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Increasing the United States Tariff-Rate Sugar Quota for Cuba and Mexico: A Partial-Equilibrium Simulation

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Increases in the United States tariff-rate quota for sugar are simulated to determine the impact of Cuban market access and an increased Mexican allotment. The effects on both domestic and international sugar markets, including production, consumption, prices, and trade, are determined and welfare effects identified. This analysis is carried out using a partial-equilibrium simplified world trade model, *Modele Internationale Simplifié de Simulation* (MISS), which simulates, in a comparative-static framework, the effects of various policy actions.

Key Words: Cuba, Mexico, sugar, tariff-rate quota

JEL Classifications: F13, F17, Q17

In 1960, President Eisenhower enacted an economic embargo on Cuba, which is still in effect today. However, recent developments in Congress indicate a move toward cooperation with Cuba. Such actions include the introduction of the Cuban Humanitarian Trade Act of 1999, introduced in the House, the Cuban Food and Medicine Security Act of 1999, introduced in the Senate, as well as the United States–Cuba Trade Act of 2000, introduced in both the House and Senate.

The possibility of resuming trade with Cuba, along with the increase in trade with Mexico and Canada due to the North America Free Trade Agreement (NAFTA) create an environment of uncertainty in U.S. markets. Of major concern is NAFTA's influence on U.S. and Mexican sugar production, demand, and prices. This concern also holds true for the case of Cuba, the world's fifth-largest sugar exporter and, prior to the revolution of 1959, supplier of over one third of total sugar requirements to the United States (Alvarez and Castellanos). Beginning in the year 2000, Mexico will be able to export up to 250,000 metric tons (MT) to the U.S. market, and by the year 2008, will potentially have unlimited access.

The purpose of this study is to identify the status quo of the sugar markets of Cuba, Mexico, and the United States, and then simulate various increases in the current U.S. tariff-rate quota (TRQ) for sugar to include Cuba and account for increases in Mexico's allocation. The simulated effects on both domestic and international sugar markets, including production, consumption, prices, and trade, are reported. Also reported are the simulated wel-

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fare effects for the U.S. sugar market. This study will be carried out using a partial-equilibrium simplified world trade model known as *Modele Internationale Simplifié de Simulation* (MISS), which simulates, in a comparative-static framework, the effects of various policy actions.

Overview of the Tariff-Rate Quota

The current U.S. sugar program has differed from the grains, rice, and cotton programs in that the USDA has made no income transfers to beet or cane growers. Instead, the incomes of producers has been indirectly supported by limiting the amount of imported sugar through import quotas (Jurenas). The sugar program's provision of no net cost to the federal government also brought about the use of the import quota to support domestic prices and prevent loan forfeitures (Uri and Boyd). Quota allocations are given to quota-holding countries that allow the import of specific quantities of sugar produced in those nations at a first-tier, or low-tier, duty rate, which ranges from zero to 0.625 U.S. cents per pound. Imports above the allocated tariff-rate quota from either the quota-holding countries or other countries are subject to a second-tier, or high-tier, duty. This high-tier duty has historically been high enough to discourage the importation of sugar above the low-tier quota (Henneberry and Haley).

Theoretical Framework

The current work utilizes a framework (Johnson, Mahé, and Roe; Kennedy, von Witzke, and Roe; Mahé, Tavera, and Trochet) in which N commodities are produced, consumed, and traded by K countries. Vectors of supply, demand, and excess demand are used to describe aggregate levels of production, consumption, and trade in each country. The supply sector in country k produces some combination of the N commodities in order to maximize producer rents given prices, technology, and endowments. Aggregate production of the N commodities is described by the vector of supply functions:

$$(1) \quad S_k(P_k^S; Z_k^S) = [S_{1k}(P_k^S; Z_k^S), S_{2k}(P_k^S; Z_k^S), \ldots, S_{Nk}(P_k^S; Z_k^S)],$$

where $P_k^S = (P_{1k}^S, P_{2k}^S, \ldots, P_{Nk}^S)$ is the vector of prices observed by the supply sector and Z_k^S is a vector of exogenous variables, such as technology, input prices, and endowments for the supply sector of country k. The vector of demand functions describes aggregate consumption of the N commodities:

