

THE COST OF THE U.S. SUGAR PROGRAM REVISITED

JOHN C. BEGHIN, BARBARA EL OSTA, JAY R. CHERLOW, and SAMARENDU MOHANTY*

The article analyzes the welfare cost of the U.S. sugar program using a multimarket model of U.S. sweetener markets. The latter includes raw crops, sugar extraction and refining, and sweetener users (food-processing industries and final consumers). The authors address the industrial organization of food industries using sweeteners and treat the United States as a large importer. With the removal of the program, this article estimates (all figures in 1999 dollars) that in 1998 cane growers, sugar beet growers, and processors would have lost \$307, \$650, and \$89 million, respectively; sweetener users would have gained \$1.9 billion. World prices would have increased by 13.2%. The deadweight loss of the program is estimated at \$532 million. (JEL Q18, Q17, F13)

I. INTRODUCTION

The sugar program has used farm commodity and trade policy instruments to maintain domestic sugar prices at levels that exceed world prices without requiring the government to buy large quantities of

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Beghin: Visiting Scholar, Institut National de Recherche Agronomique, France; and Marlin Cole Professor, Department of Economics, Iowa State University, 568 Heady Hall, Ames, IA 50011-1070. Phone 1-515-294-5811, Fax 1-515-294-6336, E-mail beghin@iastate.edu

El Osta: Senior Economist, Center for Economics, Applied Research and Methods, U.S. General Accounting Office, Room 2035, 441 G Street, NW, Washington, DC 20548. Phone 1-202-512-3587, Fax 1-202-512-6171, E-mail ElostaB@gao.gov

Cherlow: Assistant Director, Center for Economics, Applied Research and Methods, U.S. General Accounting Office, Room 2035, 441 G Street, NW, Washington, DC 20548. Phone 1-202-512-4918, Fax 1-202-512-6171, E-mail CherlowJ@gao.gov

Mohanty: Assistant Professor, Department of Agricultural and Applied Economics, Texas Technical University, Lubbock, TX 79409. Phone 1-806-742-0277 ext. 240, Fax 1-806-742-1099, E-mail smohanty@ttu.edu

domestic sugar in most years.¹ This article analyzes the effects of eliminating the sugar program on prices, production, and welfare using a multimarket model of the domestic and world sweetener markets. Here are estimated the economic welfare effects of the program by assessing welfare losses and gains resulting from the elimination of the sugar program as an estimate of the gains (losses) accruing to each group potentially affected by the presence of the program. This analysis includes the U.S. markets for sugar beet and sugarcane production, corn and high-fructose corn syrup (HFCS) production, sugar refining, food processing, and the final consumption of sugar and food products containing sweeteners. This domestic model is embedded into a world sugar model to estimate the

1. Large quantities of sugar were forfeited to the government in 2000 and 2001 because of large imports from Mexico and larger-than-expected domestic supply.

ABBREVIATIONS

AMS: Aggregate Measure of Support
CARD: Center for Agricultural and Rural Development
CCC: Commodity Credit Corporation
CRS: Congressional Research Service
GAO: General Accounting Office
HFCS: High-Fructose Corn Syrup
TRQ: Tariff Rate Quota
USDA: U.S. Department of Agriculture
WTO: World Trade Organization

impact of the U.S. sugar program on world prices of sugar. In addition, the net loss to the U.S. economy (economic welfare gains minus losses) resulting from artificially high sweetener prices is estimated. This net loss includes economic inefficiencies (deadweight losses) and economic rent transfers to foreign sugar exporters.

The analysis deals explicitly with three issues that often have been raised in the context of U.S. sugar policy but never addressed simultaneously in previous work (Congressional Research Service [CRS], 2001; Koo, forthcoming; Marks and Maskus, 1993; Sumner, 1999; U.S. General Accounting Office [GAO], 1993). First is the recognition that the United States is a large country in the world sugar market and that U.S. policy changes affect the import price of sugar. The second focus of this analysis relates to the linkage between sugar market prices and prices paid by the consumer for goods containing sugar. The price of sugar influences the cost and price of sweetener-intensive food items and creates a pass-through effect of the sugar program on processed food to consumers. Third, the article considers imperfect competition and profit in food processing. The eventuality of a profit markup influences the extent of the pass-through of sweetener costs to consumers and therefore the distribution and size of the welfare gains from removing the sugar program.²

