinez-Vergara, 2001).

At present, the government still controls some of the sugar mills previously expropriated. The government tried to privatize the remaining mills, but constant challenges in the domestic industry slowed down the process. As of 2016, the government only has five remaining mills under its control (FAS, 2015).

Policies

Current domestic policies in Mexico include the continued ownership of some sugar mills by the government, the use of TRQ as import barriers and a reference price for sugarcane that sugar mills must pay to cane growers.

As previously mentioned, the direct ownership of sugar mills by the government continues. However, current ownership is lower compared to the initial expropriations. The government managed to sell a couple of the sugar mills in March 2015. The government only controls 5 sugar mills out of the 27 initially expropriated (FAS, 2015). Moreover, the remaining five sugar mills are under public tender for sale, administered by the Services of Administration and Disposition of Assets (SAE) (FAS, 2015).

Mexico uses TRQs when importing sugar from other countries. Mexico has free trade agreements with Nicaragua and Costa Rica, which are given preferential treatment when they export sugar to Mexico. However, Mexican companies, when importing sugar to Mexico, need a special permit from the Secretariat of Economy (SE) that regulates the amount of sugar that can be imported to the country (SIICEX, 2015). The Official Registry (Diario Oficial de la Federacion), administered by the government, publishes the amount of sugar to be imported when the government sees that sugar production will be lower or prices are higher than expected for final consumers and processing industries (Secretariat of Economy, 2012).

Mexico sets a reference price for the payment of sugarcane. CONADESUCA (2005) describes the method used to calculate the reference price. The reference price is dictated in the law of sustainable development for sugarcane. CONADESUCA (2005) states that the reference price is calculated as follows: the government collects the price of raw sugar from different major wholesale central markets in different states and divides these markets into six different regions. A simple average of the raw sugar price is calculated in each region and weighted by that region's share of population. Once the weighted price is calculated, a discounting factor of 6.4% is applied to the weighted average national price, resulting in the reference price. CONADESUCA (2005) notes that this price is considered the first payment out of two and it is announced every October before the start of the marketing year in November.

After CONADESUCA determines the price reference, an extra payment can be made to sugarcane growers besides the base payment. This is a payment made depending on the quality of the sugarcane. The LDSCA (2005), implemented a system used to calculate the quality of the sugarcane is called KARBE, which measures different properties of the sugarcane and is able to determine how much sugar can be recovered after crushing the cane for sugar production. This system rewards cane growers who have better quality and productivity and is not dependent on the productivity of the sugar mills.

As part of the final payment to sugarcane growers, CONEDASUCA (2010) adjusts the final payment in mid-June, when sugar mills that exported sugar must also pay cane growers part of the amount made by the sales abroad. This is a total weighted average of contract 16 and contract 11 and the real volume of exports.

Sugarcane Production

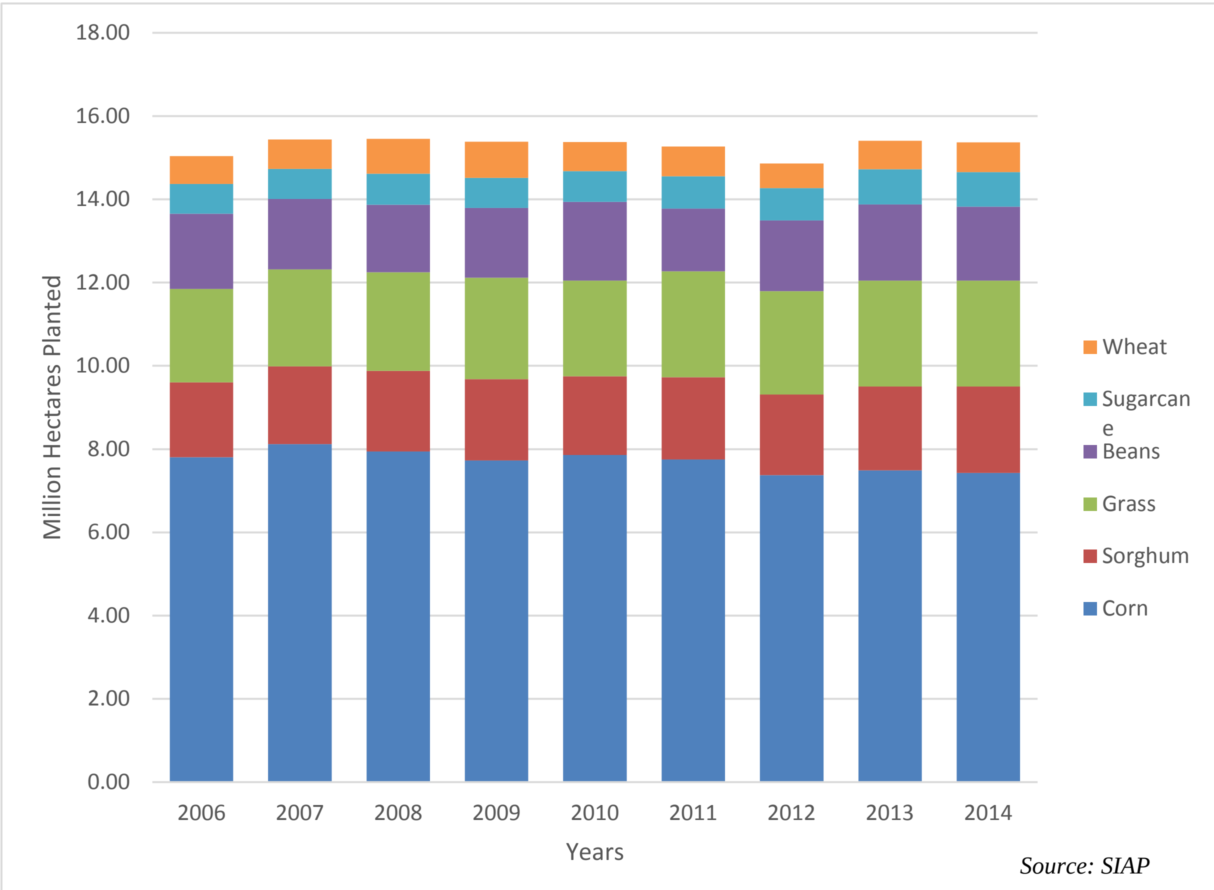

Figure1 Area Planted by Crop

Sugarcane production in Mexico mainly occurs in tropical and subtropical areas. The period of growth lasts between 11 to 17 months before harvest, depending on the climatic conditions in which sugarcane is planted. Planting occurs between the months of December and February and harvesting season goes from November to June (SIAP, 2015; INIFAP, 1997). The sugarcane marketing year goes from November to October, in which sugarcane growers sell their sugarcane to sugar mills. Most of the sugarcane fields are rain fed agriculture, which can be unpredictable

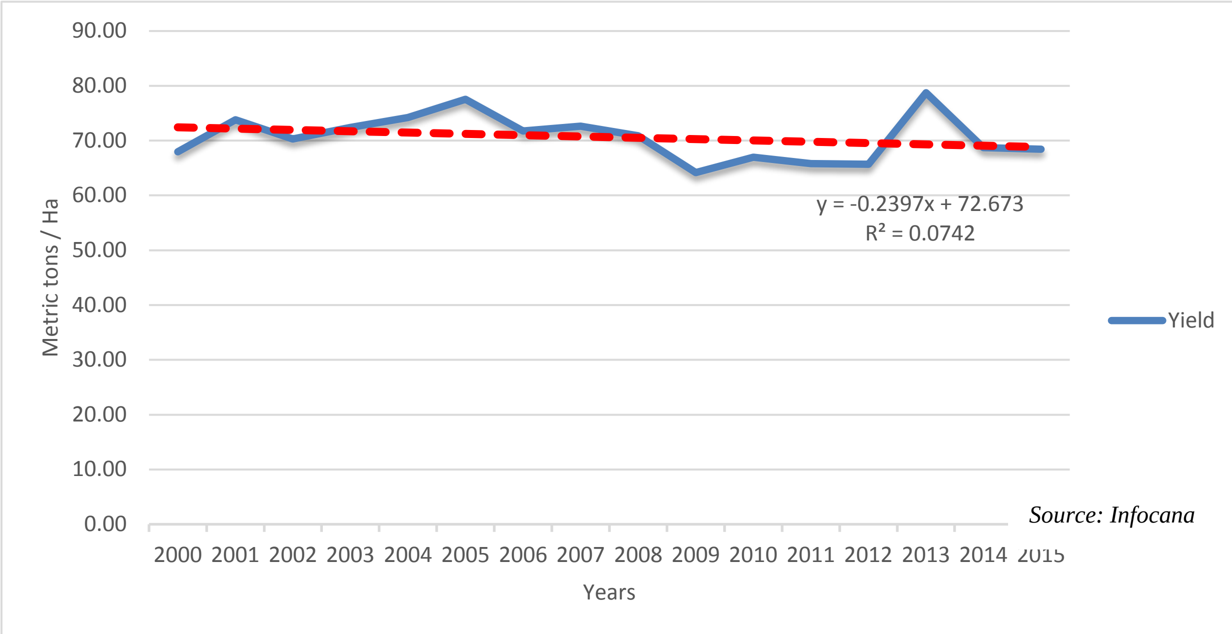

Figure 1Historic Yields For Sugarcane in Mexico

and at times insufficient cane is supplied to mills (Aguilar-Rivera et al, 2012). Climatic conditions in Mexico make for near optimal conditions to grow sugarcane at an affordable cost when compared to the U.S. and Europe sugar beet production cost (Aguilar-Rivera et al., 2012).

Sugarcane production in Mexico takes place in six different regions across 15 states (SIAP, 2015). The largest state by hectares of sugarcane planted is Veracruz, with almost 43% percent of the total sugarcane area planted in Mexico, followed by Jalisco, Nayarit, and Oaxaca (see figure 1). Land distribution in Mexico is 75% communal or ejidal and the remaining 25% is held by private entities (Aguilar-River et al, 2012). Given the high level of communal ownership of land, the cane sugar industry is characterized by small-scale farmers with an average of four hectares per cane grower (Campos-Ortiz and Oviedo-Pacheco, 2013). Sugarcane has remained among the largest commodities by area in Mexico. Although total hectares planted has varied over the years, sugarcane has been among the top eight by area. In figure 2, we can see that corn is the largest crop by hectares planted. Sugarcane hectares planted has ranged from 3.0% to 3.7% of the total area planted in Mexico. From 2006 to 2014, sugarcane area planted had a net increase of 2.7% per year. In terms of production by weight, sugarcane production is greater than production of other crops with total production of sugarcane varying between 48.8 million tons to 61.2 million tons for the years 2006 to 2014 (SIAP, 2015). The SIAP (2015) makes farm gate prices for sugarcane public in its website, typically, yearly prices in different regions of the country. Farm gate prices for sugarcane averaged 490[1] pesos per ton, with an average total production value in pesos of 25.7 billion pesos[2]from 2000 to 2015 (SIAP, 2015). The main uses of sugarcane by hectares planted are for industrial purposes (97%), followed by the production of piloncillo (unrefined whole cane sugar), fruit, animal feed and pure cane sugar (3% all these together) (SIAP, 2015).

Sugarcane yield levels in Mexico are far below yields of other countries, like Colombia, Egypt, and Peru (Campos-Ortiz and Oviedo Pacheco, 2013). Sugarcane yields have remained stable through the years from 2000 to 2015, but there is evidence of a declining trend in the more recent years (see figure 3). According to Aguilar-Rivera et al. (2012), some of the low yield levels are attributed to the outdated and low technology usage in the fields. Moreover, Aguilera-Rivera et al. (2012), state that most of the harvesting of sugarcane is manually, highly seasonal, and makes it hard to make it sustainable, given that jobs are temporary and training is difficult. Moreover, most of the sugarcane fields are underdeveloped with the majority of the sugarcane lands dependent on rain-fed agriculture. A few growing regions tend to be more developed and use irrigation systems to obtain higher yields (Aguilar-Rivera et al., 2012).

[1] 41 dollars/ton with an average exchange rate at 12 pesos/dollar over the period 2006-2014

[2] 2.1 trillion dollars at 12 pesos/dollar over the period 2006-2014

Sugar Production

State: CAMPECHE	
LA JOYA	
State: COLIMA	
QUESERIA	
State: CHIAPAS	
HUIXTLA	
PUJILTIC (CIA. LA FE)	
State: JALISCO	
BELLAVISTA	
JOSE MA. MARTINEZ (TALA)	
JOSÉ MA. MORELOS	
MELCHOR OCAMPO	
SAN FRANCISCO AMECA	
TAMAZULA	
State: MICHOACAN	
LÁZARO CÁRDENAS	
PEDERNALES	
SANTA CLARA	
State: MORELOS	
CENTRAL CASASANO	
EMILIANO ZAPATA	
State: NAYARIT	
EL MOLINO	
PUGA	
State: VERACRUZ	
CENTRAL MOTZORONGO	
CENTRAL PROGRESO	
CONSTANCIA	
CUATOTOLAPAM	
EL CARMEN	
EL HIGO	
EL MODELO	
EL POTRERO	
LA GLORIA	
LA PROVIDENCIA	
LA PROVIDENCIA, CENTRAL	
MAHUIXTLAN	
PANUCO	
SAN CRISTOBAL ZCMX	
SAN JOSE DE ABAJO	
SAN MIGUELITO	
SAN NICOLÁS	
SAN PEDRO	
TRES VALLES	
State: SINALOA	
ELDORADO	
State: TABASCO	
AZSUREMEX - TENOSIQUE	

Table 1. Sugar mills by State

Old technology and an expensive process to produce raw or refined sugar are some of the characteristics of sugar production in Mexico. As previously mentioned, the industry has seen many rounds of government intervention and changes in laws that have challenged and modified the industry structure. However, despite all the challenges this industry is facing, it is among the top ten producers and exporters of sugar, with most of the exports being supplied to the U.S.

