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Effects of Agricultural Protection on Food Manufacturing: The U.S. Sugar Program

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Abstract

Results from econometric estimation indicate that U.S. intervention in the sugar market has helped to increase the import share of sugar-containing products in the U.S. market, but that increased disposable income has played a more important role. Sugar price policy has helped U.S. imports from developed countries proportionately more than those from developing countries.

Effects of Agricultural Protection on Food Manufacturing: The U.S. Sugar Program

Since May, 1982, when the United States imposed a restrictive import quota on raw sugar imports, U.S. imports of miscellaneous sugar-containing products (sugar blends, mixtures, confectionery, bakery, and edible preparations) have increased by over 150 percent in volume and by over 120 percent in value -- from $677 million in 1982 to over $ 1.5 billion in 1986. The increase in imports of these products has been largely attributed to the price differential between domestic U.S. and cheaper, world price sugar (USDA Sugar and Sweetener Outlook and Situation, Washington Post). However, the extent to which increased imports of sugar-containing products have indeed been caused by government intervention in the sugar market, rather than by other market factors, has yet to be examined. Rising consumer income and other U.S. trade policies and programs, such as the Generalized System of Preferences, also influence the level of U.S. imports of manufactured goods. The objective of this paper is to examine the effects of sugar protection, as well as the effects of these other factors, on the demand for imports of sugar-containing products and on the U.S. food processing industry.

Among the questions the paper will address is whether substitution of alternative sweeteners has allowed U.S. food manufacturers to reduce the competitive advantage provided to foreign manufacturers by U.S. sugar policies. The paper will also examine which countries -- developed or developing -- have benefitted from artificially high U.S. sugar prices by increasing their exports of sugar-containing products to the United States. For instance, Zeitz and Valdes have documented the adverse impact of the U.S. sugar program on developing countries' sugar exports, but they did not examine

whether or not the developing countries have been able to offset some of their losses in raw sugar exports through increased exports of value-added, processed foods.

To demonstrate the effect of sugar protection on U.S. imports and on the food processing sector, the analysis will focus on explaining movements in import market shares. Four categories of sugar-containing processed foods -- canned fruits, confectionery, sweetened cocoa and chocolate, and bakery products will be examined. These categories of sugar-containing products accounted for approximately $930 million in imports in 1986.

Importance of the Problem

The data in Table 1 show the the decline in U.S. raw sugar imports which occurred during the 1980's, the rising trend in the import share of U.S. consumption of four sugar-containing product categories, and the market shares captured by developed and developing countries. The developing countries, particularly the Caribbean countries, Brazil, the Philippines, and Thailand, have suffered the greatest losses in sugar export revenues, but some developed countries, such as Australia, also export sugar to the United States. Although the U.S. government intervened in the sugar market continuously during the 1970-86 period, either through quotas, tariffs, and/or fees, U.S. prices were much higher in relation to world prices in the 1980's, averaging about 3 times the level of world prices in the 1981-1986 period, as compared to 1.5 times the world price in the 1970-1980 period.

Imports of all of the sugar-containing products shown in Table 1 rose over the 1970-1986 period. [1/] In nominal terms, the increase in U.S. imports of these products since implementation of the 1982 sugar program appears to be

Table 1--U.S. imports of raw sugar and selected sugar-containing products, total and from developing and developed countries, 1970, 1980, and 1986

Commodity	Imports			Share in U.S. Consumption [1/]		
	1970	1980	1986	1970	1980	1986
	1000 $			percent		
Canned Fruits [2/]	51,019	174,935	265,785	5.6	9.8	13.3
DC's	17,652	32,569	62,031	1.9	1.8	3.1
LDC's	33,367	142,366	203,754	3.7	8.0	10.2
Confectionery [3/]	51,064	129,717	315,455	2.7	2.6	4.0
DC's	49,198	115,798	277,941	2.6	2.3	3.5
LDC'	1,866	13,919	37,514	0.1	0.3	0.5
Sw. Cocoa and Chocolate [4/]	1,584	25,439	98,087	0.4	2.3	6.0
DC's	1,509	22,309	76,605	0.4	2.0	4.7
LDC'	75	3,130	21,482	0.0	0.3	1.3
Bakery [5/]	27,631	96,707	249,855	0.9	1.3	2.2
DC's	27,493	87,766	226,163	0.9	1.2	2.0
LDC'	138	8,941	23,692	0.0	0.1	0.2
Raw Sugar	729,116	1,987,730	669,745	45.8	46.0	28.3
DC's	40,458	206,755	59,119	2.5	4.4	2.2
LDC's	688,658	1,780,975	610,626	43.3	41.6	26.1

