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An Equilibrium Policy Model of the World Sugar Economy

This chapter reports on the specification, estimation, and use of a spatial equilibrium model of the world sugar economy. The research differs from previous work on such models in two ways. First, special attention has been given to econometrically estimating individual supply relations for each of the major countries of the world, since it was hypothesized that supply-response was the major influence in determining market behavior. Second, the model has been designed specifically to test the effects of alternative trade policies. Thus, tariffs, quotas, variable levies, and export taxes were included as policy instruments that could be applied by any chosen country and the repercussions observed in terms of price and quantity in that country and elsewhere. The work really extended an earlier model of Bates (1965), increasing the disaggregation from thirty-two to seventy-five regions and incorporating many policy instruments that he did not include. This approach may be contrasted with the aggregate econometric models of Tewes (1972) and of Adams and Behrman (1976), which illuminate more of the temporal aspects of the market but are less informative about the spatial effects of alternative policies.

Stated formally, the objectives of the research were:

1. To estimate sugar supply and demand functions for the major producing and consuming regions of the world.
2. To construct a model, using these functions, with which to ascertain the effects of alternative national and international sugar policies.

Originally it had been intended to solve the model for a series of years, but problems of computation arose. Consequently the results relate to the equilibrium that would have occurred in 1974 if producers had been able to adjust completely to their desired levels of output. This will be called a "long-run" equilibrium although, as will become apparent, some cane sugar producing countries are in fact still "trapped" in this equilibrium by the fixity of assets committed in previous periods.

This chapter is necessarily brief and only the main features of the model and results are given. A fuller presentation may be seen elsewhere (Gemmill, 1976). Although the research was primarily directed to U.S. policy, the implications for the Central and South American countries, which together produced 31 percent of the world's sugar in 1974, will be emphasized throughout.

The remainder of this introductory section outlines the features of the sugar market relevant to the model. The following section gives the structural relations of the model and very briefly reviews the supply and demand estimates that were incorporated. The third section is concerned with the results from the model and their welfare implications (in terms of producers' and consumers' surplus and government revenue). The fourth section concentrates on policy implications for Latin American countries. In the final section concluding comments are offered.

Features of the Sugar Market Relevant to the Model

In building a model, one seeks out the minimum degree of disaggregation necessary to satisfy the objective of the research. Why was it necessary to identify seventy-five regions in this model instead of disaggregating it into only two regions, say the developed and developing regions? The first response to this question is that sugar production and consumption are not concentrated in a few countries but are widely distributed worldwide. Table 6–1 gives five-year averages for production, consumption, and trade. It shows that Western Europe, Eastern Europe, Central America, South America, and Asia were all about equal producers of sugar in 1972–1976. The really large producers were the European Economic Community (EEC), Soviet Union, Brazil, Cuba, and the United States, in that order. Regarding consumption, the rank order is the Soviet Union, European Economic Community, United States, Brazil, China, and Japan. Trade in sugar flows from the surplus regions of Central America, South America, and Oceania to North America, Asia, and Europe.

Wide distribution alone does not justify a disaggregated model. The

Table 6–1. Average Production, Exports, Imports, and Consumption of Centrifugal Sugar (tonnes, raw value) in Major Countries of the World, 1972–1976

	Five-Year Average, 1972–76[a]			
Countries	*Production*	*Exports*	*Imports*	*Consumption*
Western Europe	13,031,370	1,680,864	3,571,665	14,692,107
EEC	10,189,220	1,506,671	2,184,403	10,716,217
Other W. Europe	2,842,150	1,174,193	1,387,262	3,975,890
Eastern Europe	13,646,518	726,234	3,840,643	16,525,244
G.D.R.	592,280	118,926	246,263	718,100
Poland	1,776,797	271,693	31,433	1,573,875
U.S.S.R.	8,907,200	73,236	2,681,511	11,300,800
Other E. Europe	2,370,241	262,380	881,436	2,932,469
North America	4,722,389	120,814	5,536,159	11,034,256
Canada	125,013	52,133	980,318	1,050,639
United States	4,597,376	67,681	4,555,841	9,983.617
Central America	11,938,787	7,817,232	35,072	4,021,962
Cuba	5,714,876	5,187,109	0	497,605
Dominican Republic	1,207,572	1,047,994	0	164,163
Jamaica	367,864	270,153	2,306	100,441
Mexico	2,733,753	377,522	0	2,390,117
Other C. America	1,914,722	934,456	32,766	869,656
South America	11,661,357	3,574,768	261,252	8,324,094
Argentina	1,474,609	353,722	0	1,038,625
Brazil	6,710,730	2,179,495	0	4,609,807
Colombia	886,545	154,409	0	736,244
Peru	936,564	411,191	0	518,537
Venezuela	522,540	39,967	50,857	512,290
Other S. America	1,130,369	435,984	210,395	908,591
Asia	15,546,977	3,315,088	6,330,616	18,241,008
China	3,670,000	96,854	552,759	4,070,000
China-Taiwan	805,253	482,921	0	295,621
India	4,452,815	562,456	0	3,880,580
Japan	561,783	37,906	2,622,149	3,171,399
Philippines	2,500,704	1,374,487	0	836,805
Thailand	1,099,926	614,918	0	492,302
Other Asia	2,456,496	145,546	3,155,708	5,494,301
Africa	5,357,013	2,114,404	1,841,723	4,953,612
Mauritius	690,578	634,530	23	36,787
South Africa	2,023,173	891,169	23,898	1,145,551
Other Africa	2,643,262	588,705	1,817,802	3,771,274
Oceania	4,234,755	2,441,750	198,972	1,023,452
Australia	2,942,952	2,172,727	0	759,353
Fiji	302,377	268,783	152	28,321
Hawaii	989,426	0[b]	0	34,578
Other Oceania	0	0	198,820	201,200
World Total	80,139,164	21,791,154	21,616,104	78,815,756

Source: raw data from International Sugar Organization (1977).

[a]Horizontal totals do not sum, due to the omission of changes in stocks.

[b]All exports to mainland U.S.A.

second reason for such disaggregation is the political nature of trade in sugar. Almost all exporting nations control the size of the sugar sector by quotas on individual mills or farmers. Almost all importing nations have quotas or tariffs on the entry of sugar that protect their own domestic sugar industries. The research attempts to show the effects of changes in the policies of different nations which should be separately identified in the model. It is not sufficient to identify only a few nations in this context because the trade in sugar has been characterized by international arrangements that tie together different groups of countries. Table 6–2 gives a breakdown of the sugar trade in 1973 under different arrangements: roughly 50 percent in the free market, 20 percent under the U.S. Sugar Act, 14 percent under special Cuba-Communist nation arrangement, and 8 percent under the Commonwealth Sugar Agreement. To find out who might gain and who might lose from a rearrangement of policy and trade means that interested countries have to be identified in the model but grouped for special trade arrangements.