Sugar mills are located close to sugarcane fields. Given the quick loss in sucrose, once the sugarcane is cut at harvest, it needs to be quickly transported to the closest sugar mill. To maximize sucrose content and operations, strong coordination and communication is needed among sugar mills and cane growers (Singelmann, 2003). Sugar mills operate during the same time as the harvesting season, from November to June, and the final payment adjustment for cane growers is made in mid-June. Most of the sugar produced in Mexico is raw sugar that serves as an input for other final products. Moreover, refined sugar, which usually is sold to the final consumer at local stores, is the second largest use of raw sugar in Mexico. Because sugar refining is integrated with sugar mills, the cost of producing refined sugar is just an increased cost of a process for greater refinement; no transportation cost to other plants should affect refined prices (Buzzanell, 1997).

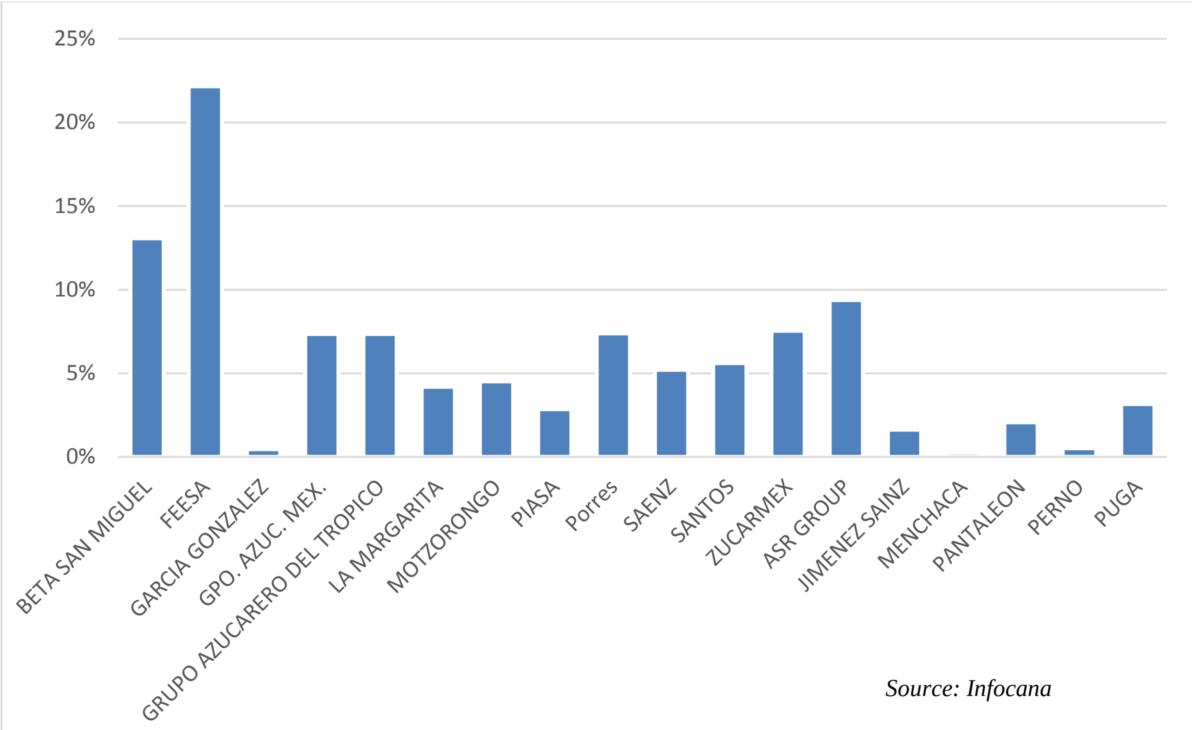

Table 2Percentage of Sugar Production by Business Group

Although raw and refined sugar are the most commonly produced sugar types in Mexico, some sugar mills produce moscabado and special white sugar. However, moscabado and special white sugar only account for less than 10% of sugar produced.

Currently in Mexico there are 51 sugar mills spread across 15 states and 6 different regions in the country. The state of Veracruz is by far the state with most sugar mills in the country, with 19 sugar mills operating in this state in 2015, followed by Jalisco with six sugar mills (see table 1).

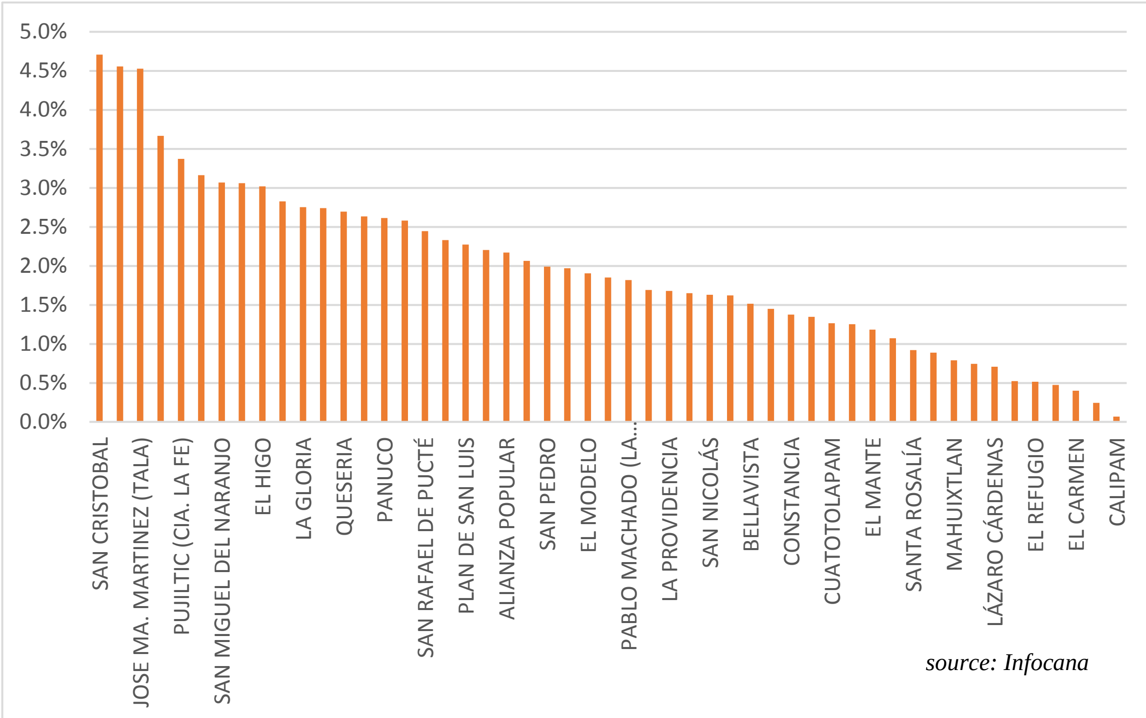

Figure 2Percentage of Sugar Production by Sugar Mill

Moreover, sugar mills are generally not owned individually. Many of the mills are incorporated into business groups that control two or more sugar mills. Twelve business groups control two or more sugar mills accounting for 45 out of the 51 sugar mills or 88% of all sugar mills. The few independently owned sugar mills account for the remaining six mills.

One of these business groups is the fund of expropriated mills (FEESA) that were in financial trouble in 2001, and received government support. FEESA, which controlled 27 sugar mills and directly or indirectly is operated by the government, accounted for almost one fourth of the volume produced of sugar in Mexico. Figure 4 shows the share of total domestic sugar production by business group, and figure 5 shows the share by sugar mill. We can see from figure 4 that the FEESA and Beta San Angel business groups have a combined market share of 35% of the total production of sugar. The concentration ratio of the four largest business groups that own mills is 52% and the HH-Index gives 1,045. Both measurements suggest a moderate concentration in the production of sugar. When mills are analyzed individually, the largest market share is 5%, the four-mill concentration ratio and HH-Index are17% and 258, respectively. Individually, each sugar mill seems to account for a small share of total production of sugar in the country, suggesting the industry is a competitive one. However, when analyzed into business groups, concentration indicators suggest that four business groups account for about half of the total production of sugar, potentially weakening the argument of perfect competition in the market.

Government intervention has taken many forms, but in 2001, the government expropriated 27 sugar mills. As of June 2015, the government currently controls five mills out of the 27 initially expropriated (FAS, 2015). The remaining five sugar mills are expected to be sold soon.

However, concerns over government involvement and the structure of the industry has raised questions about monopoly practices among the business groups. Currently the COFECE (Federal Commission of Economic Competition in Mexico), is investigating the possibility of monopolistic practices in the manipulation of production, distribution and commercialization of sugar (COFECE, 2016).

Domestic Consumption of Sugar

Consumption per capita of sugar has been decreasing in Mexico. Figure 6 shows historic sugar consumption per capita in Mexico and the U.S. Mexican consumption of sugar increased in the years 2000 to 2006. However, after 2006, consumption per capita has been decreasing. Mexican per capita consumption has remained above U.S. consumption levels, although the gap between the two is getting closer, and U.S. per capita consumption of sugar has been increasing in recent years.

Despite the importance of sugar as an input in the manufacturing industry, especially the soft-drink industry, HFCS tends to compete with sugar, making HFCS a substitute for the soft beverage and confectionary industry. Figure 6 shows the use per capita of HFCS in Mexico. Years 2002 to 2004 show the decrease in consumption of HFCS. In 2002, the beverage tax on drinks using HFCS was introduced. In 2005, imports of HFCS began to increase at high rates. An inverse relationship is shown after 2006, where HFCS domestic consumption increased while sugar consumption decreased during 2006 to 2015.

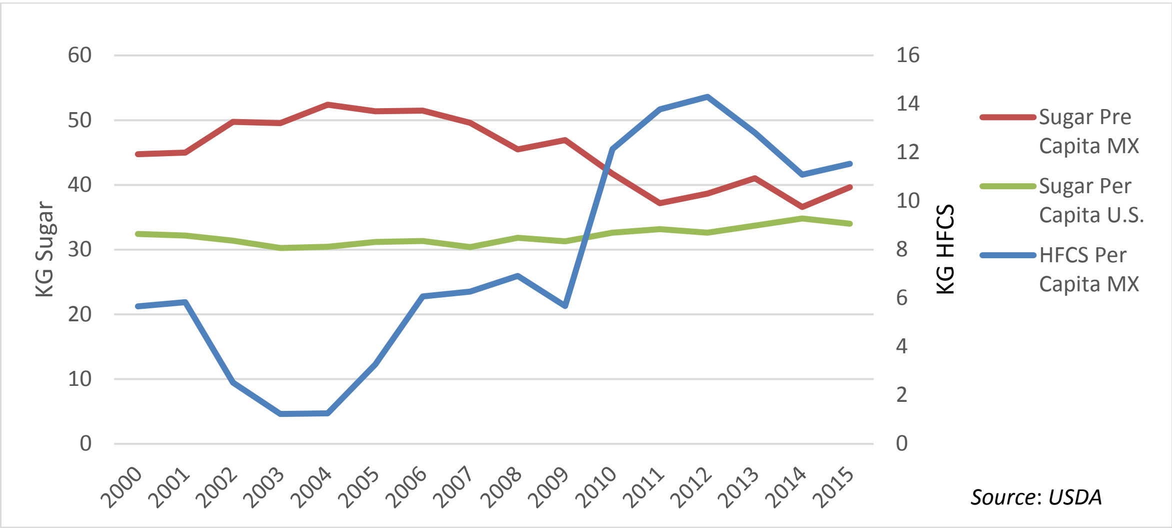

Figure 3Sugar and HFCS Consumption per Capita

Domestic consumption of sugar at the consumer level in Mexico plays a crucial role in the daily calorie intake of Mexican families. Mexico considers sugar as part of the basket of goods when calculating the consumer price index (CPI). In 2013, sugar had a weight in the CPI of 0.18 in a scale of 0 to 100 percentage points. The weight ranks sugar in 31st place out of 108 items in the sub index "Food, Beverages and Tobacco" (Campos-Ortiz and Oviedo Pacheco, 2013).

Sugar is also an important input in the beverage and confectionary industry. The beverage and confectionary industry accounts for a large share of refined sugar purchases. The outputs of this industry contributes significantly to the overall utilization of this commodity reported earlier. As in the CPI, sugar is part of the producer price index (PPI). Under the sub index "Manufacturing Industry", sugar has a weight of 0.34, ranking this input in 27th place out of the 361 items that comprise this sub index (Campos-Ortiz and Oviedo-Pacheco, 2013).