$$(2) \quad D_k(P_k^D; Z_k^D) = [D_{1k}(P_k^D; Z_k^D), D_{2k}(P_k^D; Z_k^D), \ldots, D_{Nk}(P_k^D; Z_k^D)],$$

where $P_k^D = (P_{1k}^D, P_{2k}^D, \ldots, P_{Nk}^D)$ is the vector of prices observed by the final demand sector and Z_k^D is a vector of exogenous variables for country k. The aggregate level of trade in the N commodities for country k is described by the excess demand functions:

$$(3) \quad M_k(P_k^S, P_k^D; Z_k^S, Z_k^D) = D_k(P_k^D; Z_k^D) - S_k(P_k^S; Z_k^S),$$

where $M_k = (M_{1k}, M_{2k}, \ldots, M_{Nk})$ and $M_{ik} > 0$ indicates net imports and $M_{ik} < 0$ indicates net exports of commodity i for $i = 1, 2, \ldots, N$.

The government of a country may intervene in the domestic market either through the use of price (π) or supply/demand shift (θ) instruments. A price instrument, denoted as $A_{ik}^{\pi S}$ for producers and $A_{ik}^{\pi D}$ for consumers of commodity i in country k, affects the prices observed by the supply and final demand sectors. With the world price of commodity i represented as P_i^W, the domestic price functions for country k are

$$(4) \quad P_{ik}^S = P_{ik}^S(A_{ik}^{\pi S}, P_i^W) \quad \text{and}$$
$$P_{ik}^D = P_{ik}^D(A_{ik}^{\pi D}, P_i^W), \quad \text{for } i = 1, 2, \ldots, N.$$

Supply/demand shift instruments, denoted as $A_{ik}^{\theta S}$ for producers and $A_{ik}^{\theta D}$ for consumers of good i in country k, are implicit elements of vectors Z_k^S and Z_k^D, which shift supply and demand functions by modifying nonprice elements of a producer's or consumer's decision-making process. Examples include input subsidies, acreage reduction schemes, and food stamps. To make these supply and demand shifters explicit, the vectors Z_k^S and Z_k^D are defined as follows:

$$(5) \quad Z_k^S = Z_k^S(A_k^{\theta S}, Z_k^{*S}) \quad \text{and}$$

$$Z_k^D = Z_k^D(A_k^{\theta D}, Z_k^{*D}).$$

The aggregate supply, demand, and excess demand Equations (1), (2), and (3), respectively, can be expressed as functions of world price, policy instruments, and exogenous variables by substituting the domestic price functions of Equation (4) and the function of explicit variables of Equation (5) to obtain

$$(1a) \quad S_k[P_k^S(A_k^{\pi S}, P^W), A_k^{\theta S}; Z_k^{*S}],$$

$$(2a) \quad D_k[P_k^D(A_k^{\pi D}, P^W), A_k^{\theta D}; Z_k^{*D}], \quad \text{and}$$

$$(3a) \quad M_k[P_k^S(A_k^{\pi S}, P^W), P_k^D(A_k^{\pi D}, P^W), A_k^{\theta S}, A_k^{\theta D}; Z_k^{*S}, Z_k^{*D}],$$

where $P_k^j(A_k^{\pi j}, P^W) = [P_1^j(A_1^{\pi j}, P^W), P_2^j(A_2^{\pi j}, P^W), \ldots, P_N^j(A_N^{\pi j}, P^W)]$, for $j = S, D$.