The politicization of trade in sugar may have arisen as a response to fluctuations in its traded price. Sugar is among the most volatilely priced commodities by any measure (House of Lords, 1977). On the other hand, only about 25 percent of the sugar produced is traded, and the unstable international price is partly the consequence of policies designed to give domestic price stability. The seventy-five regions of the model are listed in Table 6–3. Each region has its own demand function and many have their own supply function. The type of supply function estimated for a particular region is also given in Table 6–3.

THE MODEL, POLICIES, AND SUPPLY-DEMAND ESTIMATES

The Model

The model is one of spatial equilibrium. It assumes that the difference in the price of sugar between any two countries is equal to the transportation cost per unit plus the price effect of any trade restrictions that exist between the two. Figure 6–1 demonstrates the equilibrium that would arise in a two-country world in which transportation costs are zero but where there is a fixed tariff of $FTAR_j$ in country j. The tariff lowers the exporter's price to P_i^T and raises the importer's price to P_j^T from the free market equilibrium of P_j^F. Trade is reduced by the tariff from a free market equilibrium of q_F to q_T. The tariff raises a revenue of $\pi\epsilon\lambda\rho$ of which $\sigma\mu\lambda\rho$ is extracted from the exporting nation's producers and $\pi\epsilon\mu\sigma$ from the importing nation's consumers.

The structure of the model is as follows. Let there be m producing

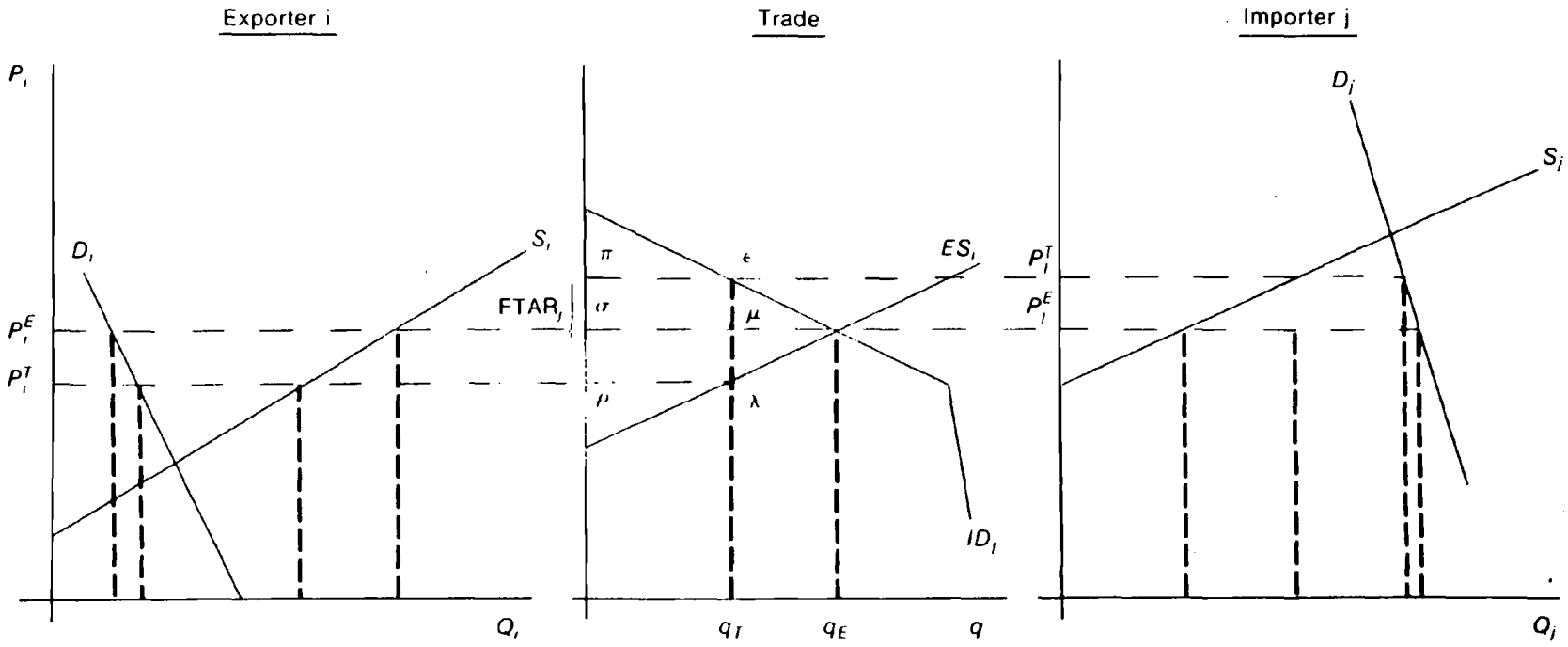


FIGURE 6–1. Two-Country Equilibrium with Tariff *FTAR*$_j$

and n consuming regions, subscript i always denoting a producing region and subscript j a consuming region.

Let Q_j^D = the quantity of raw sugar demanded in the jth region;
Q_i^S = the quantity of raw sugar supplied by the ith region;
P_j = the wholesale price of raw sugar in the jth region;
q_{ij} = shipment of raw sugar from region i to region j;
G_{ij} = cost of shipment, including trade barriers, from region i to region j.

The interrelations between these variables are described in equations 6–1 to 6–8:

Demand relations for each consuming region:

$$Q_j^D = Q_j^D\ (P_j), j = 1, 2, \ldots, n \tag{6–1}$$

Supply relations for each producing region:[1]

$$Q_i^S = Q_i^S\ (P_i), i = 1, 2, \ldots, m \tag{6–2}$$

Total quantity demanded in equilibrium equals the sum of all shipments:

$$Q_j^D = \sum_i q_{ij}, j = 1, 2, \ldots, n \tag{6–3}$$

Total quantity supplied in equilibrium equals the sum of all shipments:

$$Q_i^S = \sum_j q_{ij}, i = 1, 2, \ldots, m \tag{6–4}$$

Shipments are non-negative:

$$q_{ij} \geq 0 \quad \begin{matrix} i = 1, 2, \ldots, m \\ j = 1, 2, \ldots, n \end{matrix} \tag{6–5}$$

At equilibrium the prices in any two regions cannot differ by more than transfer cost per unit:

$$P_j - G_{ij} - P_i \leq 0, \quad \begin{matrix} i = 1, 2, \ldots, m \\ j = 1, 2, \ldots, n \end{matrix} \tag{6–6}$$

At equilibrium the sum of transfer expenditures is exactly balanced

Table 6–2. International Trade in Sugar by Type of Market in 1973

Type of Market	*Exporter*	*Importer*	*Per 000 Metric Tons*	*Percent of World Exports*	*Price in Cents Per Pound*
Under U.S. Sugar Act	Philippines	U.S.A.	1,319		
	Dominican Republic		676		
	Brazil		591		(Duty-paid
	Mexico		577		in New York)
	Others		1,672		
Total			4,835	21.8	10.29
Under Commonwealth Sugar Agreement (Negotiated Price Quota)	W. Indies & Guyana	U.K.	736		
	Mauritius		386		(f.o.b. in
	Australia		340		Caribbean)
	Others		308		
Total			1,770	8.0	5.36[a]
Under Bilateral Cuban Agreements	Cuba	U.S.S.R.	1,661		
		China	302		(f.o.b. in
		E. Germany	259		Cuba)
		Bulgaria	213		
		Others	561		
Total			2,996	13.5	6.0–11.0