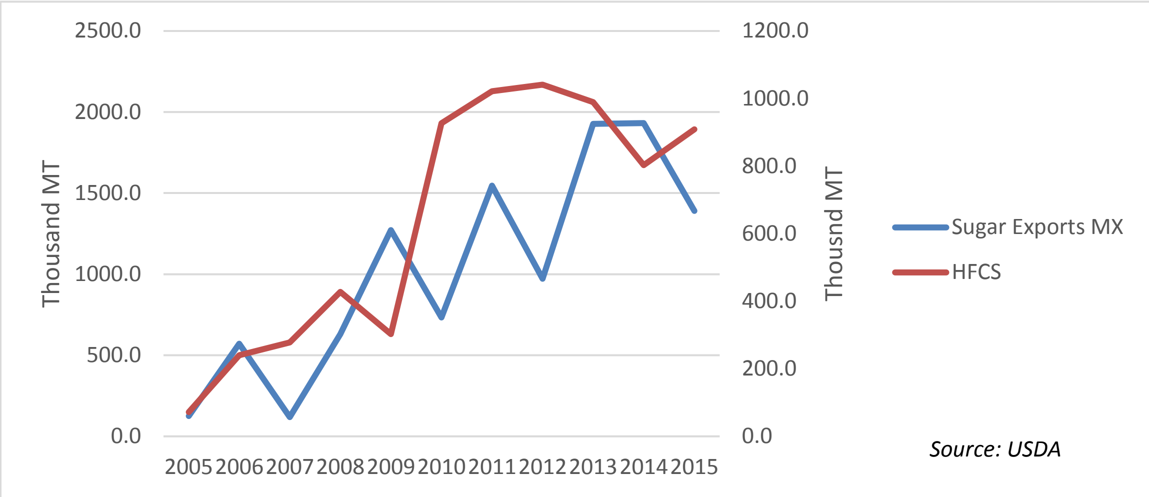

Figure 4Mexico to U.S. Sugar Exports and US to Mexico HFCS Exports

Mexican Sugar Exports and Imports of HFCS

Usually, HFCS is more attractive due to its lower price as an input when compared to sugar prices in Mexico. HFCS exports from the U.S. to Mexico have been increasing at rapid rates (see figure 7). Moreover, in the years 2002-2004, when the HFCS beverage tax was in place, imports decreased significantly from the U.S. However, once the tax was removed, imports picked up again. At the same time, sugar exports began increasing. After full implementation of NAFTA, we can see Mexican exports of sugar rapidly increased and reached their highest levels in 2013 and 2014. According to Lewis and Schmitz (2015), in 2013, Mexican exports accounted for 70% of all imports of sugar that entered the U.S. in that year.

Literature Review

Previous Literature on Mexico and U.S. trade on Sugar

The state of the extensive literature regarding the trade effects between the U.S. and Mexico under NAFTA are summarized in this section. Few studies have analyzed the effects of sugar trade between these two countries. Most of the literature has found that, overall, the effect of NAFTA increases the sum of sugar producer, consumer and taxpayer surplus for both countries after removing the TRQ for raw sugar and HFCS products in 2008. Some literature has considered the case of substitution between raw sugar and HFCS as competing inputs in processing industries and the trading effects between these two countries. Moreover, the effects of removing government programs are explored in both countries.

Schmitz and Lewis (2015) use a partial equilibrium model to quantify the gains after 2008 from the NAFTA agreement. They define two scenarios, one in which Mexico exports free of duties and the second scenario in which Mexico continues to export under the pre-2008 TRQ (250,000 MTRV) policy regime. They use short-run elasticity estimates from the FAPRI sugar baseline model for the lower range and a higher elasticity estimate from Kennedy and Schmitz (2009) to perform a counterfactual analysis. Empirical results show that U.S. consumers gained and producers in the U.S. lost some surplus due to lower prices. The annual average consumer surplus in the U.S. increased between $612 million and $1.7 billion, annually. Free trade in sugar cost producers in the U.S. between $150 million and $538 million dollars. Net welfare increased by $138 to $362 million dollars. Mexican consumer and producer surplus mostly offset each other, leaving Mexico with a net welfare gain of only $29 million to $67 million dollars.

Consistent with the results from Schmitz and Lewis (2015), Beghin and Elobeid (2015) employ a partial equilibrium model to show that removing the U.S. sugar program can have a similar impact on consumer welfare. Estimates show that the removal of the U.S. sugar program can increase consumer welfare in the U.S. from $2.9 billion to $3.5 billion (Beghin and Elobeid, 2015). Compared to Schmitz and Lewis, the removal of the U.S. sugar program has the same directional effect on consumer surplus. However, the effects are bigger due to the removal of TRQs and, by removing the U.S. sugar program, the impact on imports is larger. U.S. producers are affected the most under this regime; lower prices affect cane growers and sugar refiners. The sugar containing product industry in the U.S. switches from HFCS to raw sugar and Mexico imports more HFCS (Beghin and Elobeid, 2015).

The use of HFCS and sugar as competing inputs in the processing sector, like the confectionary and the soft drink industry, could have an impact on the amount of trade flows of these two commodities. Due to the higher cost of raw sugar in Mexico as an input commodity, there are some expectations that the soft drink industry will use HFCS as an input. If Mexico's beverage industry heavily imports HFCS and reduces the use of sugar as an input, then sugar will be diverted to other markets and could become a more attractive commodity input for the U.S. processing sector.

Knutson et al. (2010) look at one policy option where Mexico increases its tariff rate quota on imports from third countries. Their study shows that, if Mexico allows more imports from abroad by increasing their TRQ, cheaper raw sugar from the international markets would not offset prices of HFCS as an input. Under this policy option, Mexican raw sugar, would find its way to the U.S. In a second policy scenario, they look at increased imports of HFCS to Mexico from the U.S. Due to its high substitutability between sugar and HFCS, Mexican consumption of HFCS increases and production of sugar decreases. Mexican raw sugar prices decrease by 19% relative to the baseline. This results in a modest decrease in sugar production in Mexico, but the decrease in price makes

Mexican raw sugar more competitive in the U.S. As a result, the authors find a 178% increase in Mexican exports to the United States. In both scenarios, increase in imports of HFCS and increase in TRQ sugar imports, prices in the United States decrease, but loan rates are never triggered.

Abler et al. (2008) use a partial equilibrium model for sugar similar to Knutson et al. (2010). The baseline reflects policies like market allotments, price supports and TRQ. Moreover, they create two variants of the sugar baseline for the U.S., where the distinguishing characteristics of the two baselines is whether U.S. imports of sugar from Mexico are low or high. They find that under the low imports from Mexico, the New York spot price averages over 20 cents per pound over the period of 2008-2015. Under the high Mexican import baseline, the New York raw price averages 18.73 cents per pound over the 2008-2015 period. However, where the U.S. sugar program is replaced with a standard crop program, the average prices are lower than the baseline prices for both variants. Under the scenario of a standard crop program with low imports from Mexico, the average price is 18.42 cents per pound, while under the scenario of a standard crop program and high imports from Mexico the price decreases to 16.86 cents per pound.

The loan rate for cane sugar is maintained at 18 cents per pound, while beet sugar loan rate is 22.9 cent per pound for the two variants of the baseline, with high and low imports from Mexico. Under the high imports baseline, Abler et al. (2008) find that the current U.S. sugar program would not be able to operate at no cost to taxpayers. They suggest moving the U.S. sugar program into a standard crop program. However, switching the current U.S. sugar program to a standard crop program would lead to taxpayer costs, but it would lower the cost to taxpayers as compared to the current sugar program.

Table 3Mexican Sugar Market Elasticities from Previous Studies

Mexican Elasticities from Previous Studies				
Authors	FAPRI	Devadoss, Kropf, Wahl	Petrolia and Kennedy	Lewis and Schmitz[3]
Study	Sugar Baseline Outlook	Trade Creation and Diversion Effects of the NAFTA of U.S. Sugar Imports from Mexico	Increasing the U.S. Tariff-Rate Sugar Quota for Cuba and Mexico: A Partial Equilibrium Simulation	Impact of NAFTA on U.S. and Mexican Sugar Markets
Period of Study	U.S. Sugar Baseline	1994-2007	1999	2008-2013
Supply				
Own Price	0.15	0.89	0.18	0.5
Cross Price	-0.05	-	-	-
Demand				
Own Price	-0.13	-0.019	-0.14	-0.6
Cross Price	-0.22	-	-	-
Stocks Own Price	-0.43	-0.022	-	-

Note: Supply Cross Price for FAPRI Sugar Baseline for Mexico: Corn, Demand Cross Price for FAPRI Sugar Baseline for Mexico: High Fructose Corn Syrup

The elasticities developed for the paper that are introduced in more detail later, are comparable to elasticities found in previous studies. Supply elasticity is 0.17, making sugarcane supply inelastic. The cross price elasticity of competing goods, in the case of sugarcane supply in Mexico, relates to corn. Corn competes in area planted with sugarcane. However, the effect seems to be weak given the parameters found in previous study, or even outright omission of cross-price effects in supply, as well as the elasticity of -0.08 found in the present exercise, as reported later. Demand own price elasticity of this study, -0.10, is similar in magnitude to values found or used in previous studies. As for the own price elasticity of stocks, the value of the present study, -0.36, is comparable to the level found in one previous study, namely FAPRI baseline elasticities obtained

[3] Lewis and Schmitz (2015) provide two sets of elasticities for the supply and demand for Mexico. One set is the low range of elasticities provided by FAPRI Sugar Baseline and a high range elasticity from Kennedy and Schmitz (2009).

from Lewis and Schmitz (2015), but much less inelasticity than Devadoss et al. (1995). The comparison of the elasticities used in this model to elasticities found in previous studies is mostly reassuring, but the range in some instances is wide. For example, Lewis and Schmitz (2015) suggest an overall less inelastic market, whereas Devadoss et al. (1995) argue that the Mexico sugar demand, both for consumption and for stocks, are extremely inelastic.

Voluntary Export Restraints

Voluntary export restraints (VER) tend to have a lesser impact on the exporting country allowing government officials or the exporting firms to keep the rents when the VER is imposed (Allen et al., 1983). However, the VER does not benefit all exporting firms. Those firms who are excluded from the deal might not get any of the benefits from the VER. Government might enforce exports through open tenders, auctions or imposing a license to control exports (Schmitz and Lewis, 2015; Allen et al., 1983). Moreover, voluntary export restraints can cause trade divergence and while one sector of the supply chain is restricted, other products at higher levels of the chain might be imported by the country who imposed the voluntary export restraint (Ghazalian, 2016; Baylis and Perloff, 2010; Allen et al., 1983).

Suspension agreements between Mexico and the U.S. date back to 1996 with the so-called “tomato war” (Asci, Seale, Onel, Vansickle, 2010; Vansickle, Evans, and Emerson, 2003). Since then, the initial suspension agreement was untouched until renegotiations in March 2013 (Ghazalian, 2016). Previous studies found that the suspension agreement affected imports of fresh and greenhouse tomatoes and calculated the impact of both the domestic demand for imported and domestically produce tomatoes in the U.S. and the exports of tomatoes from Mexico to the U.S. Perloff and Baylis (2010) look at the suspension agreement signed for the first time in 1996. They use a reduced form structural supply and demand equation to look at the trade diversion of fresh tomatoes to Canada and other processing industries from 1998 to 2001. They find that fresh tomatoes exported from Mexico to the U.S. significantly decreased. Due to a decrease in imports of tomatoes from Mexico, the U.S. reduced exports of tomatoes to Canada. Consequently, Canadian producers took advantage of higher prices (due to the voluntary export restraint) in the U.S. and exported greenhouse tomatoes.

Ghazalian (2016) examines the effects of the renegotiated tomato suspension agreement. Under the new tomato agreement, the voluntary price restraints increased given that previous price floors were not representative of new structural costs in the industry in the U.S. In addition, inflation in Mexico increased up to 250% since the first suspension agreement was signed and prices were too low to keep up with costs. Ghazalian uses a gravity model to assess the impact on the old and new agreements and uses the estimated parameters to simulate those impacts. Comparing the new agreement with the previous one, the increase in voluntary price restraint (VPR) has a higher effect on imports from Mexico. The first agreement reduced imports by 5.7%, while the new agreement reduced imports from Mexico by 21.9%. Perloff and Baylis (2010) and Allen et al. (1983) also reflect this finding. Both papers find that, imposing trade barriers have a secondary effect on trade, which tends to divert trade to other importing nations and gives an opportunity to other export countries to enter the new markets due to higher prices.

Another unintended consequence of imposing voluntary export restraints (VER) is the deflection of the raw commodities to other processing industries. Trade barriers to lower supply chain products tend to make it back to the border as processed intermediate or final products (Ghazalian, 2016; Baylis and Perloff, 2010). The introduction of the suspension agreement deflected fresh tomatoes that could not be sold at local markets in the U.S. and were sent back for processing for tomato paste (Baylis and Perloff, 2010). Under both suspension agreements (1996 and 2013), it was found that while the imports of fresh tomatoes significantly decreased, the exports of tomato paste grew significantly (Ghazalian, 2016; Baylis and Perloff, 2010). Both Ghazalian (2016) and Baylis and Perloff (2010) found that even though fresh tomatoes were converted into tomato paste, the amount of exports of tomato paste, offset some of the decrease in exports of fresh tomatoes, but did not fully make up for the total loss of exports of fresh tomatoes.

Asci et al. (2016) develop a system of demand equations to measure the impact of a suspension agreement on domestic consumers. They first develop an aggregate model and then move to a more disaggregate demand model. They test four demand systems (National Bureau of Research (NBR) Rotterdam, Central Bureau of Statistics (CBS), and Almost Ideal Demand System (AIDS)) and finally compare the elasticities of different varieties of tomato (field grown, greenhouse, other). They conclude that consumers in the U.S. tend to see tomato imports as substitutes, which will tend to reduce the demand for field grown and greenhouse tomatoes. According to their model, consumers consider American field grown tomatoes as substitutes for Mexican field grown and greenhouse tomatoes, while Mexican field grown and greenhouse tomatoes are seen as complements. The increase in prices reduces the demand for both domestic tomatoes and imported tomatoes. Therefore, they suggest policies can affect domestic producers.