The authors estimate (all figures in 1999 dollars) that with the removal of the program, U.S. cane growers, sugar beet growers, and beet processors in 1998 would have lost about \$307 million, \$650 million, and \$89 million, respectively. Sweetener users would have gained about \$1.9 billion. The deadweight loss of the current sugar program for 1998 was estimated at around \$532 million, and the net loss to the U.S. economy was \$893 million. World sugar prices would increase by 13.2% with the removal of the U.S. sugar program. The magnitude of these aggregate gains is relatively insensitive to changes in assumptions regarding the industrial organization of the food industry, the extent of price pass-through, and the time

horizon considered. However, these assumptions affect the distribution of gains within sweetener users (food industry, final consumers). This point is elaborated later.

Several motivations underlie this investigation. First, the divergence of interests between the domestic coalition of sugar crop growers and raw cane processors on one side and cane refiners and food processors on the other has been rapidly widening with the recent increasing disparity between domestic and world raw cane prices. Second, the U.S. sugar program is a disproportionate contributor to the aggregate measure of support (AMS) monitored by the World Trade Organization (WTO) under the Uruguay Round Agreement on Agriculture. Among U.S. farmers, sugar producers received the highest policy transfer (in percentage of crop value) for the policies falling under the scrutiny of the WTO in the so-called amber box. The 1998–2000 average AMS for sugar was equal to 50% of crop value, compared to an average of 7% for all crops during this period (Hart and Babcock, 2001). The Doha round of WTO negotiations has just started, and the domestic policy debate regarding the 2002 farm bill is emphasizing compliance with existing WTO limits on trade distorting subsidies. The two policies are now more interdependent than ever because of increased WTO pressures to lower these limits in the Doha Round (Sumner, 2000). Hence, it is propitious to revisit the social cost of such large transfers and distortions in the double context of the changing political economy of the sugar program and the ongoing debates on farm and trade policy reforms.

The U.S. sugar program has been repeatedly analyzed over the years, because it not only has evolved but also resisted trade liberalization and has become one of the last bastions of protectionism in U.S. agriculture. Examples of recent analyses of distortions in the U.S. and world sugar markets include Boyd et al. (1996), Haley (1998), Koo (forthcoming), Marks and Maskus (1993), Sheales et al. (1999), and Wohlgenant (1999). These studies combine various degrees of sophistication in their assessment of the U.S. sugar program and its impact on world markets and in their treatment of sweetener demand by food processing and final consumers. This article's comprehensive approach is a novel

2. The authors do not investigate the existence of price-cost markup per se but analyze the implications of the eventuality of a markup. Markup estimates are borrowed from the empirical industrial organization literature (Bhuyan and Lopez, 1997).

and useful complement to these previous studies.

In the next sections, the authors first provide a description of the U.S. sugar program and the policy scenario considered. An overview of our modeling approach follows. Results and conclusions complete the article. An appendix, available on request, provides a detailed description of this U.S. sugar model, including the approach used to estimate welfare gains and losses for participants in the various affected markets. This appendix then describes the data and data sources used in this analysis. Finally, the appendix briefly describes the world sugar model used to assess the impact of the U.S. sugar program on world markets.

II. DESCRIPTION OF THE U.S. SUGAR PROGRAM

The sugar program functions as a price floor mechanism by guaranteeing sugar producers a minimum price by offering them loans at a rate established by law, which is shared with beet and cane farmers. This system of price support is made possible by tight trade barriers imposed on imports of sugar via a set of bilateral tariff rate quotas (TRQs) managed by the U.S. Department of Agriculture (USDA). The out-of-quota imports are taxed at a prohibitive tariff rate, which precludes importing more than the TRQ. For most years, imports are managed such that the U.S. market prices of raw cane sugar and beet sugar remain above the loan rate level, so the USDA does not have to buy up sugar forfeited under the loan program (U.S. GAO, 1999). In 2000, however, out-of-quota sugar imports originating in Mexico combined with a large domestic supply led to sugar forfeitures of about 800,000 short tons (CRS, 2001). WTO commitments constrain the USDA's efforts to tighten sugar imports, and forfeitures may occur whenever domestic supply is large. The U.S. sugar industry is challenging Mexican imports (USDA, 1999; Buzzanell, 1999).