Free Market Exports	Brazil	2,530		
	Cuba	1,774		
	Australia	1,497		(f.o.b. in Caribbean)
	EEC	1,468		
	South Africa	824		
	China-Taiwan	428		
	Poland	422		
	Dominican Republic	396		
	Argentina	396		
	Others	1,930		
Total		11,665	52.7	9.61
Free Market Imports	Japan	2,395		
	U.S.S.R.	1,016		
	Canada	952		
	Iraq	474		(f.o.b. in Caribbean)
	Yugoslavia	368		
	Malaysia	331		
	Indonesia	307		
	Iran	302		
	Others	5,658		
Total		11,803	53.2	9.61
Gross Exports in all markets		22,145	100.0	
Net Exports in all markets		19,208		
Domestically consumed		55,950		
World Production		78,095		

Source: International Sugar Organization (1977).

[a]Plus a bonus of 1.18 cents per pound for West Indies and Guyana and 0.75 cents per pound to other "less developed" suppliers.

Table 6–3. Regions and Types of Supply Functions in the Model

Continent	*Region*	*Type of Supply Function*				
		Log-Linear	*Asymmetric*	*Time Only*	*Point*	*None*
Europe	Austria					
	Belgium	✓				
	Czechoslovakia				✓	
	Denmark	✓				
	Finland			✓		
	France	✓				
	Germany (West)	✓				
	Germany (East)	✓				
	Greece	✓				
	Iceland					✓
	Ireland			✓		
	Italy	✓				
	Netherlands	✓				
	Norway					✓
	Poland	✓				
	Portugal					✓
	Spain			✓		
	Sweden			✓		
	Switzerland				✓	
	Turkey	✓				
	U.S.S.R. (West)	✓				
	U.S.S.R. (East)					✓
	U.K.	✓				
Eastern Europe:	Albania, Bulgaria, Hungary, Romania, Yugoslavia			✓		
North America	Canada (West)					✓
	Canada (East)				✓	
	U.S.A. (West)	✓				
	U.S.A. (South)	✓				
	U.S.A. (East and North)	✓				

Central America	Barbados		✓		
	Cuba		✓		
	Dominican Republic		✓		
	Guatemala		✓		
	Jamaica		✓		
	Mexico		✓		
	Nicaragua		✓		
	Puerto Rico	✓			
	Trinidad and Tobago		✓		
Central America:[a]	Bahamas, Belize, Bermuda, Costa Rica, Ecuador, El Salvador, Malta, Honduras, Netherlands Antilles, Panama, Surinam, Virgin Isles		✓		
South America	Argentina		✓		
	Bolivia and Chile		✓		
	Brazil		✓		
	Colombia		✓		
	Guyana		✓		
	Paraguay and Uruguay		✓		
	Peru		✓		
	Venezuela		✓		
Asia	China			✓	
	China—Taiwan		✓		
	Hong Kong				✓
	India		✓		
	Indonesia		✓		
	Iran		✓		
	Japan		✓		
	Korea (North and South)			✓	
	Pakistan and Bangladesh			✓	
	Philippines		✓		
	Saudi-Arabia			✓	
	Singapore				✓
	Sri Lanka				✓
	Thailand		✓		

Table 6–3. (continued)

Continent	*Region*	*Type of Supply Function*				
		Log-Linear	*Asymmetric*	*Time Only*	*Point*	*None*
Near East:	Iraq, Israel, Jordan, Lebannon, Syria			✓		
Far East:	Afghanistan, Burma, Malaysia, Nepal, Vietnam			✓		
Africa	Mauritius		✓			
	South Africa		✓			
North Africa:	Algeria, Egypt, Libya, Morocco, Tunisia			✓		
West Africa:	Cameroun, C.A.R., Chad, Dahomey, Equatorial Guinea, Gambia, Ghana, Guinea, Ivory Coast, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Spanish Sahara, Togo, Upper Volta			✓		
North-East Africa:	Ethiopia, Sudan, Somalia			✓		
East Africa:	Burundi, Kenya, Rwanda, Tanzania, Uganda, Botswana, Malawi			✓		
South-Central Africa:	Mozambique, Rhodesia, Swaziland, Zambia			✓		
South-West-Central Africa:	Angola, Congo, Nambia, Zaire			✓		
Oceania	Australia		✓			
	Fiji		✓			
	Hawaii	✓				
	New Zealand					✓
TOTALS	75	17	28	18	4	8

[a]Ecuador and Surinam strictly part of South America; also including French possessions.

by the sum of price differences times quantities shipped for all regions:

$$\sum_i \sum_j \{(P_j - G_{ij} - P_i)\, q_{ij} = 0,\ i = 1, 2, \ldots, m \qquad (6\text{–}7)$$
$$j = 1, 2, \ldots, n$$

Equations (6–3) to (6–5) are nothing more than the well-known transportation model, given the particular unit costs of transportation, G_{ij}. The addition of the demand and supply equations, (6–1) and (6–2), adds to the complexity of solution but not greatly to the conception. Equation (6–7) represents a check on equilibrium involving both equalities (6–5) and inequalities (6–6) (see Zusman et al., 1969).

Although it may be shown under certain conditions that any quota may be represented by an equivalent tariff, it is simpler in this context to treat quotas separately since they are used in such a widespread manner by importing countries. Hence there is an additional identity

$$0 \leq QUOT_{ij} \leq q_{ij}, \qquad i = 1, 2, \ldots, m \qquad (6\text{–}8)$$
$$j = 1, 2, \ldots, n$$

where $QUOT_{ij}$ is the quota given by importing region j to exporting region i.[2]

The Model and Trade Policies

Thus far the composition of G_{ij}, the transfer cost, has not been discussed. The transfer cost between regions i and j comprises: (1) the cost of transportation per unit T_{ij}; (2) tariff costs, the latter including specific or fixed tariffs, $FTAR_j$, variable or ad valorem tariffs, $VTAR_j$, and variable levies, $VLEV_j$; and (3) export taxes, $ETAX_i$. The identity for transfer cost G_{ij} combines these components as follows.

$$G_{ij} = T_{ij} + FTAR_j + VTAR_j + VLEV_j + ETAX_i \qquad (6\text{–}9)$$
$$i = 1, 2, \ldots, m$$
$$i \neq j$$
$$j = 1, 2, \ldots, n$$
$$j \neq i$$

The ad valorem tariff is itself a function of price

$$VTAR_j = P_j/(1 + V_j),\ j = 1, 2, \ldots, n, j \neq i \qquad (6\text{–}10)$$

where V_j = the ad valorem tariff rate in percentage terms.

