ESTIMATING WELFARE EFFECTS FROM THE U.S. SUGAR PROGRAM

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ABSTRACT

This article estimates the welfare effects from the U.S. sugar program on the country as a whole, and the states of Texas and Louisiana for fiscal years 2010-2018. Over the nine-year period, sugar policies have kept prices 69.1% higher than world price equivalents, thereby creating substantial deadweight losses for the nation and the state of Texas. However, certain political jurisdictions gain from this distortionary policy; for example, Louisiana's in-state producers gain on average $172.25 million more per year than the losses incurred from in-state sugar consumers. It is not unexpected that such a policy is politically difficult to reform. **JEL Classification:** F13, Q17, Q18

INTRODUCTION

The U.S. has a long history of enforcing highly restrictive import policies aimed at keeping domestic sugar prices elevated while concurrently protecting domestic producers. According to Lopez (1989), the U.S. "government has involved itself in the sugar industry all but 4 of the last 200 years." This program is administered by the U.S. Department of Agriculture (USDA) and guarantees a minimum price for domestic producers of sugar (i.e. both growers and processors) that has historically been roughly twice that of free trade sugar prices. As a result, domestic producers have enjoyed insulation from lower and often volatile world sugar prices, and have responded to the incentives by producing more sugar than they otherwise would at free trade levels. While agricultural producers have enjoyed some level of market protection, the program has increased the costs to sweetener consumers. Given its duration and effectiveness, the U.S. sugar program is one of the best case studies for estimating welfare effects of government price supports for a commodity market.

The purpose of this article is to analyze the welfare impacts of the U.S. sugar tariffs on Texas, Louisiana and the United States for the years 2010 to 2018. Calculations of producer and consumer surplus for Texas, Louisiana and for the entire country are estimated using methodology and techniques similar to the General Accounting Office (1993, 2000) and Beghin *et al.* (2003). Estimates show that complete sugar liberalization would enhance U.S. and Texas welfare, but would on net reduce Louisiana's state welfare. For calendar year 2018, the results indicate that the elimination of the sugar program would benefit U.S. consumers by roughly $3.9 billion or a total of $994 million more than producers lose. Texas consumers

would gain $342 million or $312 more than state sugar producers lose. On the other hand, Louisiana's producer surplus falls by $301 million or $245 million more than consumers gain from liberalization. Given the fact that certain political jurisdictions benefit from the program, political backing for extensions continue, while complete free trade future reform remains tenuous.

The commodity sucrose, the chemical name for the carbohydrate known as sugar, is readily harvested from either sugar cane or sugar beets. The latter can be grown in many climates as varied as California, North Dakota and Nebraska, while the former requires tropical climates. Only four states in the U.S. produce sugar cane, those being Texas, Louisiana, Florida and Hawaii. To fulfill consumer demand, the U.S. accepts sugar imports from all over the world, yet it enforces quotas, tariffs and duties in order to keep imports artificially depressed. The current top five exporters to the U.S. are Mexico, Brazil, Guatemala, Dominican Republic, and Colombia; see Table 1 for import values.

There have been several notable adjustments to the U.S. sugar program over the last twenty-five years. Notably while NAFTA was signed in 1994, it wasn't until 2008 that trade quotas between the U.S. and Mexico were essentially removed. Canadian sugar exports continue to be limited to one-tenth of one percent (0.1%) of the 10.5 million tonne U.S. sugar market, see Canadian Sugar Institute (2017). Yet, Mexico enjoyed unlimited exporting to the U.S. until 2014, after investigations concluded that Mexican sugar, subsidized by the Mexican government, was being "dumped" into U.S. markets thereby harming the domestic markets, see McMinimy (2016a). The beginning of 2015 saw major adjustments on Mexican sugar exports to the U.S., but the most important changes were that Mexico producers were limited to exporting only what the U.S. "needed" (no dumping) and that reference prices were set at 23 cents per pound by dry weight commercial value for raw sugar. Figure 1 provides a comparison of refined sugar prices for the U.S. and the World over the time period covered.