Similar cases have found that the implementation of VERs has a better outcome for exporting countries than other trade regulations. The VER that the U.S. imposed on frozen beef exports coming from New Zealand and Australia increased welfare for the exporting countries and rest of the world, while these VERs decreased welfare, more precisely the U.S. consumer welfare (Allen et al., 1983). Schmitz and Lewis (2015) believe imposing a VER on Mexican sugar exports could have been a first-best policy option for Mexico, instead of going fully to free trade. They argue that going through a quicker transition, from TRQ to free trade, instead of TRQ to VER, resulted in a negative sum of the consumer and producer surplus, mainly; consumer surplus offset the gains in producer surplus in Mexico in the year of 2008. Other studies have suggested that “voluntary” export restraints are voluntary because the exporting country can choose between limiting exports and accepting tariffs, so the fact that an exporting country accepts the VER is sufficient indication that this outcome is the best choice for the exporting country (Allen et al., 1983).

In contrast, some of the literature finds that VERs between countries are beneficial because of the exporting country and foreign domestic market competition. For example, Cheng and Hwang (1988) present a conjectural variation approach to examine under which conditions the VERs would be voluntary. In a theoretical approach, the authors find that under a competitive case, the VER increases the market share of the domestic producer (the country who imposed the VER) by constraining the exports from the country that the VER is being imposed on. Due to less supply in the country that imposed the VER, prices are expected to increase. In this case, the domestic firm believes that if it were to reduce output, the foreign firm would increase exports, not making it profitable for the domestic firm to reduce output. However, the VER limits the amount of exports from the exporting country, and by reducing exports; the VER makes it profitable for the domestic producer to decrease output. This outcome yields higher prices compared to the non-voluntary export restraint case, both domestic and export firms increase profits, making the restraint voluntary as both domestic and exporting firms are better off under a VER (as described in Harris, 1985).

Non-Competitive Market

Market power has been extensively studied in the literature. The impact of a non-competitive market can reduce consumer welfare and benefit the producers due to higher markups or prices. Not only can a non-competitive market have a negative impact in the domestic market, but it can also affect international markets. Different methods have been used to try to assess the impact of different forms of structures in the market, including both theoretical and empirical approaches.

One approach in industrial organization studies uses a conjectural variation approach to study the how industry structure affects a market. This approach allows researchers to analyze market structures based on the different conjectures that a firm might make about its competitors. These conjecture models might represent a competitive market, a Cournot competition, or collusion (Weldegebriel, 2004; Verreth et al., 2015; Cheng and Hwang, 1988). Weldegebriel (2004) develops a model to analyze how prices would be transmitted at different stages of the supply chain when there is a shock in the supply of an input. Under the assumption of oligopoly power in the retail market and oligopsony power at the farm input level, using the conjectural variation elasticity at the different stages of the supply chain, the author finds that, compared to the perfectly competitive model as a benchmark, a priori we cannot determine the degree of price transmission. This is because, depending on the functional forms of retail demand and farm input supply, the outcomes can yield different forms than or equal results to the competitive case. This leaves the study of price transmission along the supply chain inconclusive. Without further assumptions of the functional forms of supply and demand in the supply chain, Weldegebriel (2004) finds, we cannot attribute asymmetric price transmission due to market power.

The theory of price transmission between the different stages of the supply chain is not fully connected to empirical test results. Weldegebriel (2004) states that price transmission results need to be carefully interpreted when obtaining the coefficients from regressions. He adds that market power is not the only factor affecting price transmission. Moreover, without prior knowledge of functional forms of farm input supply and retail demand, little can be inferred from the numerical value of a price transmission coefficient. Von Cramon-Taubadel (1996) and Verreth et al. (2015) point out the weak ties between the theory of price transmission and the empirical approach to Error Correction Models and the interpretation of the results with the theory. Verreth et al. (2015) test for the presence of market power at different levels of the supply chain of Dutch red peppers and onions. They try to connect the theory of conjectural variation with the empirical estimation of price transmission. They find that wholesalers are able to exert some power on the degree of price transmission from the producer to retailer in the onion market. Tests using red pepper market data do not exhibit any market power; the difference is attributed to the different characteristics of the products such as product perishability and the length of the harvest period.

Other studies have attributed the different degrees of price transmission to different attributes, like processing technologies and spatially separated markets (McCorriston, Morgan and Rayner, 1998; Bailey and Brorsen, 1989). If we relax the assumption of fixed proportions, then the different processing technologies of the different supply chains can result in different outcomes of price transmission (McCorriston et al, 1998). McCorriston et al. (1998) explore how different forms of an intermediate good can be made using various technologies and inputs. Using a simulation of a theoretical model, these authors find that the degree of price transmission in the presence of non-competitive behavior can vary when the elasticity of substitution goes from fixed proportions to perfect substitutes. According to the theoretical model simulation, after controlling for market power, price transmission at different processing technologies increases or decreases, but price transmission is not perfect. Only in the case of an increase in the share of an input cost does the processing industry transmit fully this increase in cost to retailers.

Spatially separated markets may receive delayed signals from leading markets, resulting in asymmetric price transmission. Bailey and Brorsen (1989) analyzed four different markets in the fed cattle industry looking at markets with different size in sales, but almost equally concentrated. They develop an asymmetric price model comparing Texas panhandle market and the response in Colorado, Nebraska and Utah. They found that Utah responds more slowly to new information when compared to the other markets. The authors attribute this slow response to price changes to the isolated and small size of the Utah market and to a high packer concentration ratio of almost 100%. Furthermore, Bailey and Brorsen findings from the price asymmetry model shows that, negative and positive price changes from Texas panhandle. This result suggests that packers adjust to price changes equally, showing evidence of symmetry. However, the speed at which packers adjust prices tends to be faster with positive price changes when compared to negative price changes.

Summary

Different studies have looked at separate policies relating trade and non-competitive markets. Under NAFTA, full integration of sugar and HFCS has been an ongoing topic of study, generally regarding the effects of free trade of these commodities. Because U.S. HFCS has free access to the market in Mexico, there is the potential that the beverage industry of Mexico will switch to that input, reducing domestic demand for sugar. In this case, there would probably be greater sugar available for exports to the U.S. at any given price. Studies have generated mixed results, showing that different policies can have different results in terms of the prices and quantities of sugar exported to the U.S. Moreover, VERs have been a common non-tariff barrier that are likely intended to protect the domestic industry of the country imposing the VER, while allowing the exporting country to keep the rents. However, VERs can cause trade diversion at higher levels of the supply chain that can offset the losses of the VER at the lower level of the supply chain. Lastly, asymmetric price transmission can cause firms to price discriminate among spatially separated markets, taking advantage of delayed signals from leading markets. Moreover, if the domestic market is not integrated with international prices and markets are concentrated, price discrimination can be found through the supply chain.

In this paper, I examine the impact in the Mexican sugar industry of the new agreement signed between Mexico and the U.S., where Mexico exports are subject to a VER. Moreover, I use a model to test for asymmetric price transmission between international sugar prices and Mexican retail and wholesale sugar prices.

Data

Data representing the Mexico sugar market are primarily from USDA sugar and sweeteners in Mexico production and supply and from SAGARPA's agricultural and aquaculture information service (SIAP). For example, these sources were used to obtain information regarding production, consumption, stocks and trade. Monthly prices from Mexico were obtained from the SNIIM (National System for Market Information and Integration). U.S. sugar market data were collected from USDA Economic Research Service that provides information about domestic consumption, production and trade of sugar and sweeteners. The world bench mark price is the Caribbean price of sugar, also known as contract 11. Contract 11 is obtained from the New York Board of Trade. As regards to macroeconomic data, Mexico GDP, U.S. GDP, U.S. GDP Deflator, Mexico CPI, and Exchange Rates are all from the Food and Agricultural Policy Research Institute.

Export Representation for Mexico

The competitive representation of exports is strictly based on arbitrage. The key factors are the costs of buying sugar in Mexico and the revenues from selling sugar in the U.S. Other costs can enter into the decision as well. In practice, there are several options to represent this behavioral equation. For example, if the markets are well integrated, a direct price link could be used to tie the Mexican and U.S. prices, with trade a residual in a structural economic model. In time series experiments, the prices of sugar in the two countries might be co-integrated, at least after taking into account such factors as tariffs or other trade measures, transportation costs, and exchange rates. If markets are not well integrated due to policy or natural barriers, then exports in the competitive case might be represented in a structural economic model as a function of the spread between U.S. and Mexican sugar prices, potentially with other costs. If markets are not well integrated, then time series experiments are more likely to find that prices in the two markets are not co-integrated.

The factors that could explain non-competitive exports are not known. There are many possible motivations that could determine exports in the non-competitive case given that both mills and the government are sometimes both believed to be involved. Here, some examples are listed.

1. Sugar mills seek to be profitable and the government involvement, in terms of historical expropriation and current ownership of mills, suggests that the government might also prioritize mill profitability. As such, a motivation that might drive non-competitive exports is preserving mill profitability.
2. FIDCANA EXPOAZUCAR is a program that was created by the sugar mills and supervised by the government to export any excess supply of sugar. All sugar mills export

under this program, no matter how small their excess supply is. The existence of this program suggests that non-competitive exports might be used as a way to limit domestically available sugar. One potential purpose of such a policy that limits domestic supply might be to cause higher domestic prices.

3. Mills might be motivated by profitability of exports. If mills can make money by exporting, then they might choose to export more. This motivation might cause a response to relative prices of sugar at mills and in the export market that is similar in direction to the competitive market response to these prices, but perhaps not of similar magnitude.

Table 4Proxy Variables for Non-Competitive Behavior and Expected Sign

Motivation	Proxy variables in the data	Expected sign
Mill profitability	Real Mexico sugar price	Negative
Control domestic supply	Total domestic supply	Positive
	Production	Positive
	Beginning Stocks	Positive
Profitable exports opportunity	U.S. price less Mexico price	Positive
Maximize export sales	U.S. quantity demand	Positive
	U.S. quantity supply	Negative
	U.S. production	Negative
	U.S. net import demand	Positive

4. The motivation determining exports in the non-competitive case might be to maximize revenues from U.S. sales. In this case, the net import demand of the U.S., in terms of size and elasticity, might be relevant.

Table 4 lists the motivations above, proxy variables that are available and can be used, and the expected sign in each case. While other, ideal measures might be imagined that would more closely match each motivation, the data available at this time do not support more accurate representation of these motivations, much less statistical exercises to detect their relative importance.