Notes: DC denotes developed countries; LDC, developing countries.

1/ Defined as imports divided by production plus imports less exports.

2/ TSUSA import numbers 146.0000 to 150.0000, preserved and prepared fruits.

3/ TSUSA import numbers 156.3020, 157.1005, 157.1010, 157.1045, and 157.1050.

4/ TSUSA import numbers 156.2500, 156.3045, 156.3050, 156.3065, 156.4500, and 156.4700.

5/ TSUSA import number 182.2000.

Source: U.S. Department of Commerce (various years).

part of a larger trend of rising imports continued from the 1970's. However, in real terms, U.S. imports of these products rose at a much faster annual average rate in the 1981-86 period, about 14%, as compared to an average annual rate of increase of 3.6% in the 1970-80 period. At the same time, the weighted average import market share for all of these sugar-containing products rose at a faster annual rate in the later period, 9.5%, as compared to 4.4% in the earlier period.

The decline in U.S. sugar imports of about $1 billion from 1980 to 1986 was twice as large as the increase in imports of the four sugar-containing product categories shown. Because the developing countries' share in these imports is relatively small, as compared to their share in U.S. sugar imports, these countries have only been able to offset some of their sugar export losses from increased exports of these products. However, to the extent these industries are infant industries associated with externalities, then the gains to the developing countries may be greater.

Determinants of Import Market Shares

The import market share for the j^{th} sugar-containing product is defined as the share of imports in apparent consumption of product j, C_j. Apparent consumption consists of imports, I_j, and of goods produced for consumption by domestic manufacturers, D_j, where D_j is domestic production less exports:

$$C_j = D_j + I_j \qquad (1)$$

Imports of sugar-containing products are separated into two categories, those from developed countries, I_{1j}, and those from the developing countries, I_{2j}.

Clifton explained import market shares (import penetration ratios) for several manufacturing industries by examining changes in industry-specific real exchange rates. Consistent with his study, it is assumed that the import market share for the j^{th} product, M_j, is a function of the relative prices of domestic and imported goods, RC, which, in turn, is a function of the relative costs of domestic and imported goods to the domestic market. Each import market share is also assumed to be a function of other factors, (Z_j), that influence the domestic demand for product j and which differentiate between foreign and domestic goods:

$$M_j = (I_j/C_j) = f(RC, Z_j) \qquad (2)$$

and

$$M_{kj} = (I_{kj}/C_j) = f(RC, Z_j) \qquad (3)$$

where k = 1, 2 for the j^{th} product, and $\sum^{k} M_{kj} = M_j$.

In this study the domestic cost of producing the j^{th} sugar-containing product relative to the cost of imported substitutes is represented by the relationship between U.S. and world sugar prices. It is thus assumed that the relation between U.S. sugar prices and world sugar prices determines the overall cost structure and international competitiveness of the j^{th} sugar-containing product industry.

This specification also makes the simplifying assumption that movements in relative sugar prices are exogenous to the industry. Imports of sugar-containing manufactured products are also regarded as imperfect substitutes for domestic production due to differences in quality, delivery time, credit

arrangements, as well as other factors. U.S. imports of sugar-containing products from different countries and country groupings are also considered to be imperfect substitutes for each other for the same reasons.