World markets are competitive by assumption, and world prices adjust to clear world markets. Therefore,

$$(6) \quad \sum_{k=1}^{K} M_k[P_k^S(A_k^{\pi S}, P^W), P_k^D(A_k^{\pi D}, P^W), A_k^{\theta S}, A_k^{\theta D}; Z_k^{*S}, Z_k^{*D}] = 0,$$

where the right-hand side of Equation (6) is an $N \times 1$ null vector. World prices are defined as functions of the actions of individual countries. Thus the world price vector is the function

$$(7) \quad P^W = P^W(A_k^{\pi S}, A_k^{\pi D}, A_k^{\theta S}, A_k^{\theta D}; Z_k^{*S}, Z_k^{*D}), \quad \text{for } k = 1, 2, \ldots, K.$$

Empirical Analysis

The empirical framework is provided by MISS, developed by Mahé, Tavera, and Trochet. It is a multiproduct, multiregional, nonspatial, partial-equilibrium, world trade model, which simulates, in a comparative-static framework, the effects of various policy actions. Mahé, Tavera, and Trochet used the MISS for an analysis of the interaction between European and United States policies. The model consisted of seven commodities and four regions: the European Union, the United States, a market-based Rest of the World (ROW), and a centrally planned ROW. Kennedy, von Witzke, and Roe utilized the MISS to study policy decisions made during the Uruguay Round of the General Agreement of Tariffs and Trade (GATT) negotiations. This model consisted of seven commodities and three sectors: the European Union, the United States, and the ROW. Kennedy and Hughes used the MISS to analyze welfare effects of agricultural trading blocs by simulating a North American customs union.

The present model consists of four regions: Cuba, Mexico, the United States, and an aggregated ROW. In order to create a framework in which cane sugar and beet sugar are perfect substitutes, only one commodity is specified within the model: refined sugar. By expressing beet and cane production in terms of sugar produced rather than beet or cane produced, the levels of supply can be directly compared with the levels of demand. Thus the model assumes sugar is produced by the farmer and sold directly to the consumer. However, to capture supply response differences between beet and cane production, two distinct production sectors, sugar beet producers and sugarcane producers, are specified in each region that produces the same commodity. Of course, since Cuba and Mexico produce sugar primarily from sugarcane alone, their respective levels of sugar beet production are zero. One demand sector is specified, representing aggregate consumption of sugar by both industrial and nonindustrial users. Since only one commodity is specified within the model, only one price is specified as well. This assumption has two important implications. First, the results of this analysis will not take into account the impact of high-fructose corn syrup. In addition, given that the model uses an equivalent

Table 1. Production, Supply, and Distribution of Sugar, Fiscal Year 1999, in 1,000 Metric Tons Raw Value

	Beginning Stocks	Production	Imports	Exports	Domestic Consumption	Ending Stocks
United States	1,523	7,597	1,655	209	9,079	1,487
Beet		4,013				
Cane		3,584				
Mexico	670	4,985	0	590	4,400	665
Cuba	290	3,780	0	3,200	720	150
ROW	23,309	114,307	34,265	31,921	110,158	28,341
Beet		28,310				
Cane		85,997				
Total	25,792	130,669	35,920	35,920	124,357	30,643

Note: All figures rounded to the nearest whole number. ROW is rest of the world.
Source: USDA *Sugar and Sweetener Situation and Outlook Report* SSS-228, May 2000 and FAS GAIN reports.

price for sugar beets and sugarcane, there will be no cross-effects between cane and beet sugar.

This model makes use of the London Daily Price for refined sugar reported by the U.S. Department of Agriculture (USDA) as the world refined sugar price. To model domestic price departure from world prices, protection coefficients are specified for each region. In the case of the United States, this coefficient is based on the U.S. wholesale refined beet sugar price, Midwest Markets, reported by *Milling & Baking News* and listed in the USDA Economic Research Service (ERS) *Sugar and Sweetener Situation and Outlook Report* (SSR). Since the United States utilizes an import quota to support domestic prices, initial protection coefficients for supply and demand are equal. This is also true of Mexico, which, beginning in the year 2000, is required under NAFTA to implement a similar import control system. Mexico's protection coefficient is based on refined sugar prices reported in the USDA FAS GAIN Reports (USDA, FAS). Cuba is assumed to respond to the world market price, and thus has a protection coefficient of 1.

For simplicity, transportation costs are assumed to be zero. Given this, each region has a margin coefficient of 1. This is a realistic assumption given the proximity of the countries analyzed; transportation costs between the three counties are small relative to those with the rest of the world. In addition, given the nature of the U.S. sugar policy, assuming transportation costs to be zero will have little effect on the estimation of U.S. welfare changes, a primary objective of this analysis.