Although signed in 2018 by each representative head of state, the United States-Mexico-Canada Agreement (USMCA) has yet to be fully ratified to replace NAFTA. All food and agricultural products that are currently tariff free will continue to be so, but there will be some notable changes for Canada. An important policy change for this study is that USMCA will allow an additional 9,600 tonnes of sugar to be exported to U.S. markets, see Office of the U.S. Trade Representative (2019a). Other liberating agricultural improvements include, certain dairy and poultry tariffs have been eliminated, agricultural biotechnology is receiving major innovation, fair treatment of wheat quality has been added, as well as other key achievements, see Office of the U.S. Trade Representative (2019b). While the USMCA does increase overall market access for sugar and other agricultural products, significant agricultural barriers will remain.

While this study is not the first to attempt to calculate the economic impacts of eliminating the U.S. sugar program, see for example Morcker and Tarr (1984), GAO (1993, 1997, 2000), Ellison and Mullin (1995), Boyd *et al.* (1996), Schnittker (1998), USITC (1999), Beghin *et al.* (2003), Beghin and Elobeid (2015) and McMinimy (2016b), this paper contributes to the literature by pointing to where future research should be directed, that is, toward welfare implications of the sugar program on individual states or economic agents. By doing so, economic incentives and rent motivations that affect public policy become more transparent. In this paper,

estimation of both producer and consumer gains/losses are calculated for the U.S. and the states of Texas and Louisiana. Using the compensation principle where gainers can in theory compensate losers for their loss, Louisiana's total welfare is enhanced. It is not surprising that those with financial interests within the state are willing to use resources and political influence to keep a restrictive sugar program in place.

This article is organized as follows. Section II presents the theoretical and empirical framework, Section III provides empirical results of the United States, while Section IV reports welfare estimates of Texas and Louisiana, respectively. Conclusions are drawn in Section V.

THEORETICAL AND EMPIRICAL FRAMEWORK

This paper employs Beghin's *et al.* (2003) simple partial equilibrium sugar market framework. A representative diagram can be used to visualize the welfare effects of the sugar policy. This can be seen in by combining pricing information from Figure 1 into Figure 2, where P_W represents the aggregated world price of sugar sweeteners, P_D is the price in the domestic market, 0-Q1 indicates the domestic production under free trade, Q1-Q4 represents imports under free trade, 0-Q2 denotes domestic production under the current sugar program, and Q2-Q3 is the current imports of sugar or the quantity of quota imports. The area (a+b+c+d) represents consumer loss due to the tariff. Producer surplus is area a. Tariff revenue is labeled as area c in the diagram while areas (b+d) characterize deadweight losses. Computable welfare effects of the sugar program can be found by calculating the corresponding graphical areas.

Using similar empirical methodology outlined in GAO (1993, 2000) and Beghin et al. (2003) meaningful measurements of net national welfare and total deadweight loss are computed. Assume the following constant elasticity of demand and supply equations (1) and (2) below. That is, a parameter is used in constant elasticity functions to show that the elasticity of demand and/or supply does not change throughout the relevant study range.

$$Q_D = e^{\alpha} p^{\eta} , \tag{1}$$

$$Q_S = e^{\beta} p^{\varepsilon} , \tag{2}$$

where e is the base of the natural logarithmic function (or 2.218), η is price elasticity of demand, ε is price elasticity of supply, p is domestic price of sugar, and α and β are shift parameters.

To solve for consumer surplus loss, the demand curve is integrated between the domestic and world price of sugar, shown below as

$$\Delta CS = {}_{PW}\int^{PD} e^{\alpha} p^{\eta} dP , \tag{3}$$

or

$$\Delta CS = (e^{\alpha} / \eta + 1) \times (P_D^{\eta+1} - P_W^{\eta+1}) . \tag{4}$$

Equivalently, producer surplus is found by integration between world and domestic

prices above the supply curve in Figure 2. This yields

$$\Delta PS = {}_{PW}\int^{PD} e^{\beta} p^{\varepsilon} dP , \quad (5)$$

or

$$\Delta PS = (e^{\beta} / \varepsilon + 1) \times (P_D^{\varepsilon+1} - P_W^{\varepsilon+1}) . \quad (6)$$

To solve for the value of the shift parameters, linearize the original supply and demand curve equations to solve for A and B, shown below

$$\alpha = \ln Q_D + \eta(\ln P) , \quad (7)$$

$$\beta = \ln Q_S + \varepsilon(\ln P) . \quad (8)$$

NATIONAL WELFARE ESTIMATES

Table 2 below presents the 2010-2018 national statistics that were used to estimate equations (4) and (6). The estimates for the elasticities of demand and supply were obtained as the median from a range of estimated elasticities from a literature review of sweetener welfare models and sweetener supply and demand models. The price elasticity of demand used in this article is –0.05, and the price elasticity of supply used is 0.50. Both values fall near the mean of the encountered range of estimated elasticities, see Australian Bureau of Agricultural Resource (1990) and Lin and Novick (1998), Beghin et al. (2003), and Zen et al. (2011).