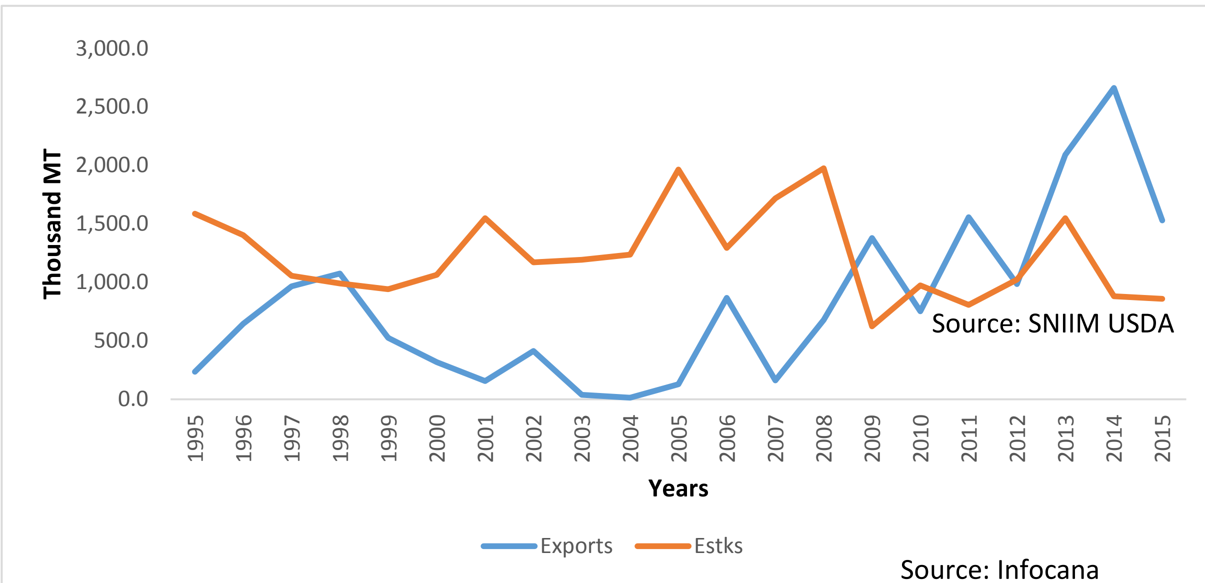

Figure 5Ending Stocks and Mexican Exports of Sugar

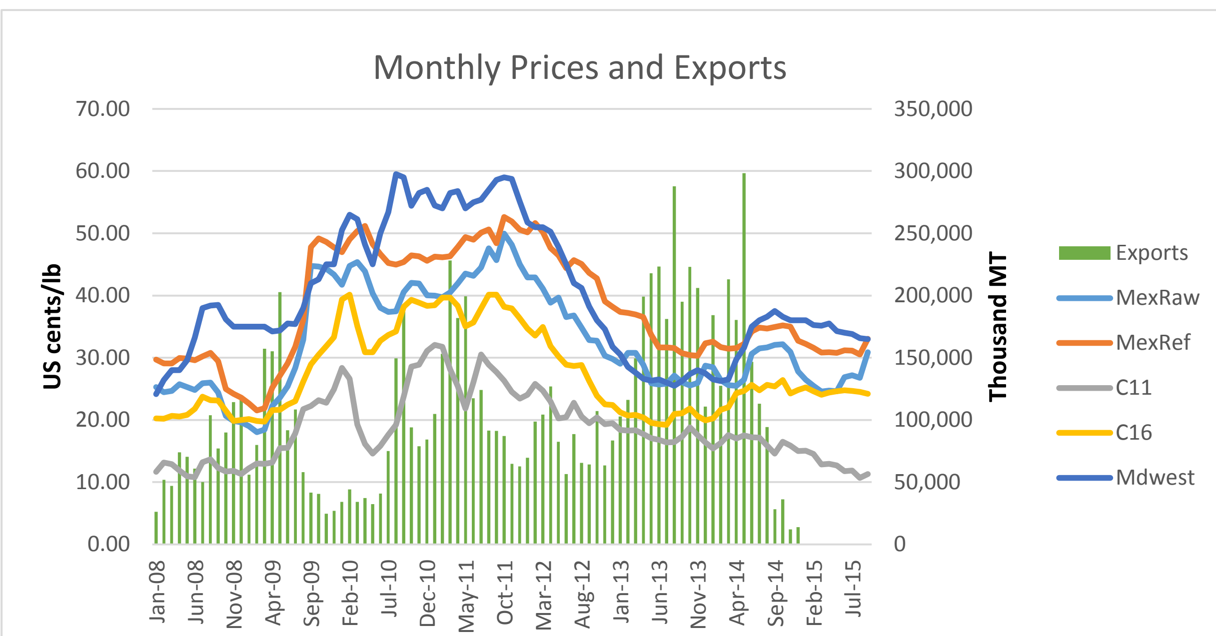

Figure 6Monthly Prices and Exports

The time series experiments help find any price discrimination in the markets. If Mexican sugar mills are colluding, with or without government involvement, then prices from other international markets and different levels of the domestic supply chain, might not affect pricing behavior of sugar mills. However, government policies can affect domestic prices and the co-integration of Mexican prices with other world markets and different levels of the supply chain. Despite the possibility of a colluded market, market integration can still have an effect in export behavior from Mexican sugar mills. The following general outcomes of market prices and quantities are suggested by observing the data.

1. There seems to be an inverse relationship between stocks and exports (Figure 8).
2. The domestic sugar price of Mexico is bounded by two prices, refined beet sugar price and contract 16. When the Mexico raw sugar price gets close to contract 16, raw sugar price in Mexico moves upward. When the Mexico national price of raw sugar is above or close to the refined beet sugar price, raw sugar price in Mexico moves downwards.

The Secretariat of Economy in Mexico (2012) notes that this price variation is partly due to the price integration of both markets. The report states, “This behavior signals an inverse relation between Mexican prices and U.S. prices that generates a margin of excess supplies to export the product. However, this margin of excess supplies, most of the times, reduces stock levels, causing prices in Mexico to increase considerably” (pg. 37). Market data appear support this claim (see figure 9).

The challenge is to represent exports in a manner that reflects the possible motivations and corresponds to observed patterns in the data.

In the first instance, non-competitive exports are a function of the quantity produced in the U.S., the spread of the real contract 16 sugar price less the real price of raw sugar Mexico, and the real price of raw sugar in Mexico or price relative to an average. Based on the assessment above, U.S. production is expected to have a negative impact on exports. The spread between export and domestic sugar prices is expected to have a positive sign. The variation in the real raw sugar price is negative. Moreover, time series models are a function of the monthly prices of raw and refined prices of Mexico to contract 11, 16 and Midwest refined price of sugar beet. These prices are expected to have an effect in the decision making of sugar mills and the decision of exporting or keeping sugar domestically. International markets can also influence domestic prices through different forms of market integration or policy influence.

Empirical Methods

In order to understand the relationship between the domestic prices in Mexico and the domestic price in the U.S. with Mexican price, I use a series of prices over a period of 15 years to look at the co-movement between the price series. I test the transmission through the supply chain in the Mexican domestic market and see how integrated the markets between the U.S. and Mexico are, as well as the international sugar market. Moreover, a second analysis is used to further understand the impact of the new suspension agreement signed in 2014. A structural partial equilibrium model is built with relevant policies, including the policies established between Mexico and the U.S. in the recent suspension agreement, and is used to project prices and quantities over a period of ten-years to assess the impact on the sugar trade between these two countries.

Price Transmission

To test for long-run relationships between domestic prices in Mexico and the relationships between Mexican, U.S., and international prices, I use the Engle-Granger Two-step Co-Integration test (Engle and Granger, 1987). In order to be able to use the Engle-Granger method, we first have to check for any unit root presence, meaning that the data are not stationary. In order to test for the presence of non-stationarity, we apply the Augmented Dickey Fuller (ADF) test to the different price series. It is important to specify the number of lags when performing the unit root test and throughout the analysis. The misspecification of lags could lead to two different outcomes. First, a low number of lags may cause the error terms to be serially correlated, which might bias the results. Second, if too many lags are specified in the model, we lose degrees of freedom. To ensure that the optimal number of lags are included in the model, I use the number of lags that minimizes the Bayesian Information Criterion (BIC).

If the ADF test shows that the individual series has a unit root because we do not have enough evidence to reject the null hypothesis, then the series is not stationary and further inspection is needed. Consequently, in order to remove the unit root in the series, the data need to be differenced. If the data are differenced one time before becoming stationary, then the series is said to be integrated of order one [i.e. I (1)]. The data can be differenced as many times as needed to ensure stationarity. However, one condition for a pair of series to be co-integrated is that they must be integrated of the same order, otherwise their relationship might only be spurious.

The Engle-Granger method consists of two steps. First, the long-run relationship between the different pairs of prices is estimated. For example, the relationship between the log price of raw sugar and the log of other price series can be estimated by OLS as follows:

$$P_{ti} = \beta_0 + \beta_1 P_{tj} + \varepsilon_t \qquad (1)$$

Where $P_{ti}$the raw sugar is price in Mexico and P_{tj} is other price of sugar either from the same country or from international markets, while β_0 is the transaction cost, β_1 is the price transmission elasticity between the two pair of series and ε_{ti} is the error term. Second, for the co-integration test, we take the errors from the estimated price transmission equation and test them for a unit root using ADF test again. If the errors do not exhibit any unit root, i.e. the null hypothesis of unit root is rejected in favor of the alternative hypothesis, and then it means that both series are co-integrated. If it is the case that these two series are co-integrated of the same order, then it means that there is a linear combination of these two series that is stationary. When the two series are co-integrated, according to Engle and Granger, we can quantify these deviations from long run. Given that price transmission only shows the long run relationship, error correction models (ECM) can be used to test for short-run dynamics. Therefore, a necessary condition for ECM is that two series are co-integrated.

ECMs have been popular for estimating price adjustments. Previous studies (Von Cramon-Taubadel, 1998; Verreth et al., 2015; Goychuk and Meyers, 2014) have used ECMs to study the amount of time it takes for prices to go back to an equilibrium. As previously mentioned, several factors can influence the time it takes for short-run deviations to return to equilibrium. One of these factors is market power. Market power theory suggests that at different levels of the supply chain, there can be market concentration that controls prices and, thus, the transmission of prices might not be symmetric. In this paper, I test if there is evidence of asymmetric price transmission in the supply chain and at the international level.

For the case of symmetric price transmission, we would expect prices to move the same along the supply chain. For example, if the price of an intermediate good goes up due to higher operating costs at the farm level, then we would expect that prices increase as well at the end of the supply chain. However, if the cost is reduced and prices of inputs go back to normal, then if price transmission were symmetric we would expect the end user price to decrease at the same relative rate as observed when prices rise. Alternatively, when input price falls at the farm level but the final consumer price takes longer to return to equilibrium than it did when prices were rising, then we have a case of asymmetric price transmission. The symmetric price transmission equation is then specified as follows:

$$\Delta P_{ti} = \beta_0 + \alpha_1 e_{t-1} + \sum_{k=1}^{p-1} \gamma_k \, \Delta \mathrm{P}_{t-k,i} + \sum_{k=0}^{p-1} \emptyset_k \Delta P_{t-k,j} + \varepsilon_t \qquad (2)$$

Where $\Delta P_{ti}$the first difference in raw sugar price in Mexico, α is the speed of adjustment from the deviation from equilibrium, e_{t-1} is the errors from equation (1), where $e_{t-1} = P_{ti} - \mathrm{P}_{tj}$. The term

α_1 should have a negative sign: when the independent variable is above the equilibrium, the adjustment back to equilibrium will tend to require an upward correction in the dependent variable and in *Pi*. However, when the dependent variable is greater than the independent variable, then the dependent variable will be corrected downwards to equilibrium. Lagged variables are added to account for short-run dynamics.

To test for asymmetric price transmission, I estimate a threshold autoregressive model (TAR) (Goychuk and Meyers, 2014, Verreth et al, 2015, Von Cramon-Taubadel, 1998). Von Cramon-Taubadel proposed segmenting the error correction term into two different variables, a positive error correction and a negative error correction. The positive error correction term contains all the positive lagged residuals and the negative error correction term contains the negative lagged residuals of the long run equilibrium model in equation (1).

$$e_{t-1}^{+} \quad \begin{cases} e_{t-1} & \text{If} \quad e_{t-1} > 0 \\ 0 & \text{If} \quad e_{t-1} \leq 0 \end{cases}$$

$$e_{t-1}^{-} \quad \begin{cases} e_{t-1} & \text{If} \quad e_{t-1} \leq 0 \\ 0 & \text{If} \quad e_{t-1} > 0 \end{cases}$$

The final specification for the asymmetric ECM is:

$$\Delta P_{ti} = \beta_0 + \alpha_1 e_{t-1}^{+} + \alpha_2 e_{t-1}^{-} + \sum_{k=1}^{p-1} \gamma_k \Delta \mathrm{P}_{t-k,i} + \sum_{k=0}^{p-1} \emptyset_k \Delta P_{t-k,j} + \varepsilon_t \quad (3)$$

WhereΔP_{ti},β_0,$\Delta \mathrm{P}_{t-k,i}$ and $\Delta P_{t-k,j}$ is the same as in equation (2), and α_1^{+} and α_2^{-} are the asymmetric coefficients. e_{t-1}^{+} indicates that the price is too high compared to its long-run equilibrium. The converse is true for the e_{t-1}^{-} term. Like Verreth et al (2015), I test for the hypothesis that $\alpha_1 = \alpha_2$. If the null hypothesis is rejected, then there is evidence of asymmetric price transmission.

Theoretical Model for Partial Equilibrium

Area and yield equations determine the supply of sugar. For some countries, two supply equations are estimated due to supply of sugar coming from two sources, sugar beet and sugarcane. However, given that Mexico only produces sugar from sugarcane, one sugar supply is estimated.

Sugar cane area depends on expected real gross returns and expected competing crop price. As a proxy for expected real gross returns, the lagged real price expectation times yield is used to calculate lagged real returns. Real corn price is used as a competing crop given that sugar area competes with corn. U.S. marketing year for corn overlaps with Mexican sugar marketing year, real corn prices are then preferred compared to lagged real corn prices. Corn real gross returns per hectare could be used to reflect more accurately the incentive for land allocation, as for sugar, but corn yield is not included in the model at this time. To capture the dynamics of producers' planting decisions, the lagged area variable is included. Area harvested is then

$$SUCA_t = f(SUCA_{t-1}, RGrossRet_{t-1}, RCP_t),$$

where$SUCA_t$, is the sugar area harvested, $RGrossRet_{t-1}$ is the real gross returns and $RCP_t$is the real price of corn.

Sugar cane yield depends upon technology adoption and expected prices and costs. Due to lack of data on costs at the farm level, sugarcane yield is a function of real price and a trend:

$$Yield_t = f(\,Real\ Average(refined\ sugar\ price, raw\ sugar\ price)_{t-1}, trend).$$

Sugarcane production is an identity of sugarcane area harvested times yield:

$$SUCAPR_t = SUCA_t * \ Yield_t.$$

At the sugar mill level, extraction rate is the amount of raw sugar that can be obtained from crushing the cane. Then, extraction rate is a function of technology and previous' year real price of raw sugar:

$$ExtRate_t = f(Real\ Raw\ Sugar\ Price_{t-1}, trend).$$

Then sugar production is an identity of sugarcane production and the extraction rate of sugar from cane sugar. Total sugar production is

$$SUPRD_t = \ SUCAPR_t * ExRate_t.$$

Per capita consumption is a function of the average of the real price of raw and refined sugar and a substitute, in this case, HFCS consumption. HFCS quantity is used because Mexico HFCS price data are not available at this time. Domestic sugar demand per capita is defined as

$$DomConsCap_t = f(Real\ Average\ (Raw\ Sugar\ Price, Refined\ Sugar\ Price)_t, HFCONS_t).$$

Total consumption of sugar is a multiplication of consumption per capita by population size in Mexico as

$$SugarCons_t = DomconsCapt_t * \ Pop_t.$$

Ending stocks reflect opportunity cost of holding higher inventories and this depends on the domestic prices. Usually we would expect stocks to be lower at high prices and have higher ending stocks when prices are low. In addition, current production and beginning stocks are added into the equation to reflect the overall volume of the product that is available in any particular year. This equation is

$$EndStks = f(Real\ Raw\ Sugar\ Price_t, Sugar\ Production, EndStks_{t-1}).$$

Mexican imports depend on the raw domestic price and the refined domestic price of Mexico. This equation is intended to reflect the policy decision to allow more or less imports by discretionary application of over-quota tariffs that appear to be intended to stabilize domestic market prices. As such, this equation takes the form

$$IMP_{mx} = f(Refined\ Sugar\ Price / Raw\ Sugar\ Price)$$

The potential motivations that drive sugar exports are complicated, as noted elsewhere, and the limited amount of relevant historical data might explain why statistical experiments to test hypotheses have not been rewarding. Three equations are used to represent different motivations or representations of exports are implemented. This choice allows the equilibrium model to be used to test various assumptions about what could drive export behavior in the future.