The Federal Agriculture Improvement and Reform Act of 1996—the 1996 farm bill—modified the sugar program without fundamentally decreasing the support received by growers. Six changes and key features were to (1) legislatively retain the USDA's 1995 loan rate levels for the 1996–2001 period of 18

cents per pound for raw cane sugar and 22.9 cents per pound for refined beet sugar, (2) assess a new 1-cent penalty on each pound for raw cane sugar and a 1.07-cent penalty on each pound of refined beet sugar forfeited to the government, (3) eliminate a requirement that the sugar program operate at no net cost to the federal government, (4) limit processors' opportunities to forfeit sugar to the Commodity Credit Corporation (CCC) by not allowing forfeitures if the TRQ is 1.5 million tons or less, (5) eliminate the USDA's authority to impose marketing allotments for sugar, and (6) increase the assessment on processors by 25% to 0.2475 cent per pound for raw cane sugar and 0.2654 cent per pound for beet sugar (U.S. GAO, 2000). The latter measure was suspended for fiscal year 2000/01, saving the producing industry about \$83 million (CRS, 2001).

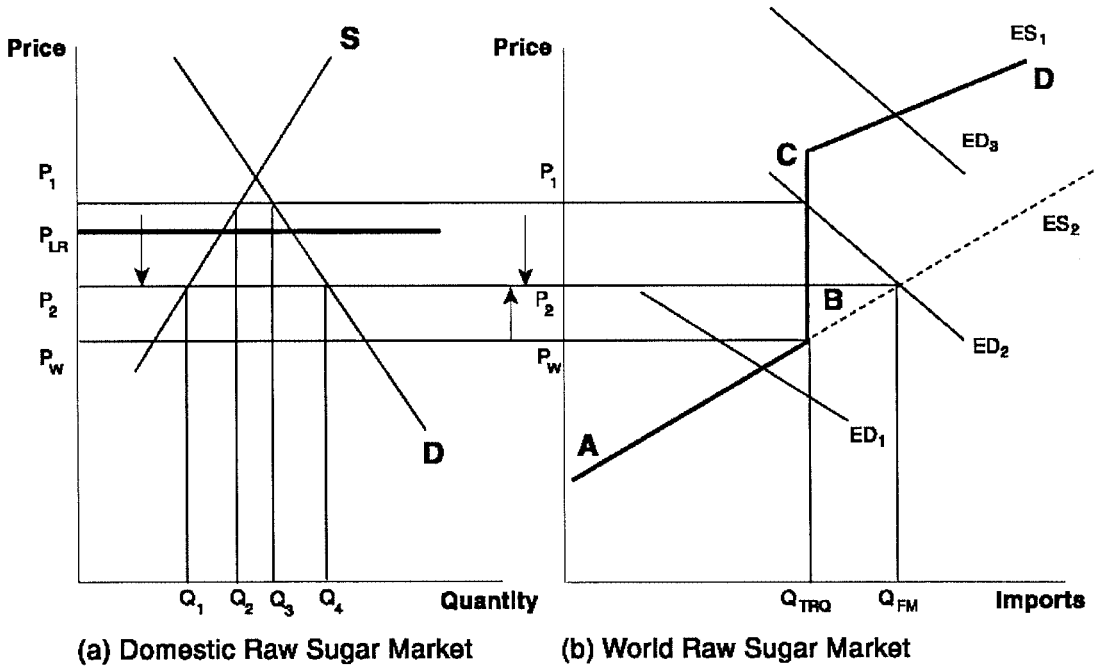
According to the 1996 farm bill, when USDA sets the TRQ level at or below 1.5 million tons, loans made through the CCC are recourse in nature (forfeiting the crop pledged as collateral to the CCC to repay the loan is not allowed). Congress repealed this authority to make recourse loans in its 2001 agriculture appropriation measures (CRS, 2001). For years when the TRQ is set higher than 1.5 million tons, loans made to the CCC are nonrecourse in nature (the loan provides processors the option of forfeiting the sugar pledged on their CCC loan instead of repayment). This option becomes important to processors if domestic sugar prices drop below the USDA's loan rate plus transportation and interest costs but minus the 1-cent-per-pound penalty (U.S. GAO, 2000). Including CCC outlays related to sugar stocks would increase the estimates of the social cost of the sugar program. For instance, net CCC outlays (loans minus repayments) were \$465.5 million in 2000. Removing the sugar program would eliminate these net outlays.