From 2010 to 2018 the average refined sugar price within the U.S. was 38.14 cents per pound compared to 22.54 cents per pound average (69.1% greater) for the rest of the world, refer again to Figure 1.

By integrating equations (4) and (6) between the world refined price and the domestic sweetener price, the changes in consumer surplus and producer surplus can be computed for each year. The domestic sweetener price was found by weighting the averages of consumption of HFCS and wholesale refined sugar. Consumer and producer surplus are found by integrating between the two price limits. Historical HFCS-42, HFCS-55, domestic wholesale sugar, and world-refined sugar prices are taken from the USDA Sugar and Sweetener Situation and Outlook Report, 2019.

Net national gain/loss is the difference between the change in consumer surplus and the change in producer surplus,

$$\text{Net National Gain/Loss} = \Delta CS + \Delta PS . \quad (9)$$

Also, tariff revenues, depicted in area c in Figure 2, can be calculated by multiplying the difference in price by the current level of imports. The deadweight loss associated with this market distortion is shown as the sum of area b and d, or mathematically as

$$\text{Deadweight Loss} = \Delta CS + \Delta PS + \text{Tariff Revenue} . \quad (10)$$

Table 3 reports the welfare implications of the U.S. sugar program for years 2010-

2018. These estimates show that consumers lost an average of $3.1 billion dollars per year due to the U.S. sugar program. Domestic producers, on the other hand, benefited on average by approximately $2.4 billion dollars during the same period, resulting in a net national loss of $690 million on average. Assuming that the government collects and returns all the tariff revenue in the form of a nondistortionary lump-sum rebate, the country suffers a deadweight loss of $201 million. Importantly, the net national loss over the nine-year horizon total over $6.1 billion, clearly indicating a significant cost to the nation over time. These national estimates are consistent with similar studies.

STATE COMPARATIVE WELFARE ESTIMATES

The welfare effects upon the states of Texas and Louisiana can be extrapolated using similar techniques and methods. Assuming that a typical state consumer is equally likely to consume sugar or HFCS as any other consumer, there is no reason why consumer gains/losses cannot be found by simply multiplying national consumer loss by the proportion of U.S. population residing in the state. In 2018, Texas and Louisiana accounted for roughly 8.7% and 1.4% of the total U.S. population, respectively. Thus, their share of the consumer loss amounts to $342 million for Texas and $55.6 million for Louisiana. Producer surplus totals $29.7 million for Texas in 2018, well below the losses suffered by its' consumers. However, the estimated benefits received by Louisiana's producers and growers exceed $301 million for fiscal year 2018, thus, enhancing economic welfare in the state. See Tables 4 and 5 for complete results. Note that Texas produced 4.3% of total U.S. sugar cane production, while Louisiana produced over 40% of U.S. sugar cane.

Note that Louisiana's response to the sugar program is contrary to national and Texas welfare response. Table 5 reports that the program has become increasingly important to Louisiana since 2016. The state's net welfare benefit has increased from $199.6 million in 2012 to $245.01 million, a 23% increase from 2012 to 2018.

Applying this welfare test to those states with significant sweetener interests would likely yield a similar net result. Referring back to Tables 4 and 5, one can hypothesize that the sugar program positively affects large and politically consequential states such as: Florida, North Dakota, Minnesota, and Colorado. Given the political forces of these states and other "vested interests," it is not difficult to see why sugar reform has progressed slowly. For example, a study from the U.S. International Trade Commission (2017) estimates that if sugar support was lifted, farming and manufacturing employment in the sector would fall by roughly 11 percent. Therefore, successful reforms will likely depend on support from those states that are net sweetener consumers.