Similarly, the variable levy, such as that of the European Economic Community, depends on the threshold (minimum import) price at destination and supply price at origin as given by

$$VLEV_j = PTH_j - T_{ij} - P_i, \qquad \begin{matrix} i = 1, 2, \ldots, m \; i \neq j \\ j = 1, 2, \ldots, n \; j \neq i \end{matrix} \qquad (6\text{–}11)$$

$$VLEV_j \geq 0$$

where PTH_j = the predetermined threshold price in region j, below which imports may not occur.

Information concerning tariffs was obtained from the *International Customs Journal.* Information on the cost of transportation was provided by Thomas Bates of San Francisco State University. Bates developed a complex cost function that was approximated informally, allowing for inflation to 1974, by

$$t_{ij} = 0.03 \; (D_{ij})^{0.5} \qquad (6\text{–}12)$$

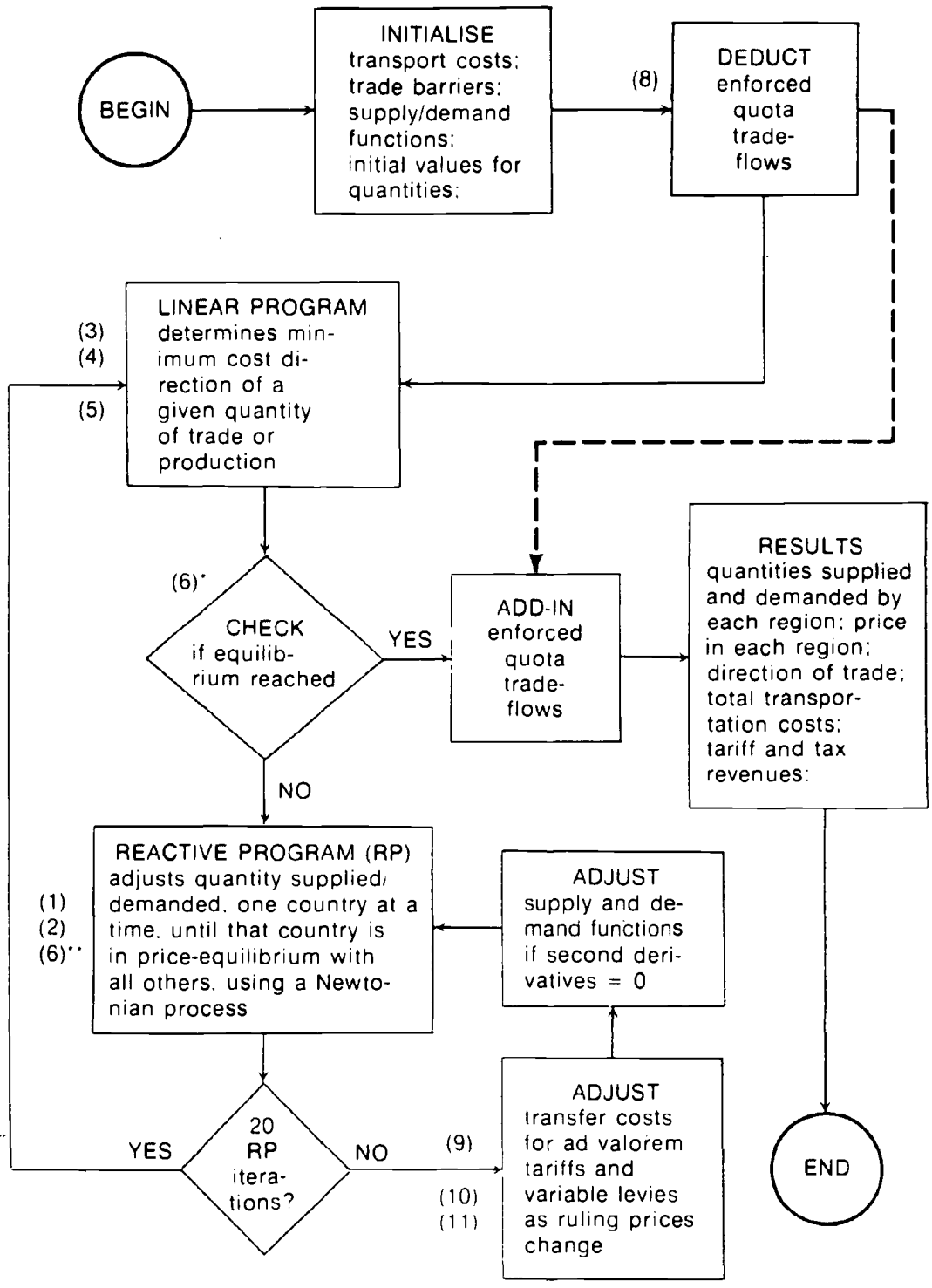
where t_{ij} = the cost in 1974 cents per pound per nautical mile
and D_{ij} = the distance between i and j in nautical miles

The per unit transportation cost is the product of these two variables.

$$T_{ij} = t_{ij} D_{ij}. \qquad (6\text{–}12a)$$

A matrix of distances was drawn up using the U.S. naval publication, "Distances Between Ports" (U.S. Naval Oceanographic Office, 1964). Distances within Europe, the Soviet Union, the United States, and Canada were included on an overland basis where appropriate. Overland costs were assumed to be the same as those by sea. As an example of the shipping costs implied by Equation (12a), the Cuba-New York route (1,199 nautical miles) is estimated to cost 1.04 cents per pound, whereas the Australia-New York route (9,692 nautical miles) costs 2.95 cents per pound. The distances in the matrix assumed the Suez Canal to be closed. This was a reasonable assumption in simulating 1974 equilibria but would slightly distort prices (particularly in the Near East) in projections.

Such spatial equilibrium models were introduced by Samuelson (1952) and solved by Takayama and Judge (1964) using quadratic programming. Considered as a maximization problem, the objective is to maximize the global sum of producers' and consumers' surplus



Numbers in parentheses are equation numbers.
*(6) for all countries simultaneously, which with (5) satisfies (7).
**(6) for one country at a time, i.e., $i = 1, 2, \ldots m$ and $j = 1$ or 2 or $\ldots n$.

FIGURE 6–2. Flow Diagrams for Solution of Sugar Model

after the deduction of transfer costs. Samuelson called this net social payoff (*NSP*) and it may be written:

$$NSP = \sum_{j}^{n} \int_{0}^{qj^{D}} P_j\,(Q_j)dQ_j - \sum_{i}^{m} \int_{0}^{qi^{S}} P_i\,(Q_i)\,dQ_i - \sum_{i} \sum_{j} q_{ij}G_{ij} \qquad (6\text{–}13)$$

Tramel and Seale (1963) developed approximate solutions by a method called reactive programming, and a modification of that approach, starting from an algorithm by King and Ho (1972), was used in the present work. Figure 6–2 gives an approximate idea of how the model is solved. Following initialization of the variables, quota flows are deducted. A linear program then allocates quantities to different markets, minimizing transfer costs. A check is then made for price equilibrium, and if it does not exist, the reactive program adjusts quantities supplied and demanded using a Newtonian process. After each iteration, transfer costs are adjusted, and as ad valorem tariffs and variable levies change, prices change. After every twentieth iteration of the reactive program, the linear program is again used. When equilibrium is reached to the desired tolerance, quota flows are added in again and the results provided.