III. POLICY REFORM SCENARIO

The policy scenario for this analysis removes the TRQs for imported raw and refined sugar and the USDA's loan program for sugar processors that supports the price of domestic sugar (see Moschini, 1991, for a discussion of the economics of the TRQ). Figure 1 shows the effects of removing both

FIGURE 1

Effects of Removing the TRQ and the USDA's Loan Program on U.S. Prices and Quantities of Raw Sugar



the raw sugar TRQ and the USDA's loan program: panel (a) represents the domestic raw sugar market; panel (b) represents the world raw sugar market faced by the United States.

In panel (b), two rest-of-the-world excess supply situations, ES_1 and ES_2 , corresponding to different trade scenarios, are shown. In the presence of a TRQ, the United States faces a kinked rest-of-the-world excess supply function, as in the bold line ABCD on ES_1 . The vertical line segment BC on ES_1 represents the level of the TRQ, below and beyond which there is a supply response to price by foreign exporters. Moreover, below the level of the quota, Q_{TRQ} , the in-quota tariff applies; beyond that level, the out-of-quota tariff applies. The excess supply curve ES_2 corresponds to the rest-of-the-world excess supply in the absence of import restrictions in the United States. The effect of the TRQ on U.S. imports and prices depends on the location of the U.S. excess demand for imports relative to the excess supply.

Panel (b) displays three potential U.S. import demand situations, ED_1 , ED_2 , and

ED_3 . The excess demand curve ED_1 represents the U.S. import demand below the level of the TRQ, whereas the excess demand curve ED_3 represents the U.S. import demand above the level of the TRQ. At excess demand ED_2 , the TRQ is binding. Price and quantity reach equilibrium at the intersection of the U.S. excess demand curve ED_2 and the kinked rest-of-the-world excess supply curve ES_1 perceived by U.S. importers on its vertical segment BC.

With the removal of the TRQ, increased world imports of raw cane sugar drive down domestic prices. At the same import demand, this situation corresponds to a new equilibrium level: the point where ED_2 intersects ES_2 , the rest-of-the-world excess supply curve without import restrictions, with increased U.S. import demand Q_{FM} .

Because of the USDA's loan program for sugar processors, however, domestic prices would still not be free to drop to the world price level. Under the loan program, producers would still be eligible to forfeit their sugar to the government and receive the loan

rate, P_{LR} . The loan rate mechanism constitutes a price floor for domestic sugar producers, maintaining sugar prices at the loan level, P_{LR} , as in panel (a). With the joint removal of the TRQ and the sugar loan program, the domestic sugar price is free to fall below the loan rate level. In Figure 1, panel (b), this situation corresponds to a new price and trade equilibrium level. In the domestic market in panel (a), this corresponds to U.S. imports increasing from Q_2Q_3 , the original quota Q_{TRQ} in panel (b), to Q_1Q_4 , or Q_{FM} in panel (b). These increased U.S. imports lead to a drop in the domestic price from P_1 to P_2 . However, P_2 is higher than the original world price of P_w .

The authors consider a similar removal of the TRQ for imported refined, or "white" sugar. World trade in refined sugar has increased because of policies in the European Community, the entry of toll refiners,³ and a decrease in freight and refining costs. Removing the TRQ for refined sugar has the same qualitative effect as removing the TRQ for raw sugar: the U.S. price for refined sugar would decrease with an increase in the demand for refined sugar imports. A lower U.S. refined sugar price would then cause a decrease in the quantity of domestic refined sugar supplied and a subsequent decline in the demand for domestic raw sugar.

IV. OVERVIEW OF THE MODELING APPROACH

To quantify the welfare gains and losses from the U.S. sugar program, the following steps were used. First, the authors simulate the elimination of the program to determine price and production responses in both domestic and international sugar markets. This step involves specifying complete U.S. and world sweetener models in the presence of the U.S. sugar TRQ and commodity loan program. To do this, an international sugar model was used. This model was developed by the Center for Agricultural and Rural Development (CARD) at Iowa State University and for the purpose of this analysis, contains an added multimarket module of the U.S. domestic sweetener economy as one of

its component countries.⁴ The multimarket domestic sweetener model includes such markets as corn, sugar crops, raw and refined sugar, food processing, and HFCS.