The first export equation is based strictly on the assumption of a competitive environment. This export equation depends on the real domestic price of raw sugar in Mexico:

$$EXP_{mx} = f(Real\ Raw\ Sugar\ Price)$$

The next two equations provide alternative means to estimate export values under the assumption of a non-competitive environment. These equations are

$$EXP_{mx}^{NC} = f(Real\ Raw\ Sugar\ Price, Domestic\ Sugar\ Production, US\ Demand) \text{ and}$$

$$EXP_{mx}^{NC} = f(Refined\ Beet\ Sugar\ Price\ U.S., Raw\ Sugar\ Price\ U.S., Raw\ Sugar\ Price,$$

$$Ending\ Stocks\ Mexico),$$

where the first non-competitive export representation considers the possible motivations of sugar mills to collude as specified in table 3. The second non-competitive export representation is a fit pattern approach where I assume past government policies and programs continue into the future with the assumption that mills are already colluding.

The export equations are not implemented in the model at the same time. Instead, three different versions of the model are used, with the representation of exports being the characteristic that differentiates these representations.

Total sugar supply in Mexico is the sum of sugar production, sugar imports and beginning stocks:

$$Supply = SUPRD + EndStks_{t-1} + IMP_{mx}$$

Total sugar demand for Mexico is

$$Demand = SugarCons + EXP_{mx} + \ EndStks_t$$

The equilibrium raw price is determined by equating supply and demand. A price linkage is used to determine the refined price of sugar in Mexico as a function of the raw sugar price, or

$$Refined\ Sugar\ Price = f(Raw\ Sugar\ Price, Z_i)$$

where Z_i are other factors controlling for refined sugar price in Mexico.

Results

Price Transmission and Error Correction Model

As a first step, to perform the ADF test correctly, the series were examined for the order of integration and the number of lags. Table 7.1 presents the results of the unit root test with and without differencing the data. The number of lags were chosen by minimizing the Bayesian Information Criterion (BIC). The unit root test for the different prices shows that none of the price series is stationary. Furthermore, I re-run the test on the first difference of the log levels.

Table 5ADF Test for Unit Root

	Unit Root test			Unit Root test first difference		
Price Series	No. lags	Constant	Trend	No. Lags	Constant	Trend
Raw Sugar Price Mexico	2	-2.60	-2.78	1	-7.39**	7.38**
Refined Sugar Price Mexico	2	-2.27	-2.44	1	-6.95**	6.95**
Contract 11	2	-1.65	-1.88	1	-8.19**	-8.20**
Contract 16	2	-1.89	-1.99	0	-9.37**	9.35**
Midwest Refined Beet Price	2	-2.01	-1.97	1	-7.44**	7.46**
Average Midwest-Contract16	2	-1.90	-1.90	1	-6.92**	6.92*

Note: ** and * are 5% and 10% significance, respectively

The results show that, after taking the first difference of the log prices, and adding the number of lags required to minimize the BIC, the first difference is sufficient to make the data stationary. Thus, raw price of sugar, refined price of sugar, Contract 11 and 16, and the Midwest price of refined beet sugar are *I* (1). The test includes a trend in case a price is trending upwards or downwards. In any case, the trend seems to be insignificant and has no effect on the outcome.

Next, the long-run relationship among the different pairs and their price transmission elasticity were estimated. Table 7.2 presents the results of the long-run coefficients from the price transmission. Given that all price series are in logs, we can interpret the coefficients as elasticities. We find that the refined sugar price of Mexico has an almost unit elasticity of transmission with respect to the price of raw sugar in Mexico. This elasticity is expected given that refined sugar and raw sugar are integrated at the sugar mill level, so increases in demand of refined sugar would directly transmit the price increase to raw sugar. However, we find that contract 11, which is the international price of sugar, has little transmission or effect on raw sugar of Mexico. This can be attributed to the trade policies Mexico has to protect the sugar industry. As previously discussed in the policy section, Mexico employs a TRQ, which insulates the Mexican market from international prices to an extent.

Moreover, Contract 16, which is considered the domestic price of raw sugar in the U.S., seems to have a high elasticity of price transmission with respect to the raw sugar price in Mexico. The Midwest price seems to have an impact in the price of raw sugar in Mexico. The average of the two prices, Contract 16 and Midwest, seems to have high transmission elasticity impact on Mexican prices, which could be an indication of officials in Mexico trying to keep the price within some range. Moreover, this could mean that government seeks to maintain domestic raw sugar prices within some reasonable range that will ensure positive rents to sugar mills.

Table 6Price Transmission Elasticities

	Raw Price of Sugar Mexico
Refined Price Mexico	1.03**
Contract 11	0.35**
Contract 16	0.91**
Midwest Refined Price of Beet sugar	0.59**
Average Midwest and Contract 16	0.73**

Note: ** and * are 5% and 10% significance, respectively

Table 7Engle-Granger Co-Integration Test

The Engle-Granger method is used to test for co-integration. In order to test for co-integration, I

Pair of Series	No. of lags	ADF
Raw Price Mexico - Refined Price Mexico	2	-4.53**
Raw Price Mexico - Contract 11	2	-3.54**
Raw Price Mexico - Contract 16	2	-4.11**
Raw Price Mexico - Midwest Refined Price	2	-3.52**
Raw Price Mexico - Average of Midwest and Contract 16	2	-3.70**

Note: ** and * are 5% and 10% significance, respectively

use the error terms from equation (1) and include the number of lags that minimize the BIC. Once the correct specification of lags is included, the ADF test is run on the errors. Table 7.3 shows the results from the ADF test. We find that all price series are co-integrated with the raw price of Mexico at the 5% significance level or less. Although the transmission might not be strong with the Contract 11, the co-integration test suggests that the Mexican sugar price tends to move with international and U.S. markets.

Co-integration among the price series is a necessary condition to continue with further analysis like ECM. The Engle-Granger method shows that all price series are co-integrated with raw price of sugar from Mexico. Therefore, we apply the ECM to find the speed adjustment of prices when the raw price of sugar in Mexico is in disequilibrium with other prices. Table 7.4 shows the results of the ECM, in which an autoregressive model is fitted with the first difference of the raw price of sugar from Mexico as the dependent variable. It is a function of previous lags of raw sugar from Mexico and a contemporaneous effect and one lag of the other price series.

The results indicate that previous lags for the raw sugar price of Mexico are significant at the 5% percent level. If for example, raw sugar price in Mexico is 10 cents higher than the value implied by its long-run relationship with contract 16 price in the previous month, then the raw sugar price of Mexico will be corrected downwards by 0.13%. The contemporaneous effect of the refined sugar price in Mexico has a higher impact than the value of the previous month, and the previous month accounts for a negative adjustment. The overall effect in the raw sugar price of Mexico can be attributed to the elasticity and co-integration level between the raw sugar price and refined sugar price of Mexico. We find that across prices, contemporaneous effects have a higher impact on raw sugar price, and that previous month price effects are all positive and significant.

Error correction terms are all significant and with the expected sign. We see that the speed of adjustment is faster for the refined sugar price of Mexico with a coefficient of 0.18. Contract 16 is the second with the highest adjustment for raw sugar price of Mexico. Durbin-Watson (DW) test results are provided to test for autocorrelation in the residuals. All DW statistics are close to two, which means that we fail to reject the null hypothesis of no serial correlation in the residuals.

To continue the analysis and see if different levels of the supply chain can control prices, we continue to develop an asymmetric price transmission model. Table 7.5 shows the result for the asymmetric price transmission, an extension of the error correction model as specified in section 4.1. The results show the expected sign for the different error correction terms, the positive and negative error correction. In the Mexican sugar prices, I find that the positive error correction term adjusts slower when raw sugar price in Mexico is above its equilibrium relative to Mexican refined sugar price. Moreover, the negative error correction term adjusts faster when raw sugar price in Mexico is below the refined sugar price of Mexico.

Similar to the findings of Von Cramon-Taubadel (1998), the negative error correction term is significant and has bigger impact than the positive error correction term. This suggests that wholesale prices will adjust faster towards equilibrium, where the wholesale margins of the pork market are “squeezed”. However, when margins are stretched, the speed of adjustment will be slower. The level of integration between raw sugar and refined sugar in Mexico, suggests that sugar mills will adjust their prices at a faster rate when raw sugar price is below the refined price long-run equilibrium. Moreover, it will take longer to return to equilibrium when raw sugar price is above the refined sugar price. When tested for symmetry, we use the F-test to see if $\alpha_1 = \alpha_2$ in the error correction terms. The test suggests that we have symmetry in the raw and refined price transmission.

Table 8Error Correction Model

	ΔP_t^{Rwmx}	ΔP_t^{Rwmx}	ΔP_t^{Rwmx}	ΔP_t^{Rwmx}	ΔP_t^{Rwmx}
Constant	0.000418	0.00169	0.0017	0.00137	0.00137
ΔP_{t-1}^{Rwmx}	0.36469**	0.35453**	0.36945**	0.37549**	0.36587**
ΔP_{t-2}^{Rwmx}	0.03196	0.02442	0.03543	0.02894	0.02985
ΔP_t^{Refmx}	1.21463**	-	-	-	-
ΔP_{t-1}^{Refmx}	-0.49775**	-	-	-	-
ΔP_t^{C11}	-	0.24077**	-	-	-
ΔP_{t-1}^{C11}	-	0.09272	-	-	-
ΔP_t^{C16}	-	-	0.2932**	-	-
ΔP_{t-1}^{C16}	-	-	0.02926	-	-
ΔP_t^{MWPR}	-	-	-	0.12559*	-
ΔP_{t-1}^{MWPR}	-	-	-	0.07532	-
ΔP_t^{AvMC11}	-	-	-	-	0.21555**
ΔP_{t-1}^{AvMC11}	-	-	-	-	0.09137
e_{t-1}^{rwref}	-0.18541**	-	-	-	-
e_{t-1}^{rwc11}	-	-0.08808**	-	-	-
e_{t-1}^{rwc16}	-	-	-0.13108**	-	-
e_{t-1}^{rwmw}	-	-	-	-0.09017**	-
e_{t-1}^{rwavg}	-	-	-	-	-0.10391**
R-sq	0.87	0.26	0.28	0.23	0.26
Durbin-Watson	2	1.97	1.976	1.95	1.96
F-test	227.48**	12.29**	13.48**	10.56**	11.9**

Note: ** and * are 5% and 10% significance, respectively

Similar to the findings of Von Cramon-Taubadel (1998), the negative error correction term is significant and has bigger impact than the positive error correction term. This suggests that wholesale prices will adjust faster towards equilibrium, where the wholesale margins of the pork market are “squeezed”. However, when margins are stretched, the speed of adjustment will be slower. The level of integration between raw sugar and refined sugar in Mexico, suggests that sugar mills will adjust their prices at a faster rate when raw sugar price is below the refined price long-run equilibrium. Moreover, it will take longer to return to equilibrium when raw sugar price is above the refined sugar price. When tested for symmetry, we use the F-test to see if $\alpha_1 = \alpha_2$ in the error correction terms. The test suggests that we have symmetry in the raw and refined price transmission.

The results of the symmetry test across the different price series are not significant in four out of the five models, so we fail to reject that symmetric price transmission is present in those comparisons. The only model with asymmetric price transmission is the Midwest Refined price of beet sugar. In this model, when raw sugar price from Mexico is higher than the refined beet sugar price in the Midwest, then the raw sugar price from Mexico exhibits a downward adjustment of -0.18.