Summary of Supply and Demand Estimates

A model is only as credible as the functions that comprise it. Considerations of space prevent a full presentation of the supply and demand equations, which may be seen elsewhere (Gemmill, 1976). Equations for U.S. and European beet sugar supply were of a double logarithmic form. U.S. cane sugar supplies were projected under an assumption of profit-maximizing adjustment, using an analysis based on cross-section and time-series data. The own-price elasticities for each of the beet sugar producing countries and for U.S. cane sugar are presented in Table 6–4. As a general characterization of responsiveness, weighted average price elasticities are given in the subtotal rows. These indicate an EEC elasticity of 1.05, an elasticity for Eastern Europe of 0.26, and an overall U.S. elasticity of 1.77.

Altogether twenty-eight major cane sugar producing countries were recognized in the model. Separate cane area and yield equations were estimated, but the latter proved unimportant and are not presented here. The functions concerned with cane investment in terms of land area were of the form:

$$(HA_t/PP_t^*) = \beta_0\gamma + \beta_1\gamma\,(PP_t^*/PMX_t) + (1-\gamma)\,(HA_{t-1}/PP_{t-1}^*) \qquad (6\text{–}14)$$

(continued on page 138)

Table 6–4. Supply Elasticities For Beet Sugar and U.S. Cane-Sugar

Country	*Production in Thousand Tonnes Raw Value 1974*	*Elasticity With Respect to*			*Percent Annual Change Due to Other Factors*
		Own Price[b]	*Input Price*	*Alternative Product Price*	
Belgium	604	0.30	−0.30	—	3.85
Denmark	416	1.30	−1.65	—	0.93
France	2,945	1.64	−2.09[c]	—	0.53
West Germany	2,436	0.87	−0.10[c]	−0.61 (wheat)	2.60
Ireland	146	—	—	—	0.25
Italy	1,008	0.57	−0.55	−0.03 (apples)	1.56
Netherlands	777	1.14	−3.87[c]	−0.29 (potatoes)	4.33
United Kingdom	617	0.44[d]	−0.27[c]	—	2.00
Sub-Total (EEC)[a]	9,305	1.05	—	—	1.88
Austria	403	—	—	—	—
Finland	82	—	—	—	—
Greece	187	—	—	—	6.84
Portugal	9	--	—	—	—
Spain	667	—	—	—	4.75
Sweden	301	—	—	—	—
Switzerland	72	—	—	—	—
Turkey	834	—	—	—	3.43
Sub-Total (Other Western Europe)	2,555	—	—	—	2.43

Czechoslovakia	750	0.01	—	—	—
East Germany	570	0.32	—	—	—
Poland	1,600	0.28[e]	—	—	0.37[e]
U.S.S.R.	8,256	0.32	—	—	2.27
Rest of Eastern Europe	1,699	—	—	—	3.03
Sub-Total (Eastern Europe)	13,145	0.36	—	—	1.99
U.S. Beet: East	1,425	0.91	−0.79	—	0.05
West	1,220	2.71	−1.57	—	0.04
U.S. Cane: Florida[f]	728	4.23	—	—	—
Hawaii[f]	944	0.99	—	—	—
Louisiana[f]	539	0.75	—	—	—
Puerto Rico[f]	263	0.00	—	—	—
Texas[f,g]	67	2.59	—	—	—
Sub-Total (U.S.A.)	5,186	1.77	—	—	—

Source: Based on the author's computations.

[a]Including 356,000 tonnes from French Overseas Departments.

[b]Domestic price, except for Communist nations for which world free-market was used.

[c]Fertilizer price only.

[d]For yield only: elasticity of 1.00 assumed for model and for weighted average below.

[e]From land-area equation.

[f]From simulated output at 10 cents per pound sugar price.

[g]From an assumed supply schedule.

where:

HA = thousand hectares of cane
PP^* = average of real price of sugar exported at times $t - 1$ and $t - 2$
PMX = highest value of PP^* ever attained
β_0, β_1, γ = parameters
and t = year subscript

This equation makes cane investment a response both to the recent price of exports, in real terms, and to the highest price of such exports ever attained. When PP^* is less than PMX there is a short-run, inelastic response to changing prices. When PP^* is equal to PMX, that is, price is at a new high, more elastic responses may occur although the maximum response that this function allows is limited to an elasticity of one.[3] The elasticities derived from this equation for the sample period (usually 1950–1972) are shown in Table 6–5. They are called "indicative" elasticities because they are calculated on the assumption that $(HA_t/PP^*_t) = (HA_{t-1}/PP^*_{t-1})$.

The long-run elasticities seem to be "reasonable" in magnitude (from 0.2 to 1.0), but the seven negative short-run elasticities, implying an increase in supply as export price falls (over a limited range), require an explanation. To some extent pooled pricing, under which returns to producers are held constant regardless of export prices, may be the cause.[4] In addition, some fixed asset theories would be consistent with an expansion of output when prices fall once capital has been committed (Johnson and Quance, 1972). Four of the negative short-run elasticities are close to zero and therefore not of great importance. Indeed, the important features are that the long-run elasticities are of acceptable magnitude and *larger* than the short-run elasticities.

Demand

The demand for sugar was examined in seventy-three countries in two distinct ways. First, time-series data were analyzed for each country whenever possible. Second, the time-series and cross-section data were pooled and "international" equations were estimated, with each country having its own intercept to allow for differences in taste. Three different kinds of equations were estimated, semilogarithmic, double logarithmic, and Ramsey, of which the semilogarithmic was used in the model. This form is given in Equation (6–15) in the specification used for pooled time-series and cross-section estimation:

$$Q_{it} = \sum_{j=1}^{N-1} w_j + \beta_0 + \beta_1 \log Y_{it} + \beta_2 \log P_{it} + E_{it} \qquad (6\text{–}15)$$

where

Q is kilogram per head of sugar consumed in raw value
w is a dummy variable equal to zero unless $j = i$
Y is real income per head (thousands of 1972 dollars)
P is real price per kilogram of raw sugar at retail (1972 dollars)
E is a disturbance term
$\beta_0, \beta_1, \beta_2$ are parameters
i denotes i^{th} country ($i = 1 \ldots N$)
j denotes j^{th} country ($j = 1 \ldots N$)
t denotes year
N denotes number of countries

Corrections were made in estimating individual time series for autocorrelation and in the international equations for both autocorrelation and heteroscedasticity.