In the U.S. domestic model, the authors simulate the sugar program's elimination by removing the two TRQs and allowing more domestic demand to be satisfied by lower-priced world imports. Simultaneously, as the U.S. demand for sugar increases, the world sugar price rises somewhat. The USDA's loan program for sugar processors is also removed, and the domestic market prices of sugar are allowed to fall below the loan rate levels. After these reforms, by arbitrage, U.S. domestic raw and refined sugar prices (adjusted for transportation costs) reach world price levels.

On the domestic supply side, the authors use the domestic component of the CARD international sugar model to estimate welfare changes due to the change in the price of sugar. The new U.S. raw sugar price filters through the domestic U.S. sugarcane and sugar beet markets, lowering the prices and production quantities of these products. By arbitrage, the new domestic refined sugar price determines how much of the refined sugar use will be sourced domestically or imported. The allocation of domestic production between beet processors and raw cane sugar refiners is determined by equating their new marginal cost to the new refined sugar price.

On the demand side, for food processors that use sweeteners, the relative price of the HFCS and sugar sweetener has changed. These sectors adjust their sweetener mix accordingly, and these adjustments then feed back into the HFCS and corn markets.

For each of these producing industries, the authors measure the changes in realized profits that would result from a change in the quantity demanded and/or the price if the sugar program were eliminated. Within the domestic sweetener model, the authors estimate welfare changes for a comprehensive demand sector, including sugar processors and refiners, sweetener-using industries, and the final consumer. The changes in realized profits resulting from higher sweetener prices

3. Toll refiners export refined sugar processed from imported raw sugar. See Poonyth et al. (2000) for a recent analysis of EU sugar policies.

4. A technical appendix describing the sugar portion of the world CARD model, along with the U.S. multimarket sweetener module, is available on request from the authors.

for sweetener-using food industries, at the four-digit Standard Industrial Classification level, are then estimated. The authors specify the marginal cost of production of these industries as well as their derived demand for sweeteners. As part of this specification, the authors calibrate the marginal cost and derived demand by assuming food industries use an initial markup (price-marginal cost) of 20% to price their goods.

As part of this analysis, two polar assumptions are considered about the market power of these industries: full retention of cost savings by sugar-using food industries, and full pass-through of cost savings to consumers. Furthermore, it is assumed that consumers would be affected by the sugar program's elimination through the change in the prices of both the refined sugar and the food items purchased containing a significant amount of sweetener. The authors apply an incomplete demand system approach to sweetener-intensive food and sugar consumption based on LaFrance (1998) and LaFrance et al. (2002; LINQUAD),⁵ and use an exact welfare measure (equivalent variation) to estimate these changes in consumers' expenditures.⁶

In the first polar case, consumers' welfare increases because of lower retail sugar prices but prices for other food goods remain unchanged. The food industry, by increasing its markup, is the major beneficiary from the reform and absorbs the cost savings. This outcome yields lower benefits to consumers; it is the outcome that sugar program proponents often claim would result if it were ended. In the second and opposite case, consumers benefit from lower food prices in addition to the lower retail sugar price. Food processors keep their initial markup but pass on to consumers the decrease in marginal cost induced by lower refined sugar prices. From the per-

spective of consumers, this is the most optimistic outcome.

Finally, the authors aggregate all welfare gains and losses from these groups to estimate the welfare loss (gain) experienced from eliminating the sugar program as an estimate of the gain (loss) accruing to each group from the presence of the program. The difference between welfare gains and losses is the net loss to the U.S. economy, which consists of transfers to foreign producers that result from artificially high prices for the raw sugar exported to the United States and economic inefficiencies (pure efficiency losses). These inefficiencies result from the use of higher-cost domestic resources to produce sweeteners (instead of importing lower-cost sugar) and reduced total sugar consumption.

The model is calibrated to 1998 data, the most recent available data on sweetener use in the U.S. food industry at the time of the investigation.⁷ The authors also used 1996 data to see how different the welfare estimates would be under a different price regime. One possible limitation of the model is that a more general equilibrium approach of the entire agricultural sector may have been able to give more long-run effects by, for example, identifying what alternative crops would be produced in the absence of the program or how many producers would leave the industry entirely. However, general equilibrium models take a more broad-based approach, often leaving out important market details (see Boyd et al., 1996, for an example of such a trade-off). The approach is designed to represent a compromise between capturing the most important sweetener market relationships with the available data and keeping the model itself tractable.