Table 9Asymmetric Price Transmission

	ΔP_t^{RawM}	ΔP_t^{RawM}	ΔP_t^{RawM}	ΔP_t^{RawM}	ΔP_t^{RawM}
Constant	-0.00201	0.00421	0.00369	0.0115	0.00914
ΔP_{t-1}^{RawM}	0.36781**	0.3546**	0.37035**	0.37686**	0.36847**
ΔP_{t-2}^{RawM}	0.03525	0.02343	0.03397	0.03957	0.03302
ΔP_t^{RefM}	1.2188**	-	-	-	-
ΔP_{t-1}^{RefM}	-0.50518**	-	-	-	-
ΔP_t^{C11}	-	0.24387**	-	-	-
ΔP_{t-1}^{C11}	-	0.08873	-	-	-
ΔP_t^{C16}	-	-	0.29524**	-	-
ΔP_{t-1}^{C16}	-	-	0.02574	-	-
ΔP_t^{MWPR}	-	-	-	0.10456	-
ΔP_{t-1}^{MWPR}	-	-	-	0.06309	-
$\Delta P_t^{AvgMWC16}$	-	-	-	-	0.20605**
$\Delta P_{t-1}^{AvgMWC16}$	-	-	-	-	0.07316
$e_{t-1}^{raw-ref+}$	-0.10841	-	-	-	-
$e_{t-1}^{raw-ref-}$	-0.24523**	-	-	-	-
$e_{t-1}^{raw-C11+}$	-	-0.10984**	-	-	-
$e_{t-1}^{raw-C11-}$	-	-0.07042	-	-	-
$e_{t-1}^{raw-C16+}$	-	-	-0.15022**	-	-

	-	-	-0.10857*	-	-
$e_{t-1}^{raw-C16-}$					
$e_{t-1}^{raw-MW+}$	-	-	-	-0.19982**	-
$e_{t-1}^{raw-MW-}$	-	-	-	-0.02196	-
$e_{t-1}^{raw-avg+}$	-	-	-	-	-0.18853**
$e_{t-1}^{raw-avg-}$	-	-	-	-	-0.04074
R^2	0.8726	0.2689	0.2873	0.2617	0.2765
Durbin-Watson	2.002	1.97	1.972	1.925	1.939
Test for symmetry	1.71 [F(1,167)]	.25 [F(1,167)]	.20[F(1,167)]	5.11**[F(1,167)]	3.17*[F(1,167)]

Notes: * and ****** represent 10% and 5% significance.
Test of Symmetry: $\alpha_1^+ = \alpha_2^-$

The results of the time series experiments relate to the question of market structure, including in particular the question of what motivates Mexico sugar exports. Some of these results are consistent with the hypothesis of competitive exports. For example, results of price transmission elasticities and co-integration show that Mexican market is integrated to the world and U.S. market, but the response between Mexican sugar market and other markets varies. For example, Mexico tends to respond more to U.S. price changes than world price changes Although, Mexico has a TRQ for imports of sugar, contract 16 and contract 11 integration to Mexican prices could partially be explained by the price reference policy and how it is constructed. At the same time, some of the series experiment results are consistent with non-competitive exports. Relevant results are the negative error correction term in raw sugar price and refined sugar price of Mexico and the asymmetric price transmission between the average of contract 16 and Midwest price of refined beet sugar. The speed of the negative error correction term in the series raw and refined price of

Mexico, adjust slower when raw price is above the long-run equilibrium, allowing sugar mills to control prices for a period of time. Moreover, the Midwest asymmetric price transmission and the average of Midwest and contract 16 show that Mexico's price might be controlled to stay within Midwest refined beet price and contract 16. When Mexican raw sugar price gets expensive relative to the long run equilibrium to the average of Midwest price and contract 16, it adjusts faster relative to when it is below the long-run equilibrium. This can be consistent with margin supplies increasing and decreasing, creating this inverse relation between contract 16 and Midwest refined price.

As noted earlier, time series methods might not be enough to answer these questions with confidence. Moreover, the time series methods are necessarily backward looking, as the evidence is based on historical data, so the results might not be applicable to the future market conditions, particularly if the new trade agreement causes some change in market behavior.

Alternative Baselines under Different Export Equations

In this section, details about the three baselines and their different scenarios in exports are presented. Three baseline scenarios are run to project different endogenous variables over the period of 2016 to 2025. The models are grounded on a series of assumptions about the general economy and agricultural policies. The alternative baselines reflect the different possibilities that different motivations drive exports based on the different concepts presented in section 4. Baseline under Competitive Exports

Table 10Baseline with Competitive Exports

Mexico Sugar Supply and Utilization										
Competitive Baseline										
Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Marketing year	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25
					(Thousand hectares)					
Sugarcane area harvested	789	809	812	821	834	848	862	877	892	908
					(Metric tons per hectare)					
Sugarcane yield	68	68	67	67	67	66	66	66	65	65
					(Thousand metric tons)					
Sugarcane production	54,027	55,368	54,710	55,033	55,642	56,240	56,859	57,468	58,094	58,740
					(Percent)					
Sugar extraction rate	12	12	12	12	12	12	12	12	12	12
					(Thousand metric tons)					
Sugar production	6,406	6,553	6,479	6,521	6,596	6,669	6,744	6,818	6,894	6,973
Sugar imports	107	115	114	113	112	112	112	112	112	112
Sugar domestic use	4,926	5,137	5,192	5,247	5,315	5,389	5,463	5,540	5,618	5,697
Sugar exports	1,344	1,424	1,411	1,396	1,391	1,388	1,387	1,385	1,383	1,381
(Exports to U.S.)	1,327	1,407	1,394	1,379	1,374	1,371	1,370	1,368	1,366	1,364
(Other exports)	17	17	17	17	17	17	17	17	17	17
Sugar ending stocks	1,102	1,210	1,201	1,192	1,193	1,197	1,203	1,209	1,214	1,221
					(Pesos per 50 kilograms)					
Standard sugar price	484	425	441	458	468	476	483	491	499	506
Refined sugar price	555	492	510	529	540	549	557	566	575	583
					(US cents per pound)					
Standard sugar price	28	24	24	23	23	23	22	22	21	20
Refined sugar price	32	27	27	27	27	26	25	25	24	24

In the first baseline, with competitive exports, sugarcane area is expected to increase by 16% over the period of the simulation (see table 9). However, yields are expected to decrease as the majority of sugarcane fields are rain-fed and low usage of technology in the field, representing a continuation the recent trend in yield. Consequently, sugar production increases due to higher area harvested, but it only increases by less than ten percent, over the ten-year period. Exports, which are considered to be competitive, remain almost the same throughout the outlook, ranging from 1.3 to 1.4 metric tons, a total increase of almost 3 percent in exports to the U.S. Raw sugar price increases 4 percent over the ten-year projection.

Baseline under Non-Competitive Exports

Table 11Baseline with Non-Competitive Exports

Mexico Sugar Supply and Utilization										
Non Competitive Baseline with Economic Motivations										
Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Marketing year	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25
(Thousand hectares)										
Sugarcane area harvested	789	820	824	832	849	869	888	909	929	950
(Metric tons per hectare)										
Sugarcane yield	68	71	69	69	69	69	68	68	68	67
(Thousand metric tons)										
Sugarcane production	54,027	58,115	57,254	57,453	58,584	59,756	60,683	61,894	62,969	64,063
(Percent)										
Sugar extraction rate	12	12	12	12	12	12	12	12	12	12
(Thousand metric tons)										
Sugar production	6,417	6,882	6,782	6,815	6,955	7,096	7,212	7,360	7,492	7,628
Sugar imports	102	113	113	109	107	107	105	104	103	102
Sugar domestic use	4,817	5,106	5,176	5,180	5,214	5,283	5,316	5,374	5,429	5,477
Sugar exports	1,501	1,708	1,715	1,772	1,852	1,908	2,003	2,081	2,160	2,248
(Exports to U.S.)	1,484	1,691	1,698	1,755	1,835	1,891	1,986	2,064	2,143	2,231
(Other exports)	17	17	17	17	17	17	17	17	17	17
Sugar ending stocks	1,060	1,241	1,245	1,216	1,212	1,224	1,222	1,231	1,238	1,243
(Pesos per 50 kilograms)										
Standard sugar price	536	440	449	490	517	527	554	571	590	612
Refined sugar price	611	508	518	564	592	604	634	653	674	698
(US cents per pound)										
Standard sugar price	31	24	24	25	25	25	25	25	25	25
Refined sugar price	35	28	28	29	29	29	29	29	28	28

In the second baseline, exports are driven by different motivations, like sugar mills profitability, control of exports, and domestic supply. In this case, sugarcane area is expected to increase by 20% over the 10-year projection (see table 10). Sugar yield falls only slightly because of a strong price. Sugar production is expected to rise from 6.4 million MT to 7.6 million MT, an increase of roughly 19% in production over the 10 years. Under this baseline, exports in marketing years 2016/2017 increase. Due to lower prices after 2016 and an increase in the production of sugar, sugar mills increase their exports. Exports are expected to increase to the U.S. by 24%, from 2017 to 2025. Prices remain above the 400 pesos/50kg or 23 USD cents/lb.

Baseline under Non-Competitive Exports under a Best-Fit Approach

Table 12Baseline with Non-Competitive Exports and a Pattern fit

Mexico Sugar Supply and Utilization										
	Non Competitive Baseline with Best Fit Exports									
Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Marketing year	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25
	(Thousand hectares)									
Sugarcane area harvested	789	808	826	846	868	889	911	932	954	977
	(Metric tons per hectare)									
Sugarcane yield	68	68	68	68	68	67	67	67	67	66
	(Thousand metric tons)									
Sugarcane production	54,027	55,278	56,226	57,477	58,755	59,910	61,162	62,295	63,524	64,797
	(Percent)									
Sugar extraction rate	12	12	12	12	12	12	12	12	12	12
	(Thousand metric tons)									
Sugar production	6,405	6,557	6,676	6,831	6,987	7,130	7,283	7,424	7,576	7,734
Sugar imports	107	107	104	103	102	100	100	98	97	96
Sugar domestic use	4,934	4,990	5,016	5,051	5,096	5,133	5,181	5,220	5,258	5,301
Sugar exports	1,332	1,626	1,765	1,880	1,985	2,095	2,193	2,300	2,411	2,523
(Exports to U.S.)	1,315	1,609	1,748	1,863	1,968	2,078	2,176	2,283	2,394	2,506
(Other exports)	17	17	17	17	17	17	17	17	17	17
Sugar ending stocks	1,106	1,153	1,153	1,154	1,162	1,164	1,173	1,176	1,179	1,186
	(Pesos per 50 kilograms)									
Standard sugar price	480	495	526	553	573	600	619	646	672	697
Refined sugar price	551	568	601	631	653	683	704	733	762	790
	(US cents per pound)									
Standard sugar price	28	27	28	28	28	28	28	28	28	28
Refined sugar price	32	31	32	32	32	32	32	32	32	32

The best-fit approach assumes implicitly previous export policies and patterns continue into the future. Under this baseline, sugarcane area harvested is expected to increase 23% from 790 thousand hectares to 977 thousand hectares from 2016 to 2025 (see table 11). Sugar yields slip somewhat in this baseline. Sugar Production increases 10% over the period of analysis a total of 7734 thousand MT in 2025. Exports to the U.S. rapidly increase in 2017 to 1.6 million MT, a

22% increase from the previous year. However, exports continue to increase over the period of analysis at a much slower pace, an average of 6% after 2017 to 2025. Raw sugar price in Mexico increase linearly from 480 pesos per 50kg bag to 697 pesos per 50 kg bag (27.68 USD cents/lb. to 28.25 USD cents/lb.).

Scenario Analysis Results

In December of 2014, Mexico and the U.S. signed a new agreement that would limit the amount of sugar exports from Mexico to the U.S. Under this agreement, Mexico only exports sugar to the U.S., by voluntarily reducing its exports, based on U.S. total needs. U.S. need for the purposes of this agreement is calculated using a formula determined by the USDA as follows:

U.S. Total Needs of Sugar = 1.135*(Total Domestic Use in the U.S.) – Total U.S. Domestic Supply,

where

Total U.S. = Domestic Use and Total Exports, and

Total Supply= Domestic Production plus Total Imports <u>excluding Mexican Imports.</u>

A second policy included in the agreement is that Mexico is also subject to a minimum price when selling raw sugar to the U.S. The export price must be at least 22.25 cents per pound. The minimum price and the voluntary export restraint are included in the three different baselines that were previously mentioned.

The suspension agreement on Mexican exports has different effects on Mexican sugar market. Depending on the assumptions on market structure for exports, the policies can have an impact on the area planted, sugar production, and prices domestically.

Scenario Analysis under Competitive Exports

Mexico Sugar Supply and Utilization										
Percent Change from Baseline										
Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Marketing year	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25
					(Thousand hectares)					
Sugarcane area harvested	0.0%	-0.4%	-0.1%	0.0%	-0.8%	-0.8%	-1.0%	-0.4%	-0.1%	-0.2%
					(Metric tons per hectare)					
Sugarcane yield	0.0%	-0.2%	0.1%	0.0%	-0.5%	-0.2%	-0.3%	0.1%	0.1%	-0.1%
					(Thousand metric tons)					
Sugarcane production	0.0%	-0.7%	0.0%	0.0%	-1.3%	-1.1%	-1.3%	-0.3%	0.0%	-0.3%
					(Percent)					
Sugar extraction rate	-0.1%	0.0%	0.0%	-0.1%	0.0%	-0.1%	0.0%	0.0%	0.0%	-0.1%
					(Thousand metric tons)					
Sugar production	-0.1%	-0.6%	0.0%	-0.1%	-1.3%	-1.1%	-1.3%	-0.3%	0.0%	-0.4%
Sugar imports	1.7%	-0.8%	-0.3%	4.0%	1.7%	2.5%	-0.7%	-0.7%	0.9%	2.3%
Sugar domestic use	0.7%	-0.3%	-0.1%	1.3%	0.6%	0.8%	-0.3%	-0.2%	0.3%	0.8%
Sugar exports	-3.7%	-0.5%	-0.2%	-7.0%	-6.7%	-8.7%	-3.5%	-1.1%	-2.4%	-5.6%
(Exports to U.S.)	-3.7%	-0.5%	-0.2%	-7.1%	-6.8%	-8.8%	-3.5%	-1.1%	-2.4%	-5.6%
(Other exports)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Sugar ending stocks	1.2%	-0.8%	-0.3%	2.2%	0.3%	0.6%	-1.4%	-0.9%	0.4%	1.0%
					(Pesos per 50 kilograms)					
Standard sugar price	-3.4%	1.5%	0.5%	-7.2%	-3.3%	-4.6%	1.5%	1.4%	-1.6%	-4.2%
Refined sugar price	-3.2%	1.4%	0.5%	-6.7%	-3.1%	-4.3%	1.4%	1.3%	-1.5%	-3.9%
					(US cents per pound)					
Standard sugar price	-3.4%	1.5%	0.5%	-7.2%	-3.3%	-4.6%	1.5%	1.4%	-1.6%	-4.2%
Refined sugar price	-3.2%	1.4%	0.5%	-6.7%	-3.1%	-4.3%	1.4%	1.3%	-1.5%	-3.9%

The competitive exports scenario reduces the amount of exports to the U.S. The effects of the voluntary export restraint are not big on the export amount when compared to the baseline. For the period of the projection, Mexico exports are generally higher than the limit set by the agreement. The exceptions are in fiscal years 2017 and 2018, when exports fall short of the agreement by 345 thousand MT and 18 thousand MT. Moreover, for the years that Mexican export of sugar to the U.S. are constrained because Mexican exports exceed the amount agreed in the contract, the exceeding amount ranges from 7.1 thousand MT to 146 thousand MT.