The results from pooled international estimation using the semilogarithmic function are summarized in the form of average price and income elasticities in Table 6–6 at various price and income levels. This method of presentation shows very clearly how both income and (absolute value of) price elasticities fall as price falls and as income rises. The figures in brackets are some of the cross-sectional estimates of Viton and Pignalosa (1961) for 1956 converted to a 1972 basis; they exhibit a more compressed set of values but are of the same order of magnitude. For countries for which time-series estimation gave reliable results, these were used in the model. Otherwise, the pooled results were used.

RESULTS FROM THE MODEL UNDER ALTERNATIVE POLICIES

This section presents the results from simulating the world sugar economy in long-run equilibrium in order to discover the effects of alternative policies. It is divided into two parts: first, the values of the endogenously determined variables—wholesale price, quantity supplied, and quantity demanded—are given; second, the prices and quantities are converted, via producers' and consumers' surplus, to

Table 6–5. Sugar Cane Area Investment Elasticities

Country	*Short-Run Investment Elasticity*	*Long-Run Investment Elasticity*
Argentina	0.295	0.943
Australia	0.011	0.539
Barbados	0.383	0.835
Bolivia and Chile[a, b]	−0.006	0.212
Brazil	0.281	0.676
China-Taiwan	0.308	0.424
Colombia	0.508	0.807
Cuba	0.039	0.485
Dominican Republic[c]	−0.159	0.579
Fiji	0.121	0.726
Guatemala	0.464	0.844
Guyana	−0.034	0.701
India[c]	0.225	0.526
Indonesia	0.190	0.244
Iran[a]	0.359	0.508
Jamaica	0.448	0.840
Japan[a, b]	0.295	0.455
Mauritius	0.100	0.716
Mexico	0.610	0.931
Nicaragua	−0.131	0.836
Peru	0.543	0.874
Philippines	0.408	0.923
South Africa	−0.679	0.178
Thailand	−0.219	0.368
Trinidad and Tobago	0.036	0.736
Venezuela	−0.451	0.877
Central America[a]	0.417	0.850
Paraguay and Uruguay	0.306	0.461

Source: Based on the author's computations.

[a]Dependent variable is Q_t/PP_t^* rather than HA_t/PP_t^*.

[b]Includes some sugar beet also.

[c]Hectares growing and not hectares harvested.

welfare losses and gains. It should be noted that the supply functions were estimated in relation to a variety of domestic and international prices that were converted into 1974 dollar values for solution of the whole model. Similarly, the demand functions were estimated in relation to retail prices, and in solving the model, these were converted to prices at the wholesale level.[5] The spatial equilibria take account both of transportation costs and trade distortions and were computed at projected 1974 population and income levels.

Equilibrium Prices and Quantities

The model was solved for each of thirteen different combinations of policies, ranging from a fully distorted set, reflecting the high level of

Table 6–6. Price and Income Elasticities at Various Price and Income Levels from the Semilogarithmic Equation (Income in Dollars, 1972, and Price in Cents per Pound 1972)

	Price Elasticities					
Price \ *Income*	*100*	*200*	*500*	*1,000*	*3,000*	*5,000*
10	−0.880	−0.511	−0.329	−0.259	−0.194	−0.173
20	−2.254	−0.791 (−0.582)[a]	−0.426 (−0.360)	−0.316 (−0.310)	−0.224 (−0.235)	−0.197
30	−26.205	−1.165 (−0.762)	−0.515 (−0.461)	−0.362 (−0.355)	−0.246 (−0.260)	−0.214
40	—	−1.753 (−0.913)	−0.614 (−0.532)	−0.404 (−0.395)	−0.265 (−0.281)	−0.228
50	—	−2.879	−0.699	−0.444	−0.282	−0.241
60	—	−6.060	−0.801	−0.483	−0.297	−0.252

	Income Elasticities					
Price \ *Income*	*100*	*200*	*500*	*1,000*	*3,000*	*5,000*
10	1.041	0.605	0.389	0.306	0.229	0.205
20	2.667	0.936 (0.545)[a]	0.504 (0.337)	0.373 (0.290)	0.265 (0.220)	0.233
30	31.000	1.379 (0.713)	0.609 (0.431)	0.428 (0.332)	0.291 (0.243)	0.254
40	—	2.074 (0.854)	0.715 (0.498)	0.478 (0.370)	0.313 (0.263)	0.270
50	—	3.406	0.827	0.525	0.333	0.285
60	—	7.169	0.947	0.572	0.351	0.298

Source: Based on the author's computations.

[a]Figures in brackets are the cross-sectional estimates of Viton and Pignalosa for 1965 converted to a 1972 basis.

protection that existed in 1974 in the developed countries, to completely free trade. Rather than giving the results for each individual country, the results in prices for the United States, European Economic Community, and Cuba and quantities for the United States, European Economic Community, and the whole world are summarized in Table 6–7.

The six policy variables of Table 6–7 require a short explanation. A plus (+) in the diagram denotes a policy in operation and a minus (−) the abandonment of a policy. The "U.S. Sugar Act" policy included quotas of 4,882,000 tons, a 0.625 cents per pound tariff, and the banning of nonquota imports. The "EEC Levy" policy denied entry to the European Economic Community of raw sugar at less than the threshold price of 14.62 cents per pound and countervailing charges insured compliance with the policy. The "Cuban Quotas" policy directed 2,745,000 tons of Cuban exports to Communist countries. The "Commonwealth Quotas" policy directed 1,383,000 tons to be delivered from Commonwealth countries (excluding Australia) to the United

Table 6–7. Policy Experiments and Long-run Equilibria

	Policy					
Experiment Number	*U.S. Sugar Act*	*EEC Levy*	*Cuban Quotas*	*Commonwealth Quotas*	*Other Tariffs*	*Export Tax*
I	+	+	+	+	+	−
II	−	−	−	−	−	−
III	−	+	+	+	+	−
IV	+	−	+	+	+	−
V	−	−	+	+	+	−
VI	−	+	−	+	+	−
VII	10% VTAR	+	+	+	+	−
VIII	−	−	−	+	+	−
IX	+	+	+	−	+	−
X a	+	+	+	+	+	2¢/lb.
b	+	+	+	+	+	6¢/lb.
c	0.625¢/lb. FTAR	+	+	−	+	10¢/lb.
d	0.625¢/lb. FTAR	+	+	−	+	20¢/lb.
1973	+	+	+	+	+	−
1974	0.625¢/lb. FTAR	+	+	−	+	−

Source: Based on the authors' computations.

Notes: VTAR denotes ad valorem tariff. FTAR denotes specific tariff.