MISS does not specify beginning or ending stocks for each region. Instead, general "world stocks" are specified, which account for world excess supply/demand in order to balance the model. Table 1 contains production, supply, and distribution data for Cuba, Mexico, the United States, and the ROW, reported in SSR. For fiscal year 1999, average wholesale refined sugar prices were 22.87¢/lb., 27.02¢/lb., and 9.81¢/lb. for Mexico, the United States, and the world, respectively (USDA, 2000).

The elasticities used in the empirical model were obtained from various sources. Own-price elasticities for Cuba, Mexico, and U.S. sugar supply and demand are categorized according to short-run, long-run, or term indefinite elasticities. Using production and consumption levels, percentage shares of the ROW market were calculated and then used as weights for the respective elasticities to arrive at ROW own-price elasticities of supply for beet and cane production, as well as ROW demand elasticities. Table 2 summarizes the own-price supply and demand elasticities chosen for the model. Since sugar beets and sugarcane do not compete for land, cross-price

Table 2. Own-price Supply and Demand Elasticities Used in *Modele Internationale Simplifié de Simulation* (MISS)

	Short-run Elasticities				Long-run Elasticities			
	U.S.	Mexico	Cuba	ROW	U.S.	Mexico	Cuba	ROW
Supply								
Beet	0.34	—	—	0.10	0.86	—	—	0.43
Cane	0.14	0.18	0.13	0.23	0.40	0.67	0.68	0.62
Demand								
Sugar	−0.14	−0.73	−1.40	−0.64	−0.50	−0.73	−1.40	−0.64

Note: ROW is rest of the world.
Source: Production and consumption data were taken from USDA ERS *Sugar and Sweetener Situation and Outlook Report* SSS-228, May 2000, and USDA FAS GAIN reports. Elasticities were taken from Devadoss, Kropf, and Wahl; Gardiner, Roningen, and Liu; Messina and Seale; Sigua; Uri and Boyd; Tanyeri-Abur et al.; and Tyers and Anderson.

elasticities of supply were assumed to be zero. Also, since sugar is the only commodity within the model, there are no cross-price elasticities of demand.

Trade Liberalization Scenarios

Four scenarios, summarized in Table 3, were developed in which the United States import quota was gradually increased relative to the base year. These scenarios are carried out to simulate increased imports of sugar to the United States from both Mexico and Cuba.

The base scenario simulates NAFTA sugar provisions with the side letter during its first 6 years. This results in Mexico being able to export up to 25,000 MT to the United States, depending on its surplus production level. Mexico was required by the sixth year of NAFTA, 2000, to adopt a tariff-rate quota system with rates that match the tariff levels employed by the United States (ERS, 1999). Given this, no policy changes are simulated for Mexico; they are incorporated into the base scenario.

Table 3. Scenarios Simulated in *Modele Internationale Simplifié de Simulation* (MISS)

	U.S. Import Quantity Allocated (Metric Tons)		
Scenario	Cuba	Mexico	Total
Base	0	25,000	25,000
1	0	250,000	250,000
2	100,000	500,000	600,000
3	500,000	500,000	1,000,000

Scenario 1 simulates years 7 through 14 of the agreement, with potential Mexican access into the U.S. market of 250,000 metric tons raw value (MTRV). Since the base scenario contains Mexico's previously allocated 25,000 MTRV, scenario 1 imposes a quota increase of 225,000 MTRV. Scenario 2 simulates Mexico, under an unlimited access status, exporting 500,000 MTRV to the United States, whereas Cuba is allocated 100,000 MTRV. In scenario 3, Cuba and Mexico are each given an import quota allocation of 500,000 MTRV.

Simulation Results

The results of these simulations are presented in Tables 4–6. Table 4 summarizes U.S. and world refined sugar price changes relative to the base scenario in cents per pound, dollars per MT, and percentage terms using both short- and long-run supply elasticities. Table 5 summarizes U.S. supply and demand changes, relative to the base, in both MT and percentage terms. Finally, welfare changes for the U.S. market are reported in Table 6. The following discussion addresses each scenario, and its effect on prices, production, consumption, and welfare.