CONCLUSION

The welfare implications of a restrictive trade policy are well known and widely accepted. The protected industry experiences benefits at the cost to consumers. The estimates in this article show sugar restrictions lead to overall welfare losses for the U.S. population. Net national loss averaged $690 million for the 9-year period covered. However, as is the case for Louisiana, certain political jurisdictions gain

from distortionary policies. Louisiana producers averaged a gain of nearly $216.68 million, while consumers lost only an average of $44.43 million for the 9-year period. On net Louisiana experiences a boost in state welfare, but this conclusion assumes that (1) this benefit is accruing to the processors and growers of the state and not to the processors outside the state, and (2) the compensation principle holds.

The optimality of the program also comes into question because the Pareto criterion of welfare economics is violated as welfare gains come only by reducing the welfare of others. Resource misallocation, rent seeking behavior, and welfare reduction occur as a result of the program, but given the existence of large and motivated segments of the nation that benefit from the U.S. sugar policy, it is not surprising that it is politically difficult to reform.

While this paper provides welfare and deadweight estimates, notable limitations of this study and where future research is needed include calculating the employment effects from eliminating the sugar program on agriculture and processing manufactures similar to the U.S. International Trade Commission (2017) study. For comparisons, these labor market effects could be examined at the state specific or if the data are available county specific level. With county level data, it would be interesting to exam how concentrated sweetener production and processing really is within sweetener producing regions. Another area where future research could provide insight is the calculation of specific producer welfare losses from program elimination. That is, losses from eliminating the sugar program would fall upon some combination of producers, refiners, and intermediaries like supply chain services.

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FIGURE 1
U.S. AND WORLD REFINED SUGAR PRICE

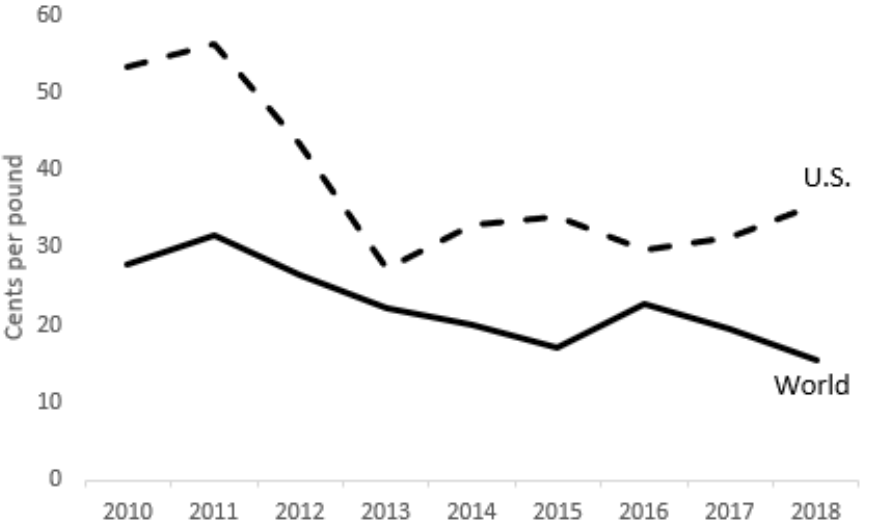

FIGURE 2
MARKET EFFECTS

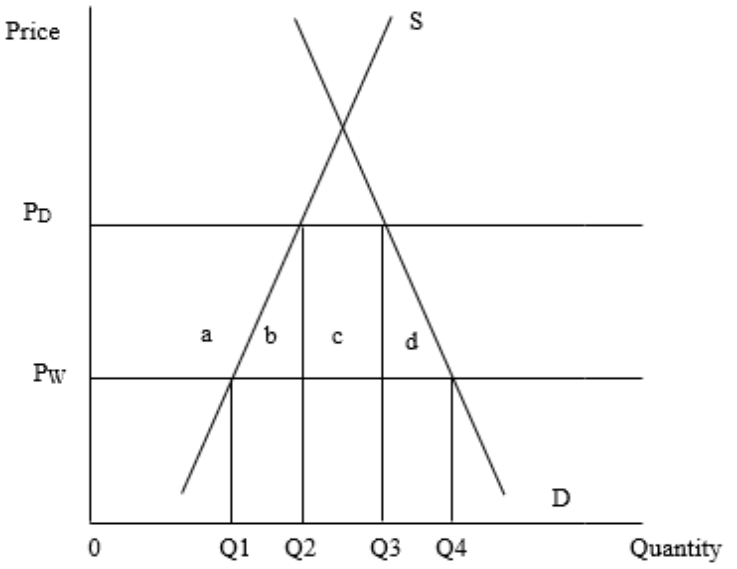

TABLE 1
TOP SOURCE COUNTRIES OF RAW AND REFINED SUGAR (2018)

Country	Millions of US$
Mexico	672.4
Brazil	208.9
Guatemala	134.0
Dominican Republic	103.9
Colombia	97.3

Source**:** USDA (2019a) Sugar Monthly Import and Re-Export Data.