Table 6–7. (Continued)

Experiment Number	Prices			
	Free-Market New York	*U.S. Domestic New York*	*EEC (France)*	*Cuban Domestic*
I	7.76	11.89	12.79	6.72
II	10.85	10.72	11.36	9.81
III	10.23	10.33	12.56	9.19
IV	9.17	11.82	9.87	8.13
V	11.24	11.13	10.31	10.20
VI	9.78	9.53	12.83	8.74
VII	9.86	11.01	12.74	8.82
VIII	10.40	10.22	10.78	9.36
IX	7.43	11.86	13.83	6.39
X a	9.07	11.91	12.84	6.03
b	10.13	11.88	12.61	3.09
c	13.77	14.48	13.78	2.73
d	16.24	16.24	14.59	1.36
1973	11.68	11.42		
1974	31.03	29.50		

EEC Threshold Price is 14.6172¢/lb.
Prices are c.i.f. in 1974 cents/lb.

Table 6–7. (Continued)

Experiment Number	United States		E.E.C.		World
	Imports	*Domestic Production*	*Imports*	*Domestic Production*	*Production and Consumption*
I	4882	5987	1383	9303	78535
II	5674	5216	2808	8112	77575
III	6380	4544	1383	9305	77818
IV	4882	5991	3918	7140	77627
V	5718	5148	3587	7451	77393
VI	6902	4013	1383	9295	77820
VII	5954	4951	1383	9296	78301
VIII	6263	4644	3275	7663	77134
IX	4882	5990	366	10196	78830
X a	4882	5991	1383	9305	78752
b	4882	5990	1383	9292	77391
c	3443	7375	322	10223	76245
d	1443	9322	− 204	10717	75281
1973	4831	5731	313	10177	78095[a]
1974	5188	5398	1036	9237	78909[a]

Quantities are in thousand metric tons of raw sugar.
[a]Production.

Kingdom. The "Other Tariffs" policy imposed all other specific and ad valorem tariffs known to exist. Finally, the "Export Tax" policy imposed a tax on exports from all cane-producing countries, ranging from 2 to 20 cents per pound, as a representation of the possible effect of a cartel of exporters.

Before proceeding to a discussion of the individual results in Table 6–7, two general comments will be made. First, under all of the different policies the volume of world production is relatively constant. This results not only from the low magnitudes of changes in price that are induced by the alternative policies, but also from the ease with which beet production may be substituted for cane production. Even under a huge export tax of 20 cents per pound (*Xd*), the volume of world production is not greatly curtailed but its geographical distribution merely changes. Second, prices are considerably lower than those existing in 1974, even under the imposition of a large export tax by cane exporters. This suggests that relatively low average prices are likely to continue for some time.

The differential impact of each policy will be examined by comparing it with the appropriate alternative. The first such comparison is between the historical set of policies (I) and *completely free trade* (II). Surprisingly, world production would decline by 960,000 tons under free trade. The underlying cause is the increase in free market price, from 7.76 to 10.85 cents per pound, and the associated increase in sugar prices in exporting countries, while prices decline in previously protected importing nations. Since the price elasticity of demand is higher in the exporting nations as a group than in the importing nations, the high prices reduce consumption by more in the exporting countries than the lower prices increase consumption in the importing countries. The net effect in equilibrium is a small decline in world production (and consumption). The effect of free trade on U.S. and EEC prices and production is less than might have been expected. In both regions some domestic production is replaced by imports and the domestic price falls to meet the free market price (which has risen). Imports to the United States increase by 792,000 tons or 16 percent and to the European Economic Community by 1,505,000 tons or 103 percent.

The second comparison is between policy set (I) and a set in which there is *no U.S. Sugar Act* (III). Note that Cuban sugar was allowed entry to the United States in this experiment, unlike the current (1978) situation. World production and consumption decline slightly (by 717,000 tons). U.S. and free market prices become synonymous, but the free market price rises much more (+2.47 cents) than the U.S. domestic price falls (−1.56 cents). The hypothesis of Sanchez (1972)

that the U.S. Sugar Act raised free market prices is rejected by this experiment—the converse is true. Because the U.S. domestic price falls more than it would under free trade, imports rise correspondingly more. As compared with the benchmark I, imports rise 1,498,000 tons or 31 percent and domestic production declines 1,443,000 tons or 24 percent.

The third comparison is between the benchmark (I) and the *unilateral end of its protective levy by the European Economic Community* (IV). Just as with the abolition of U.S. protection in III, the free market price is raised (by 1.41 cents), but in this case the EEC price (as measured in France) falls considerably (by 2.92 cents), indicating that the United States influences world price more than does the European Economic Community. The consequent decline in EEC production is quite large, being 2,162,000 tons or 23 percent, while imports expand correspondingly by 2,535,000 tons or 183 percent. World production remains remarkably constant under this as under each of the other policies.

The fourth comparison is between the benchmark (I) and the *simultaneous abolition of trade barriers by the United States and European Economic Community* (V). The major effect is to raise the free market price even more than under free trade. U.S. prices are slightly higher than under free trade,[6] but EEC prices fall and there is a corresponding decline in EEC production. The implication of experiment V, as compared with III and IV, is that orchestrated reduction of trade barriers by the United States and European Economic Community would lead to smaller problems of domestic adjustment than the unilateral reduction of trade barriers by either region alone.

The fifth comparison is between the unilateral ending of the U.S. Sugar Act (III) and the *simultaneous ending of the U.S. Sugar Act and Cuba's Quota Agreements* (VI). Cuban sugar may now enter the United States in larger amounts. Also the free market price (as measured at New York) and the U.S. domestic price are both lower under VI than under III. U.S. domestic production suffers its severest decline, by 1,974,000 tons (33 percent) as compared with the benchmark (I). U.S. imports rise similarly by 2,020,000 tons (41 percent) as compared with I.

The sixth comparison is between III, the policy set with no U.S. Sugar Act, and VII, *a policy set in which the United States imposes a 10 percent ad valorem tariff on sugar*. The effect is very slight. There is a small decline in free market price, a small rise in U.S. domestic price, and a correspondingly small replacement of imports by domestic production in the United States.

The seventh comparison is between free trade (II) and the *continua-*

tion alone of the Commonwealth quotas and other countries' tariffs (VIII). All prices fall in this set relative to free trade and consequently U.S. and EEC domestic production also fall, but the magnitude is small.

The eighth comparison is between I and the *ending of the Commonwealth Sugar Agreement (IX)*. Free market price declines slightly, but the EEC price rises somewhat and the latter region becomes almost self-sufficient in sugar, importing a mere 366,000 tons. The importance attached by the United Kingdom in continuing the Commonwealth Sugar Agreement on behalf of the Commonwealth exporters is seemingly justified by this experiment.