Scenario 1 simulates Mexico's gaining access into the U.S. sugar market for 250,000 MT. Using the short-run elasticities, the U.S. refined sugar price falls 6.96% relative to the

Table 4. Refined Sugar Price Changes Relative to the Base, 1,000 Metric Tons Raw Value

Scenario	U.S. Quota Level	Short-run Elasticities			Long-run Elasticities		
		Cents/lb.	$/MT	% Change	Cents/lb.	$/MT	% Change
U.S. refined sugar price							
Base	25	26.98	594.58		26.98	594.58	
1	250	25.10	553.19	−6.96	26.00	572.99	−3.63
2	600	22.42	494.09	−16.90	24.51	540.23	−9.14
3	1,000	19.67	433.39	−27.11	22.86	503.84	−15.26
World refined sugar price							
Base	25	9.81	216.21		9.81	216.21	
1	250	9.83	216.73	0.24	9.83	216.55	0.16
2	600	9.87	217.53	0.61	9.85	217.10	0.41
3	1,000	9.91	218.46	1.04	9.88	217.73	0.70

base to 25.1¢/lb. The world refined price rises slightly, by 0.24%, to 9.83¢/lb. U.S. beet production drops by 2.42%, whereas cane production falls by 1.00%. U.S. demand rises by 1.02%, to 9.17 million MT. When long-run elasticities are used, the U.S. refined sugar price falls by only 3.63% relative to the base, to 26.0¢/lb. The refined world price rises by 0.16%, an amount slightly less than estimated when using the short-run elasticities. U.S. beet production drops by 3.13%, whereas cane production falls by 1.47%. U.S. demand rises by 0.52%, to 9.13 million MT.

Scenarios 2 and 3 simulate Mexico, under an unlimited access status, exporting 500,000 MT to the United States. Cuba is given a quota of 100,000 MT and 500,000 MT, respectively. Using short-run elasticities, the U.S. refined sugar price falls by 16.90% and 27.11% relative to the base. These domestic price impacts, 9.14% and 15.26% declines, are less severe when long-run elasticities are used. The refined world price rises slightly, by 0.61% and 1.04%, under scenarios 2 and 3 when short-run elasticities are used. As expected, the world price changes are less severe, 0.41% and 0.70%, when using long-run elasticities. The short-run elasticity results show U.S. beet production dropping by 6.10% and 10.19%, whereas cane production falls by 2.56% and 4.33%. U.S. demand rises by 2.63% and 4.53% for scenarios 2 and 3, respectively. When long-run elasticities are used, U.S. beet production drops by 7.91% and 13.27%,

Table 5. U.S. Supply and Demand Changes Relative to the Base, in 1,000 Metric Tons Raw Value

Scenario	Quota Level	Beet Supply	Percent Change	Cane Supply	Percent Change	Demand	Percent Change
Short-run elasticities							
Base	25	4,013.00		3,584.00		9,079.00	
1	250	3,915.89	−2.42	3,548.16	−1.00	9,171.61	1.02
2	600	3,768.21	−6.10	3,492.25	−2.56	9,317.78	2.63
3	1,000	3,604.08	−10.19	3,428.81	−4.33	9,490.28	4.53
Long-run elasticities							
Base	25	4,013.00		3,584.00		9,079.00	
1	250	3,887.39	−3.13	3,531.32	−1.47	9,126.21	0.52
2	600	3,695.57	−7.91	3,449.24	−3.76	9,201.57	1.35
3	1,000	3,480.47	−13.27	3,354.27	−6.41	9,292.36	2.35

Table 6. United States Changes in Consumer and Producer Surplus and Net Welfare Gains for Alternative Scenarios Using Short-run and Long-run Elasticities

Scenario	Consumer Surplus Change ($)	Producer Surplus Change ($)	Net Surplus Change ($)
Short-run elasticities			
1	377,696,374	−311,688,430	66,007,944
2	924,346,211	−746,513,078	177,833,133
3	1,496,591,122	−1,179,095,985	317,495,137
Long-run elasticities			
1	196,525,242	−162,094,589	34,430,653
2	496,774,490	−400,608,687	96,165,803
3	833,508,603	−654,768,044	178,740,559

whereas cane production falls by 3.76% and 6.41%. U.S. demand rises by 1.35% and 2.35%.