Specification of Import Share Equations

The market share equations can be written as

$$M_{jt} = F(RS_t, Y_t, DG_t, Z_{jt}) \qquad (4)$$

where M_{jt} is the percentage value share of imports in domestic consumption of the j^{th} sugar-containing product in period t; RS_t is the ratio between the U.S. wholesale price of refined sugar (Northeast) to the duty-inclusive, world raw sugar price, f.o.b. Caribbean ports, adjusted for transportation to New York and for processing costs, in period t; Y_t is real disposible income per capita in period t, deflated by the consumer price index (CPI) in period t; DG_t is a dummy variable to reflect the introduction in 1976 of the Generalized System of Preferences (GSP) for manufactured goods imported by the United States, and Z_{jt} represents a vector of import demand shifters specific to product j in period t. The market shares are further separated into two categories, the share captured by imports from developed countries, MO_j, and the share captured by imports from developing countries, MD_j.

Government intervention that maintains U.S. prices for sugar higher than equivalent foreign prices would be expected to act as an export subsidy for those foreign manufacturers who have access to cheaper foreign sugar. This subsidy should cause the demand for imports of sugar-containing products to rise, ceteris paribus, and the demand for the similar domestic product to

decline (shift inward) as consumers substitute lower priced imports for domestic goods. To the extent this subsidy is captured by the relative price of U.S. to foreign sugar, it is expected that RS_t will be positively related to M_j. Since the U.S. government intervened in the sugar market continuously during the estimation period in one way or another, no distinction was made between behavior before and after the introduction of the current sugar program.

Real disposible income per capita, Y_t, is included to capture the effects of changes in real purchasing power and, to some extent, to allow for the economy's movement through the business cycle. It is expected to be positively related to M_j for a normal good.

United States imports of sugar-containing products from many developing countries benefit from temporary, duty-free tariff preferences under the GSP program. According to Baldwin and Murray, granting tariff preferences to manufactured imports from certain beneficiary countries will result in an increase in total imports of the eligible products as imports from beneficiary countries rise and a corresponding decline in domestic production -- the trade creation effect. Thus we would expect to see a positive relationship between DG and M_j, and between DG and MD_j. However, there will also be a tendency for domestic consumers to substitute lower-priced imports from preferred sources for the imports from non-preferred sources -- a trade diversion effect. Thus a negative relationship is expected between DG and MO_j, when MO_j measures the market share captured by the developed countries.

Z_{jt} represents a vector of real prices for product-specific ingredients that would be expected to shift the demand schedules for imports and domestically supplied sugar-containing products. Included in Z_{jt} are the real prices of alternative sweeteners, glucose and high fructose corn syrups, the real price

of cocoa, and the real price of wheat. Any change in the price of a key ingredient used in domestic production is expected to be positively related to the import market share, M_j. For instance, an increase (decrease) in the price of an alternative sweetener can lead to its decreased (increased) use in product formulas and affect the competitiveness of the product vis a vis sugar-containing subsititutes (Carmen). Thus a positive relationship is expected between these prices and M_j. Similarly, a change in cocoa prices will affect both importers and domestic producers alike, since cocoa is not produced in the United States, but it can also affect import demand for some sugar-containing products as domestic manufacturers substitute other ingredients for imports that are cocoa-intensive. We would expect an increase (decrease) in the cocoa price to result in reduced (increased) import demand and import market share for cocoa-intensive, sugar-containing imports.

Results

Equation (4) was estimated using regression analysis for four broad groups of sugar-containing products -- canned fruits, confectionery, sweetened cocoa and chocolate, and bakery products -- using time series data from 1970 to 1986. Import demand for confectionery was further divided into demand for confectionery imports containing chocolate and for imports not containing chocolate. The data on the value of domestic production used in constructing the import market shares for the four categories of products were obtained from the Department of Commerce, Bureau of Census, Value of Product Shipments, various years. Data on the value of exports and imports were obtained from U.S. Department of Commerce, Bureau of the Census, U.S. Imports for Consumption and U.S. Exports.

As constructed using raw data on the nominal value of production, imports, and exports, movements in the calculated value shares reflect both changes in the terms of trade as well as any real changes in the volume share of imports in domestic consumption. To correct for this terms of trade effect, the import value data were deflated by an index of changes in the unit value import price of the j^{th} sugar containing product (1970=100), and production and export value data were deflated by the U.S. wholesale price index (1970=100). As modified, the import market shares reflect the change in the value share of imports in 1970 constant dollars.