Sugar market impacts of this scenario are presented in terms of percentage changes from the baseline. Under the agreement, Mexico exports almost 4% less than in the baseline in fiscal year 2016. This change results in 3% lower raw and refined sugar prices domestically as compared to the baseline. Ending stocks increase as a result of lower export demand, which total demand is lower. Raw sugar prices in Mexico decrease by 2% average over fiscal years 2016 to 2025 relative to the baseline. Sugarcane area harvested increases over the 10-year projection. However, area harvested decreases from the baseline due to lower prices, which decreases gross returns to sugarcane growers. Sugar production, being dependent on cane production, also decreases, but elasticities are less than one so the overall effect on sugar production is 0.5% less than the baseline.

Although prices are overall lower than the baseline, they follow an upward trend and range between 425 and 498 pesos per 50 kg (20 cents/lb USD and 27 cents/lb USD). This is well above the historic average. Over the last 21 years, the price of raw sugar in Mexico has averaged around 309 pesos per 50 kg, and in the last 8 years, since NAFTA went into full effect; raw sugar price averaged 430 pesos per 50 kg.

Scenario Analysis under Non-Competitive Factors Determining Exports

Under the Scenario where Mexican exports are driven by different motivations, we find that the export limit is exceeded over the period of analysis except for fiscal year 2017. In fiscal year 2017, Mexican exports of sugar fall short of the voluntary export restraint by 65 thousand metric tons. A combination of low prices in the previous year, a decrease in area harvested following the lagged response and a decrease in sugar production, combined with a decrease of imports, all cause raw sugar prices surge 8% compared to the baseline.

In the first five years of the scenario, the agreement decreases Mexican exports by 18% from the baseline. During this same period, stocks build up and increase 3%, while imports increase 8%.

Raw sugar prices in Mexico decrease 13% over the first five years when compared to the baseline. Domestic consumption of sugar remains between 3 and 4% above the baseline from 2016 to 2020. Sugarcane area response is delayed, but the lower prices eventually reduces the returns and area harvested.

	Percent Change from Baseline									
Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Marketing year	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25
					(Thousand hectares)					
Sugarcane area harvested	0%	-2%	0%	-2%	-4%	-5%	-5%	-5%	-5%	-6%
					(Metric tons per hectare)					
Sugarcane yield	0%	-1%	0%	-1%	-2%	-1%	-1%	-1%	-2%	-2%
					(Thousand metric tons)					
Sugarcane production	0%	-3%	0%	-4%	-6%	-6%	-6%	-6%	-7%	-8%
					(Percent)					
Sugar extraction rate	-0.2%	0.1%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.4%	-0.5%
					(Thousand metric tons)					
Sugar production	0%	-3%	0%	-4%	-6%	-6%	-7%	-7%	-7%	-8%
Sugar imports	7%	-4%	13%	14%	11%	12%	10%	11%	14%	17%
Sugar domestic use	3%	-1%	4%	4%	4%	4%	4%	4%	5%	6%
Sugar exports	-14%	-1%	-17%	-27%	-30%	-34%	-33%	-34%	-38%	-42%
(Exports to U.S.)	-14%	-1%	-17%	-27%	-30%	-34%	-33%	-34%	-38%	-42%
(Other exports)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sugar ending stocks	5%	-4%	5%	5%	2%	2%	1%	1%	2%	3%
					(Pesos per 50 kilograms)					
Standard sugar price	-13%	8%	-20%	-23%	-18%	-20%	-18%	-19%	-23%	-27%
Refined sugar price	-12%	7%	-19%	-21%	-17%	-19%	-17%	-18%	-22%	-26%
					(US cents per pound)					
Standard sugar price	-13%	8%	-20%	-23%	-18%	-20%	-18%	-19%	-23%	-27%
Refined sugar price	-12%	7%	-19%	-21%	-17%	-19%	-17%	-18%	-22%	-26%

The VER has a stronger effect on exports to the U.S. in the second half of the projection. Over the last five years, exports to the U.S. decrease on an average of 36%. Over the last five years, an average of 754 thousand metric tons are expected not to make it to the U.S. market due to the VER. Consequently, excess supplies of sugar in Mexico increase, and reduces domestic prices of raw sugar by an average of 22% compared to the baseline during the last five years of the projection. Some of the excess supplies of sugar that did not make it to the U.S. are offset by domestic use due to a decrease in price. On average, domestic use of sugar increases 256 thousand metric tons, or an increase of 5% over the fiscal years of 2021 to 2025. Raw sugar prices decrease by 17% over the entire projection when compared to the baseline.

Scenario Analysis under Non-Competitive with Pattern Fit to Exports

Due to lack of sufficient relevant annual data, the many potential proxy variables and other obstacles to statistical estimation. I fit the export equation with historical values using non-statistical methods. Patterns of exports and price relationships, in general terms, drive this representation. This representation also assumes that previous policies and behavior continue into the future whatever the reasons or goals of such policies and behavior by sugar mills and government, as in previous experiments.

					Mexico Sugar Supply and Utilization					
Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Marketing year	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25
					(Thousand hectares)					
Sugarcane area harvested	0%	0%	-2%	-3%	-5%	-5%	-6%	-6%	-7%	-7%
					(Metric tons per hectare)					
Sugarcane yield	0%	0%	-1%	-1%	-2%	-2%	-2%	-2%	-2%	-3%
					(Thousand metric tons)					
Sugarcane production	0%	-1%	-4%	-4%	-6%	-7%	-8%	-8%	-9%	-10%
					(Percent)					
Sugar extraction rate	0%	0%	0%	0%	0%	0%	0%	0%	-1%	-1%
					(Thousand metric tons)					
Sugar production	0%	-1%	-4%	-4%	-7%	-8%	-9%	-8%	-9%	-10%
Sugar imports	1%	11%	6%	14%	12%	15%	12%	13%	16%	19%
Sugar domestic use	1%	4%	3%	5%	5%	6%	5%	6%	7%	8%
Sugar exports	-3%	-18%	-19%	-31%	-35%	-40%	-39%	-40%	-44%	-48%
(Exports to U.S.)	-3%	-18%	-19%	-31%	-35%	-40%	-39%	-41%	-44%	-49%
(Other exports)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sugar ending stocks	1%	6%	2%	5%	3%	3%	1%	2%	3%	4%
					(Pesos per 50 kilograms)					
Standard sugar price	-3%	-18%	-12%	-23%	-21%	-24%	-21%	-23%	-27%	-31%
Refined sugar price	-2%	-17%	-11%	-22%	-20%	-23%	-20%	-22%	-26%	-29%
					(US cents per pound)					
Standard sugar price	-3%	-18%	-12%	-23%	-21%	-24%	-21%	-23%	-27%	-31%
Refined sugar price	-2%	-17%	-11%	-22%	-20%	-23%	-20%	-22%	-26%	-29%

Exports to the U.S. are expected to fall by an average of 665 thousand metric tons over the 10-year projection with the VER in place. Moreover, the last five years have the biggest impact, with an expected decrease of 961 thousand metric tons. This is equivalent to a decrease of 32% of exports to the U.S. for the entire period and a decrease of 43% over the last 5 years of the projection when exports are constrained by the agreement.

Excess supplies of sugar in Mexico increase, putting downward pressure on domestic prices. Prices are expected to range between 405 pesos to 498 pesos per 50 kg (between 22 cents to 27 cents per pound USD). This is a total decrease in domestic raw sugar price of 20% from the baseline. Lower prices have an effect in the sugarcane area, production and domestic consumption. Sugarcane area harvested does not decrease much over the first half of the projection. However, as returns begin to decrease due to lower prices, area harvested decreases the most over the second half of the projection. Area harvested decreases a total of 2% over the first five years of the projection and 6% over the second half, an average of 4% difference from the baseline from 2016 to 2025.

Sugar production responds faster to price changes, the first half of the period sees a drop in sugar production of 3%, and there is a decrease of 9% in the second half, when compared to baseline sugar production. Sugar production decreases 6%, on average, over the entire period. Moreover, lower prices encourage the beverage and confectionary industry to consume more sugar, as well as household consumption. Domestic use is expected to increase by an average of 5% over the baseline.

Conclusion

Mexican exports of sugar to the U.S. raises important research questions. In the fiscal years of 2012 and 2013, sugar exports to the U.S. increased to new record levels, triggering price support levels in the U.S. The American Sugar Alliance petitioned Department of Commerce and the International Trade Commission to investigate the possibility that Mexico was dumping sugar and subsidizing sugar exports. Moreover, government ownership of mills raised questions about whether the market is competitive or non-competitive. After preliminary results of antidumping and countervailing duties investigations, results showed that Mexico had indeed subsidized and dumped sugar into the U.S. After rounds of negotiations, governments reached an agreement where Mexico committed itself voluntarily to restrain its exports. Mexican exports are now constrained to U.S. total needs based on a formula that determines the level of imports from Mexico. The implications of the VER can have different economic impacts depending on the level of non-competitive behavior in the Mexican export market. In order to test for non-competitive market, I use time series analysis to test for asymmetric price transmission and market integration among spatially separated markets. Moreover, I develop a partial equilibrium model where I estimate the impact of the VER under a competitive and non-competitive Mexican export market. Mexican raw sugar market was found to be integrated to international and U.S. In addition, given the integration of production of raw sugar and refined sugar at sugar mill level, the co-integration test results suggest that Mexican raw and refined sugar markets are integrated. The influence of the international and domestic markets has on raw sugar prices varies, however. Raw sugar prices are influenced greatly by the U.S. price and to a lesser extent by the world raw sugar price. The price transmission effect from raw sugar price in the U.S. and world raw sugar could be caused, at least in part, by the reference price system that determines the payment for sugarcane derived from raw sugar domestic market prices and international sales. Moreover, asymmetric price transmission models showed that raw sugar prices in Mexico adjust at a slower rate when they are above the long-run equilibrium with respect to the refined sugar price of Mexico, than when the raw sugar price is below the refined sugar price. However, there was not enough evidence to reject the null hypothesis of symmetric price transmission, domestically. Mexican raw sugar price is integrated to U.S. raw sugar price and Midwest refined beet sugar price. Although, raw sugar price in Mexico responds asymmetrically to price changes from the Midwest refined beet sugar price, it does not show that exporters are able to take actions that keep the raw sugar price in Mexico higher than in the U.S.. Time series results show that raw sugar price in Mexico is integrated with international prices and at different levels of the supply chain. However, the results do not support the hypothesis of Mexican sugar mills colluding and controlling domestic prices.

Time series experiments suggest little or no collusion in the Mexican export market of sugar. However, time series experiments are not a perfect measure for analyzing competition among markets. Moreover, competition in the historical period might not be relevant for coming years. Therefore, we test different forms of the Mexican export markets, competitive and non-competitive, to assess the impact of the VER under the different export market structures.

Three different baselines regarding different market representations were used to assess the economic impact of the new agreement between the U.S. and Mexico. All scenarios show that prices will decrease with the VER when compared to their respective baselines without the VER. In the case with competitive exports, the VER causes only small changes in the sugar price in Mexico. However, when exports assume more collusion in the market, the baseline levels of sugar exported to the U.S. are much larger so imposing the VER has a more serious effect. The lowest projected price the scenarios with the VER in place is roughly 400 pesos per 50 kg (22 cents per pound USD). This price is 30 pesos lower than the average from the last 8 years since full implementation of NAFTA.

The introduction of the new agreement with the VER is likely to have modest impacts on Mexican sugar market given that there appears to be limited or no collusion in exports. Domestically, sugar production decreases on average from its baseline over the projection period. However, the decrease in sugar production is minimal. Lower domestic prices increases the domestic consumption of sugar, but this percentage change over the projection period is also small.

This study has limitations in the results. Time series results show that there is no evidence of collusion. However, time series tests are not a perfect measurement of competition in the historical period and those results might not be relevant for the projection period. Under the partial equilibrium model, we tested three different specifications for exports. However, the mathematical representation for the export equation with motivations that might determine exports under the non-competitive case is still uncertain. Due to lack of data and specific variables that might represent motivations that determine exports, proxy variables were used to reflect the incentives that might drive exports.

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