V. RESULTS

For both 1996 and 1998, the authors compare the actual domestic and world prices for sugar and HFCS, with the estimated domestic and world prices if the sugar program were eliminated. Both the estimated costs of the sugar program to sweetener users and the estimated benefits to sugar beet and sugarcane producers were higher in 1998 when the

5. The LINQUAD is a functional form within the incomplete demand system approach that provides a practical model for estimation that reflects theoretically sound preference ordering. In particular, the LINQUAD quasi-expenditure function produces demand functions that are linear in deflated income and linear and quadratic in deflated prices.

6. Equivalent variation is the amount of money that, when paid to the consumer, achieves the same level of utility before the change that the consumer would enjoy with the economic change. Equivalent variation represents the minimum amount that a consumer would require to willingly forgo the change.

7. The calibration of the model is explained in a technical appendix, available from the authors on request.

TABLE 1
Welfare Gains and Losses from the Sugar
Program, 1996 and 1998
(1999 Million Dollars)

Category	1996	1998
Welfare gains accruing to producers	788	1,045
Sugarcane producers	241	307
Sugar beet growers	490	650
Sugar beet processors	58	89
HFCS manufacturers and corn growers	(1)	(1)
Welfare losses accruing to sweetener users	(1,471)	(1,938)
Net loss to the U.S. economy	(683)	(893)
Economic inefficiencies	(273)	(532)
Net transfers to foreign suppliers	(410)	(361)

Notes: Numbers in parentheses are economic losses. Full pass-through is assumed.

difference between the domestic and world prices for sugar was greater.

As shown in Table 1, the findings suggest that the sugar program cost domestic sweetener users—sugarcane refiners, food manufacturers, and final consumers—about \$1.5 billion in 1996 and about \$1.9 billion in 1998. The authors find that the total welfare gains by domestic sugar beet and sugarcane producers were about \$788 million in 1996 and about \$1 billion in 1998. About 70% of these benefits went to sugar beet growers and processors; the remaining 30% went to sugarcane producers.

The authors also find that HFCS producers did not receive welfare gains from the sugar program in either 1996 or 1998, primarily because the possibilities for substitution between sugar and HFCS are more limited now than they were in the early 1980s. The decreased substitution among sweeteners arises because technological advances have improved HFCS products and created more specialized sweetener markets (Evans and Davis, 1999; Alvarez and Polopolus, 1998). Thus, HFCS producers would not need to lower their price (move along their marginal cost curve) further to remain competitive if the sugar program were eliminated.⁸ There-

fore, the sugar program marginally affects corn producers. This finding on HFCS and corn is consistent with the earlier assessment of Rendleman and Hertel (1993).

This investigation shows that the sugar program resulted in net losses to the U.S. economy of about \$683 million in 1996 and \$893 million in 1998 because total welfare losses exceeded gains. These net losses included production and consumption inefficiencies of \$273 million in 1996 and \$532 million in 1998 and transfers of \$410 million in 1996 and \$361 million in 1998 to foreign countries allocated a portion of the TRQ for sugar imports to the United States. These transfers are net of the deadweight loss induced in the rest of the world by the U.S. sugar TRQ. Hence, these findings corroborate findings by Marks (1993) that in net the rents to foreign owners of U.S. import quotas are beneficial to the rest of the world. This remark abstracts from the skewed distribution of the gross rent transfers to a few countries caused by the U.S. sugar program. However, exporters who do not have allocated quotas may benefit from a more liberalized trading regime, as they are likely to expand exports without having to suffer an erosion of quota rents (USDA, 2001).

The distribution of the welfare losses resulting from the sugar program among the sweetener user groups depends on assumptions about the extent to which refiners' and manufacturers' cost reductions from eliminating the sugar program would be passed on to consumers. If the sugar program were eliminated, consumers would evidently benefit. However, it is difficult to predict the extent to which and speed with which intermediate users of sweeteners would pass through lower sugar costs to final consumers.

Table 2 presents two estimates of how the benefits of eliminating the sugar program might be distributed based on the two polar cases previously discussed. The first set of estimates assumes that competition induces sugar refiners to pass cost reductions on to final consumers in the form of lower prices for table sugar but that manufacturers of sugar-containing foods would retain

8. Executives from the Corn Refiners' Association, which represents HFCS manufacturers, agree with the current results. They believe the domestic HFCS market is decoupled from the domestic sugar market—that is,

HFCS prices are no longer linked to sugar prices—and the soft drink industry has relied on competition among HFCS manufacturers to minimize its sweetener prices.