Estimation of (4) involves a process in which aggregate consumption (C_j) is allocated between two competing components -- domestic production and imports. Powell has shown that this type of problem can be handled by assuming a linear allocation function and by treating any choice of m-1 of m components as stochastic. The equations for the m-1 variables can be fitted using Aitken's principle, and the parameters of the excluded equation can then be found by differencing. Using this approach, the total import market shares, M_j, were estimated for each commodity using ordinary least squares (OLS). The total import shares were further divided into the shares of the developed and the developing countries (MO_j and MD_j) and estimated using Zellners' seemingly unrelated technique (SUR). SUR provided a gain in efficiency because of the prior restrictions that the coefficients estimated for the explanatory variables included in each share equation for the j^{th} product sum to zero, and the constants to one. Some equations were corrected for first order serial correlation as indicated by p.

A possible problem using OLS is that the market share is a percentage and must fall inside the zero to one range. In ordinary regression problems, the error term can theoretically vary from minus to plus infinity. Neither the

logit or probit methods, which are often used to deal with the issue of shares, was used because these methods would violate the assumption of a linear allocation function. The fact that the dependent variable is a percentage did not give rise to any problems, however, in the range of the data used.

A. Total Import Market Shares

Estimated results for total import market shares, M_j, support the underlying hypothesis that changes in real income, as well as the relative prices of U.S. and foreign sugar, have affected U.S. import demand for four categories of sugar-containing products (Table 2). More specifically, the results indicate that increased U.S. disposible income has been the most significant factor affecting import penetration into the U.S. market across all of these products. Thus, as the U.S. economy continues to grow, the import share of these products in the U.S. market will also continue to rise, all else held constant, regardless of the level of the U.S. sugar price. The weighted average import share elasticity with respect to a change in U.S real disposible income for all of these products, evaluated at the means, is approximately 2.0. This suggests that if real disposible income were to continue to grow at the average 1982-1986 rate, about 3% per year, and all other factors are held constant, then import penetration will increase by about 6% per year.

The relative prices of U.S. and foreign sugar have had the greatest impact in increasing the import market shares of sweetened cocoa and chocolate (elasticity of .63), followed by confectionery containing chocolate (.38), and bakery products (.16). The estimated weighted average elasticity with respect to this price ratio for all of these products, evaluated at the means, is .18. Since the average annual increase in the U.S.-foreign sugar price differential

Table 2--Estimated import share equations for sugar-containing products, 1970-86

1. Canned fruit

MCF =	- .073	+ .006RS	+ .031*Y	+ .028*DG		+ .002HF	$\bar{R}^2$ = .92
	(-2.88)	(1.85)	(4.20)	(4.70)		(1.45)	DW = 2.03

2. Confectionery

MC =	- .041	+ .002*RS	+ .011*Y	- .011*DG	+ .008*CO	+ .139*GL	$\bar{R}^2$ = .85
	(-4.00)	(2.57)	(7.21)	(-9.75)	(3.42)	(2.57)	DW = 2.56
							p = -.50
MCC =	+ .010	+ .002*RS	+ .001Y	- .007*DG	+ .003CO	- .059GL	$\bar{R}^2$ = .90
	(1.90)	(6.08)	(1.75)	(-11.55)	(2.08)	(-2.12)	DW = 2.40
							p = -.58
MNC =	- .043	- .0005RS	+ .009*Y	- .004*DG	+ .005*CO	+ .187*GL	$\bar{R}^2$ = .77
	(-6.08)	(-.84)	(7.99)	(-4.72)	(2.91)	(4.43)	DW = 2.47
							p = -.35

3. Sweetened cocoa and chocolate products

MCH =	- .095	+ .005*RS	+ .024*Y	+ .005DG	- .019*CO	+ .182GL	$\bar{R}^2$ = .91
	(-5.37)	(2.82)	(6.38)	(1.51)	(-3.00)	(1.36)	DW = 2.16