Regarding welfare effects for the scenarios using short-run elasticities, consumers experience surplus gains of roughly $378 million, $924 million, and $1,497 million for scenarios 1, 2, and 3, respectively. Producers experience surplus losses of approximately $312 million, $747 million, and $1,179 million. The resulting net social gain for these three scenarios is estimated to be $66 million, $178 million, and $317 million. These welfare effects, as expected, are less severe when long-run elasticities are used in the analysis. For scenarios 1, 2, and 3, consumers experience surplus gains of $197 million, $497 million, and $834 million, respectively. Producers experience surplus losses of $162 million, $401 million, and $655 million. The resulting net social gain for these three scenarios is estimated to be $34 million, $96 million, and $179 million.

Conclusions

This study illustrates the potential economic gains through liberalization of sugar trade. However, although the use of a partial-equilibrium framework allows for an adequate analysis of the sugar market, it ignores gains and losses outside of the sugar market. For example, communities and businesses dependent on sugar production could be significantly damaged due to such changes in supply.

Another issue is that domestic sugar prices, if sufficiently depressed, could lead to increased loan forfeitures, which also means increased government spending, both with respect to the loans and on storage for the forfeited sugar. The current loan rate for beets is 22.9¢/lb., whereas the 1996 Farm Act specified that sugar program loans convert to nonrecourse loans if the tariff-rate quota is increased above 1.5 million short tons raw value (STRV) for that year (ERS, 2001). Each of the three scenarios analyzed result in total imports greater than 1.5 million STRV, an amount sufficient to trigger loan forfeitures under the old program. Loans are nonrecourse regardless of the tariff-rate quota amount.

Of equal concern is the increased price volatility and uncertainty that would be introduced as a result of increased trade liberalization. Also, the results of this study show that even with liberalization, the world price remains almost unchanged. This adds doubt to the argument that as the United States liberalizes trade, exporters will have less of an incentive to export to the U.S. because the world price would rise dramatically, lessening the gap between domestic and world prices. On the contrary, the world price remains relatively low, and unless the domestic price is allowed to equal world levels, the incentive for many countries to export sugar to the United States will remain intact.

It should be noted that there are some distortions in the estimated welfare changes reported here. Only one price, the wholesale beet price, was used to represent the U.S. market. However, the domestic raw cane price is typically a few cents per pound less than the wholesale price, and thus producer surplus losses may be somewhat overstated. Conversely, a significant portion of sugar is bought at the retail price, which is typically 12–16¢/lb. greater than the wholesale price. Hence estimated consumer gains due to trade liberalization may be too conservative. However, such deviations should not be looked upon as critical, since they would not change the direction of the welfare changes and only affect the magnitude of the estimates somewhat.

As tariffs on Mexican sugar imports fall, there will be greater incentive for Mexico to send its surplus to the United States. As NAFTA stipulates, TRQs for other countries will be cut, if necessary, to offset imports of Mexican sugar. What this means in terms of trade relations with the rest of the world remains to be seen. However, it can be expected that those countries whose sugar is displaced by that of Mexico will seek some type of reconciliation, be it countervailing duties imposed on the United States or some future negotiations allowing more foreign sugar into the United States. Also, the very use of the TRQ as a quantitative limit to imports will come under severe pressure as trade barriers are lowered and eventually dissolved for Mexico. In the extreme case, only Mexican sugar would be imported into the United States, with all other TRQs being canceled. In addition, after the transition period, Mexican sugar will be free to flow into the domestic market. Hence U.S. sugar policy may very well become ineffective as a means of supporting prices through import quotas.

With regard to Cuba, any move toward trade would certainly aid in restoring economic stability to the island. Since sugar is a major player in the Cuban economy, allowing them a fraction of total U.S. sugar imports, at U.S. prices, would give their sugar industry an immediate boost. However, similar to the situation with Mexico, any potential future access granted to Cuba would likely be offset through the reduction of TRQs for other countries.

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