TABLE 2
 Estimated Distribution among User Groups of Benefits of Eliminating the
 Sugar Program under Different Pass-through Assumptions, 1996 and 1998
 (1999 Million Dollars)

Distribution of Benefits	1996		1998	
	Partial Pass-through	Full Pass-through	Partial Pass-through	Full Pass-through
Final consumers	587	1,434	769	1,960
Food manufacturers	715	(60)	999	(85)
Sugarcane refiners	95	97	61	63
Total	1,397	1,471	1,829	1,938

Notes: The partial pass-through results represent a full pass-through by sugar refiners to food processors and no pass-through by food processors to consumers. The full pass-through results assume all cost reductions are passed through to final consumers. Numbers in parentheses are economic losses.

their cost savings. Under this partial pass-through assumption, final consumers would have gained about \$587 million using 1996 data and about \$769 million using 1998 data if the sugar program had been eliminated. Deadweight losses in 1998 would have been reduced by \$416 million as compared to \$532 million under full pass-through.

Total welfare gains from eliminating the sugar program would have been about \$1.4 billion in 1996 and \$1.8 billion in 1998 if only sugarcane refiners had passed cost reductions through to consumers. The different pass-through assumptions result in slightly different estimates of the total gains to sweetener users if the sugar program were eliminated, primarily because consumers would increase their consumption of cheaper sweetener-intensive foods, hence reducing deadweight losses further, under the full pass-through case. The assumption of price discipline in the refined sugar market is motivated by the homogeneous nature of white sugar. In contrast, when products are highly differentiated (as many sweetener-containing food products are), firms may use nonprice forms of competition, such as greater advertising.

The second set of estimates based on the full pass-through assumption yields an upper bound estimate of the potential benefits to consumers. Under this assumption, the authors estimate that the benefits to final consumers of eliminating the sugar program would have been about \$1.5 billion using 1996 data and about \$1.9 billion using 1998 data. By contrast, if processors of sugar-intensive

goods retained all cost savings from cheaper refined sugar, final consumers would experience welfare improvements, which would be about 40% of the welfare gains under full pass-through.

Table 3 compares actual sugar prices and production in 1996 and 1998 with the simulation results, which assume the termination of the sugar program. If the sugar program had been eliminated, the domestic price of raw sugar would have dropped from about 22 cents per pound to about 14.9 cents per pound in 1996 and to about 12.5 cents per pound in 1998, with comparable declines in the wholesale price of domestic refined sugar. Further, raw sugar imports would have increased by 1.1 million tons in 1996 and by 1.6 million tons in 1998 with the elimination of the program with the increased domestic demand for sugar and the decreased domestic production of sugar beets and sugarcane.

The previous results are short-run ones, because the elasticities used in the model reflect short-term rigidities in agricultural supply both in the United States and in the rest of the world. Table 4 presents estimates of the welfare changes that would have resulted from eliminating the sugar program in 1998, using larger supply elasticities than the ones used to obtain the primary estimates to simulate shorter-term changes. Supply elasticity estimates are arc elasticities evaluated for 1998 between historical and postreform values. In particular for the U.S. market, the short-run domestic supply elasticities were 0.05 for sugarcane and 0.10 for

TABLE 3
Estimated Effect of Eliminating the Sugar Program on Prices and Production

	1996 Actual	1996 without the Sugar Program	1998 Actual	1998 without the Sugar Program
U.S. raw sugar price	22.40	14.91	22.06	12.46
World raw sugar price ^a	12.24	13.41	9.68	10.96
U.S. wholesale refined sugar price	29.20	21.77	26.12	16.12
World wholesale refined sugar price ^b	16.64	19.77	11.59	14.12
Sugarcane				
Acres harvested ^c	953,700	941,300	931,500	916,200
Production	29.1	28.7	30.0	29.5
Sugar beets				
Acres harvested ^c	1,420,100	1,350,300	1,428,300	1,338,600
Production	28.1	26.7	29.9	28.0
Raw sugar imports	2.2	3.3	1.7	3.3

Note: Price is in cents per pound and production and imports are in millions of short tons (raw value).

^aThe world price for raw sugar is based on a Caribbean location. As compared with the U.S. price, the world price does not include 1.5 cents per pound in cost to transport the sugar to New York.

^bAs compared with the U.S. price, the world price for refined sugar does not include 2 cents per pound in cost for transportation.