4. Bakery products

MB =	- .020	+ .001RS	+ .007*Y	- .0003DG	+ .001RW		$\bar{R}^2$ = .92
	(-4.89)	(1.98)	(6.26)	(-.29)	(1.42)		DW = 1.99
							p = .22

Notes: M_j denotes U.S. import market share for the j^{th} sugar-containing product; CF denotes canned fruit; C, all confectionery; CC confectionery containing chocolate; NC confectionery not containing chocolate; CH, chocolate products; and B, bakery.
RS = ratio of the U.S. wholesale refined sugar price to the world raw sugar price, adjusted for processing and transportation costs.
Y = U.S. per capita disposible income, deflated by the consumer price index (CPI).
DG denotes U.S. GSP program; =1 1976 - 1986; = 0 all other periods.
CO = world cocoa price, c.i.f. New York, deflated by the U.S. wholesale price index (WPI).
GL = price of corn syrup, deflated by the WPI.
HF = price of high fructose corn syrup, deflated by the WPI.
RW = U.S. producer price of wheat, deflated by the WPI.
* indicates coefficients are statistically different from zero using a .05 level two-tailed t-test;

over the 1981 to 1986 period was about 22%, this elasticity indicates that the current U.S. sugar program has been responsible for an annual average increase in the import share of these products of about 4.0% during this period.

Due to substitution, changes in the real price of corn syrup (GL) are more important than relative sugar prices in affecting the import market share for confectionery not containing chocolate. This substitution has made confectionery imports less sensitive to the differential between world and U.S. sugar prices. The price of high fructose corn syrup also appears to have affected the import market share for canned fruits in a similar manner.

The estimated coefficient on DG indicates that the GSP program has been responsible for increasing the overall share of imports in U.S. consumption solely in the case of canned fruits, the only product analyzed in which developing countries provide the largest share of U.S. imports. The positive coefficient estimated for DG in the canned fruit equation in Table 2 suggests that the GSP program has allowed the annual import share of canned fruits to increase by about 2.8 percentage points, on average, or by $21 million annually (in 1970 dollars). The negative coefficient estimated for DG in the confectionery equation must be treated with caution, as it may be picking up the effect of an omitted variable. Specifically, the negative coefficient may represent declines in imports as developed country exporters move production to the United States once their products become established in the U.S. market (see Table 3). The estimated coefficient for DG in the bakery equation, which is not statistically different from zero, indicates that increased developing country market share due to the GSP program has been offset by decreased developed country market share (see Table 3).

B. Developed and Developing Countries' Market Shares

The results of Table 3 suggest that the developed countries have been the primary beneficiaries of U.S. sugar policy with regard to increased imports and import market share for the sugar-containing products examined. While the developing countries' exports and U.S. market share have been more responsive with respect to an increase in this price ratio in the case of sweetened cocoa and chocolate products (elasticity of 1.1 as compared to .5 for the developed countries), their imports and market share have not increased in response to this price differential for any of the other products. On the other hand, the developed countries' share of the U.S. market has increased in response to the foreign-sugar price differential for every product examined. The developed countries larger response to the U.S.-foreign sugar price differential has helped them to increase their share of U.S. imports of canned fruits and bakery products at the expense of the developing countries, and it has contributed to slower growth in the developing countries' import share of confectionery products from 1980 to 1986 (Jabará, 1988).

The reasons for the greater responsiveness of the developed countries in supplying these imports are not clear from Table 3. In the case of confectionery, it most likely stems from the types of confectionery exported by the developing countries -- confectionery not containing chocolate, imports of which have not been promoted by the U.S.--foreign sugar price differential. The developing countries' lower responsiveness may stem from inefficiencies in production, lower sugar intensity of products exported, or from interference in sugar pricing undertaken by the developing countries themselves. It should be noted that developed countries that are large exporters of these products and that also maintain high domestic sugar prices, such as the European

Table 3--Estimated developed and developing country import market share equations for sugar-containing products, 1970-86