TABLE 2
DOMESTIC CONSUMPTION AND PRODUCTION OF SWEETNERS[1]

Year	Sweetener Consumption Sugar	HFCS[2]	Total Sweetener Consumption[3]	Sugar Quota Imports	Net HFCS Imports	Sweetener Production Sugar	HFCS[2]	Total Sweetener Production
2010	10,208	7,487	17,695	3,011	218	7,963	9,163	17,126
2011	10,276	7,282	17,558	3,391	203	7,831	9,157	16,988
2012	10,466	7,187	17,653	3,294	213	8,489	9,104	17,593
2013	10,754	6,914	17,668	2,924	204	8,982	8,583	17,564
2014	10,861	6,911	17,772	3,353	224	8,450	8,549	16,999
2015	11,076	6,824	17,900	3,237	234	8,656	8,460	17,116
2016	11,234	6,689	17,923	3,031	149	8,989	8,366	17,355
2017	11,233	6,577	17,810	2,945	141	8,970	8,280	17,250
2018	11,211	6,157	17,368	2,972	145	9,292	8,048	17,340

[1] Source**:** USDA, Economic Research Service, *Sugar and Sweeteners Yearbook Tables*, May, 2019, tables 18, 29, 33, 49, and 61. All data is measured in thousands of short tons raw value and dry weight equivalents.

[2] High Fructose Corn Syrup (HFCS) is the sum of HFCS-42 and HFCS-55.

[3] Excludes values for glucose, dextrose, honey, and other edible sugars.

TABLE 3
NET NATIONAL AND DEADWEIGHT LOSS[1]

Year	Change in Consumer Surplus	Change in Producer Surplus	Net National Gain/(Loss)	Estimated Tariff Revenue	Deadweight Gain/(Loss)
2010	(4,881)	3,796	(1,084)	768	(316)
2011	(4,622)	3,672	(949)	831	(118)
2012	(3,263)	2,648	(614)	553	(61)
2013	(1,019)	842	(176)	122	(54)
2014	(2,572)	1,947	(624)	429	(195)
2015	(3,423)	2,493	(930)	547	(383)
2016	(1,426)	1,139	(286)	212	(74)
2017	(2,365)	1,815	(550)	344	(205)
2018	(3,902)	2,908	(994)	591	(403)
Average 2010-18	(3,052)	2,362	(690)	488	(201)

[1] Millions of U.S. dollars.

TABLE 4
TEXAS' NET WELFARE EFFECTS FROM THE SUGAR PROGRAM[1]

Year	Change in Consumer Surplus	Change in Producer Surplus	Net Benefit/ (Loss)
2010	(398.36)	33.66	(364.70)
2011	(380.45)	31.17	(349.28)
2012	(271.24)	23.29	(247.95)
2013	(85.43)	6.48	(78.94)
2014	(217.94)	14.38	(203.56)
2015	(293.42)	19.87	(27.55)
2016	(123.33)	9.96	(113.36)
2017	(206.08)	13.44	(192.64)
2018	(342.34)	29.66	(312.68)
Average 2010-2018	(257.62)	20.21	(237.41)

[1] Millions of U.S. dollars.

TABLE 5
LOUISIANA'S NET WELFARE EFFECTS FROM THE SUGAR PROGRAM[1]

Year	Change in Consumer Surplus	Change in Producer Surplus	Net Benefit/(Loss)
2010	(71.72)	348.49	267.77
2011	(67.87)	304.71	236.84
2012	(47.83)	247.44	199.61
2013	(14.91)	76.49	61.58
2014	(37.51)	177.88	140.37
2015	(49.79)	203.83	154.03
2016	(20.65)	105.23	84.58
2017	(33.98)	185.47	151.48
2018	(55.58)	300.59	245.01
Average 2010-2018	(44.43)	216.68	172.25

[1] Millions of U.S. dollars.