^cAcreage harvested during the previous crop year.

sugar beets and the short-run import supply elasticity was 7.26, reflecting rigidities in foreign agriculture supply. The latter is an excess supply from the rest of world faced by the United States, which explains the seemingly large magnitude.

The authors obtain longer-run welfare estimates using a double Nerlovian domes-

tic supply response with supply elasticities of 0.20 for cane and 0.26 for sugar beets and an import supply elasticity of 10.17. The results from this second set of simulations can be interpreted as the welfare gains and losses after more time has elapsed for the economy to adjust to the lower sugar prices that would result from eliminating the sugar program.

The long-term net gain (all figures in 1999 dollars) for 1998 from eliminating the sugar program might be higher—\$930 million compared with \$893 million—with the estimated reduction in deadweight loss increasing from \$532 to \$572 million. This implies that the net loss to the U.S. economy from maintaining the program may be similarly larger in the longer term because the actual sugar price with the program would be compared with the price after fuller adjustments had been made. The increase in world prices is moderate relative to the short-term impact of the policy reform. The raw sugar price increases by 12.5% on the world market although U.S. imports of raw sugar increase dramatically to 3.8 million short tons, decreasing domestic production of crops and raw sugar but boosting the domestic production of refined cane sugar based on imported raw sugar.

TABLE 4
Long-Term Welfare Effects of Eliminating
the Sugar Program (1998 Data)

Category	Gain or (Loss) (Million Dollars)
Producers' losses	(1,017)
Sugarcane producers	(301)
Sugar beet growers	(530)
Sugar beet processors	(187)
HFCS manufacturers and corn growers	1
Gains to sweetener users	1,947
Final consumer	1,953
Food manufacturers	(84)
Sugarcane refiners	78
Deadweight loss	572
Transfers to foreign suppliers	358
Net gain to the U.S. economy	930

Notes: These results assume a doubling of supply responses in agriculture and a full pass-through of program costs to final consumers. Numbers in parentheses are economic losses.

VI. CONCLUSIONS

Using a multimarket approach, the authors assessed the welfare cost of the U.S. sugar

program. The authors investigated the impact of the program's removal, accounting for endogenous world sugar prices, the pass-through of lower sugar prices in refining to food processing and to consumers, and the industrial organization of the food industry. The latter could limit the pass-through of cost savings in food processing to consumers.

For 1998 (all figures in 1999 dollars) it is estimated that with the removal of the program, cane growers, sugar beet growers, and beet processors would have lost rents of about \$1 billion. The largest losses would have occurred in beet production, followed by sugarcane production. Sweetener users would have gained about \$1.9 billion. The dead-weight loss or the social cost of the current sugar program was estimated at around \$532 million, and the net loss to the U.S. economy was \$893 million. World prices would have increased by 13.2% with the removal of the program. These estimates are quite robust to changes in assumption regarding the extent of sugar price pass-through to food retail prices. However, the distribution of gains is influenced by whether full pass-through exists (major gains to final consumers) or does not exist (major gains to food processors).

These findings are well within the ballpark of welfare impacts found in previous studies, which had a less comprehensive approach to sweetener demand and abstracted from pass-through issues in food processing (Devadoss and Kropf, 1996; Hafi et al., 1993; Koo, forthcoming; Marks and Maskus, 1993; Wohlgenant, 1999; Sheales et al., 1999). For example, Wohlgenant (1999) finds a 10% increase in world price resulting from a trade policy reform liberalizing sugar trade in developed countries. Sheales et al. (1999) found that removing the U.S. sugar program would lift world prices by about 17% and induce a net U.S. welfare gain of \$452 million, saving U.S. consumers about \$1.6 billion per year (1998–99 dollars).

The finding that corn producers have become marginal stakeholders in the sugar program resonates an earlier finding by Rendleman and Hertel (1993). In this article, the small gains/losses to corn growers hinge on the recent evolution in sweetener technology in food processing. The substitution between sugar and HFCS has decreased as sweetener use has become more specialized by food item. This finding is in contrast to

Gardner (1999), who found that the ethanol program could raise corn growers' welfare considerably. Ethanol represents a demand for corn comparable in size to corn demand derived from HFCS production. Gardner's (1999) analysis looked at a different policy (the ethanol subsidy) and, in addition, was based on a different modeling approach and used earlier data. The two results provide an interesting contrast showing how different distortions in related markets affect the corn market differently.

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