1. Canned fruit

MOCF =	- .023	+ .006*RS	+ .010*Y	- .005DG			$\bar{R}^2$ = .75
	(-2.00)	(3.64)	(2.76)	(-1.95)			DW = 2.14
MDCF =	- .048	+ .001RS	+ .021*Y	+ .032*DG		+ .002HF	$\bar{R}^2$ = .89
	(-2.44)	(.18)	(3.69)	(7.01)		(1.68)	DW = 2.11

2. Confectionery

MOC =	- .022	+ .002*RS	+ .008*Y	- .011*DG	+ .009*CO	+ .068GL	$\bar{R}^2$ = .86
	(-2.47)	(3.55)	(5.91)	(-11.15)	(4.21)	(1.47)	DW = 2.49
							p = -.52
MDC =	- .009	+ .0001RS	+ .002*Y	+ .0001DG	+ .001CO	+ .046*GL	$\bar{R}^2$ = .82
	(-8.15)	(.01)	(8.78)	(.22)	(2.08)	(5.52)	DW = 2.18

3. Sweetened cocoa and chocolate products

MOCH =	- .089	+ .003*RS	+ .018*Y	+ .004*DG	- .013CO	+ .096GL	$\bar{R}^2$ = .96
	(-7.41)	(3.13)	(8.98)	(2.90)	(-4.22)	(1.35)	DW = 2.39
							p = -.34
MDCH =	- .034	+ .002RS	+ .008*Y	+ .001DG	- .004CO	+ .099GL	$\bar{R}^2$ = .75
	(-3.75)	(2.10)	(3.83)	(.58)	(-1.29)	(1.44)	DW = 1.85

4. Bakery products

MOB =	- .017	+ .001*RS	+ .006*Y	- .001DG	+ .001RW		$\bar{R}^2$ = .90
	(-6.22)	(2.37)	(7.51)	(-1.92)	(1.55)		DW = 1.93
MDB =	- .004	+ .0003RS	+ .001*Y	+ .001*DG			$\bar{R}^2$ = .85
	(-5.18)	(.26)	(5.17)	(3.55)			DW = 1.89
							p_1 = .36
							p_2 = -.20

Notes: O denotes developed countries; D developing countries.
All other variables are defined as in Table 2.

Community and Japan, cannot use export subsidies to expand their exports of these sugar-containing products because they are processed products. However, it is clear that the differential between U.S. and world price sugar during the 1980's has helped to offset some of the other factors, such as the GSP program (canned fruits and bakery products), and larger import income elasticities (confectionery and bakery products), that had been contributing to the developing countries' rising share in U.S. imports of these sugar-containing products.

Conclusions

Results of econometric estimation indicate that the differential between U.S. and world sugar prices maintained by government intervention in the U.S. sugar market has contributed to increased U.S. imports and import market share for some sugar-containing products, but that growth in U.S. disposible income has played a larger role. In addition, the availability of cheaper, substitute sweeteners appears to have reduced the impact of the U.S.-foreign sugar price differential on imports of some types of confectionery and, to a smaller extent, on imports of canned fruits, products in which these sugar substitutes are widely used.

The results also suggest that, with the exception of sweetened cocoa and chocolate products, sugar-containing product imports from the developed countries have disproportionately benefitted from the U.S.-foreign sugar price differential. This differential has provided an umbrella under which the developed countries have been able to expand their exports of confectionery, bakery products, and canned fruits to the United States at the expense of imports from the developing countries. For these products, the price

differential has help the developed countries to overcome factors such as the GSP program that had been working to increase U.S. imports from the developing countries. The results suggest that in addition to reducing their exports of raw sugar to the United States, the U.S. sugar program has resulted in some increased competition for the developing countries from the developed countries in exporting sugar-containing products to the United States.

Endnotes

1. Emergency import quotas were placed on imports of blended syrups and other sugar-containing products with a content of sugar derived from beet or cane of over 65% by dry weight in June, 1983. Of the products examined in this paper, these quotas briefly affected imports of sweetened cocoa, which is a very minor component of the sweetened cocoa and chocolate products group.

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