The final comparisons are between the benchmark set (I) and sets with similar policies except for the addition of an *export tax of varying magnitude by the cane exporting countries* ($X\ a, b, c, d,$). Export taxes of 2, 6, 10, and 20 cents per pound were considered. At taxes of 10 and 20 cents the U.S. Sugar Act and Commonwealth Sugar Agreements were no longer functional (c and d). Taxes of 2 or 6 cents per pound would merely be impositions on importers from the free market such as Japan and Canada; hence, they would be similar in effect to previous international sugar agreements. The free market price would not rise to the level of the U.S. or EEC prices, thus avoiding disruptions in those markets. However, an export tax of 10 cents per pound, if also levied on the United States and European Economic Community, would raise prices in these two regions and encourage domestic production. Several traditional exporters of cane would cease to export, for example, Argentina, Brazil, Colombia, Guatemala, Mexico, Nicaragua, Peru, South Africa, Thailand, Venezuela, and Central America. The relatively elastic supply of domestic sugar in the United States and European Economic Community and the inelastic supply of the cane exporters result together in the easy substitution of domestic for imported sugar and only a small reduction in output worldwide. This effect is even more pronounced when a 20 cent tax on exports is imposed, the European Economic Community, now becoming a net exporter and the United States importing a mere 1,443,000 tons (a reduction of 70 percent). Australia, Barbados, China-Taiwan, Dominican Republic, Fiji, Guyana, Jamaica, Philippines, and Trinidad and Tobago are now added to the list of countries ceasing to export sugar; only Cuba is left.

These results may be more easily digested by observing in Table 6–8 the production effects of the five most interesting policies in relation to the benchmark policy set (full distortions) number I. This table also lists the effects on production in the six major Latin American sugar-exporting nations. Note that countries have been grouped under

Table 6–8. Summary of Changes in Production Relative to the Benchmark (I) Set of Policies

Region	Policy									
	Free Trade II		*No U.S. Protection III*		*No EEC Protection IV*		*No EEC or U.S. Protection V*		*10 cent per lb. Export Tax Xc*	
	Thousand Tons[a]	*%*	*Thousand Tons*	*%*	*Thousand Tons*	*%*	*Thousand Tons*	*%*	*Thousand Tons*	*%*
Argentina	+ 111	+ 7.4	+ 77	+ 5.2	+ 90	+ 6.0	+ 96	+ 6.4	− 423	−28.3
Brazil	− 24	− 0.4	+ 26	+ 0.4	+ 9	+ 0.1	+ 11	+ 0.2	− 876	−14.0
Cuba	− 20	− 0.3	− 26	− 0.3	− 10	− 0.2	− 14	− 0.2	−1205	−19.3
Dominican Republic	− 109	−10.7	− 65	− 6.4	− 10	− 1.0	− 122	−11.9	− 386	−37.8
Mexico	+ 44	+ 1.4	+ 51	+ 1.6	+ 107	+ 3.5	+ 37	+ 1.2	− 883	−28.9
Peru	− 2	− 0.2	− 17	− 2.0	− 8	− 1.0	0	0.0	− 312	−37.6
EEC	−1193	−12.8	0	0.0	−2164	−23.3	−1856	−20.0	+ 916	+ 9.8
U.S.S.R.	+1149	+11.0	+ 338	+ 3.2	+ 632	+ 6.1	+ 829	+ 8.0	+1657	+15.9
United States	− 773	−12.9	−1443	−24.1	0	0.0	− 840	−14.0	+1385	+23.1
Developed Countries	−1228	− 3.0	−1006	− 2.4	−1419	− 3.4	−1711	− 4.1	+3150	+ 7.6
Less-Developed Countries	+ 268	+ 0.7	+ 289	+ 0.8	+ 510	+ 1.4	+ 569	+ 1.5	−5441	−14.6
Cane-Sugar Exporters	+ 269	+ 0.9	+ 61	+ 0.2	+ 3	0.0	+ 63	+ 0.2	−7724	−25.0
World	− 960	− 1.2	− 717	− 0.9	− 908	− 1.2	−1142	− 1.5	−2290	− 2.9

Source: Based on the authors' computations.

[a]All tons are metric and in raw value.

headings that are not necessarily mutually exclusive; for example, Cuba is both a cane sugar exporter and a less developed country.

1. The effect of free trade is to diminish U.S. and EEC production by about 13 percent and to enhance that of the Soviet Union by 11 percent, leaving production elsewhere largely unaffected. The effect on the Latin American producers is minor. The Dominican Republic suffers an 11 percent decline in production, as it was given highly preferential treatment by the U.S. Sugar Act. Conversely, Argentina's production expands because it was only given a small U.S. quota.
2. An end to U.S. protection forces a 24 percent decline in U.S. production. The effect on Latin American countries is similar to that for free trade in terms of production, that is, rather small.
3. An end to EEC protection causes a 23 percent decline there, mainly affecting France and the Netherlands. Argentina and Mexico appear to have small production gains from such a change to policy.
4. A combined end to U.S. and EEC protection causes 14 percent and 20 percent declines in the two regions, respectively, and encourages production in the Soviet Union to the extent of 8 percent. The effects in Latin America are similar to those for free trade.
5. A 10 cent export tax on cane sugar causes a 25 percent contraction in the output of the cane sugar exporting nations. Only those exporters with small domestic markets continue to export. Of the Latin American countries that means that only Cuba and the Dominican Republic continue to export sugar.

Overall, no policy leads to an even moderate change in the international distribution of production between less developed and developed countries, even if the cane sugar exporters impose a large tax on exports, in which case their share of production falls dramatically. The experiments suggest that the gains to exporters from freer trade will not be derived from increased output but from a higher price. Before drawing welfare implications (which combine the effects of quantity and price), some comments on tariffs and transportation costs will be made. The saving in worldwide transportation costs that occurred under free trade (II) as compared with a fully protected market (I) is estimated to be $240 million or 23 percent, the costs being $819 and $1,059 million, respectively. The major adjustment in the direction of trade that is implied is, not unexpectedly, the redirection of Cuban sugar to fill almost all of the U.S. import requirements. The current direction of trade is highly disadvantageous to Cuba.

Welfare Implications of Long-Run Equilibria

In Table 6–9 comparisons are made, in terms of summed producers' and consumers' surplus and government revenues, between the benchmark solution I (full distortions) and the four most important alternatives: free trade (II), no U.S. Act (III), no EEC protection (IV), and a 10 cent export tax by cane exporters (Xc). All calculations are relative to the benchmark or most likely solution, I. In order to simplify the calculations, the supply and demand functions were assumed linear over the appropriate ranges and the small changes in tariff revenue that accrue to importers under III, IV, and Xc were assumed negligible relative to I.[7]

Considering free trade, II, the net world gain would be $330 million, of which $324 million would go to less developed countries. The largest single beneficiary would be Cuba, the largest exporter, who would gain $392 million. Since Cuba would gain more than the overall gain to less developed countries, it follows that on the average other such countries would lose under this policy. The table shows that the effect on the main Latin American exporters is, however, favorable. Argentina, Mexico, and Brazil would gain substantially while Peru would lose. Other less developed losers under this policy, not shown in the table, include countries in the Near and Far East,[8] India, the Central American countries, Indonesia, and many African countries. These losers consist of two kinds. First, those countries that had highly preferential treatment under the U.S. Act and Commonwealth Sugar Agreement have a loss of government or producer revenue. Second, importing LDCs now have to pay a higher price for their sugar, hence their losses. The explicit effects of U.S. and EEC policy are evaluated below.

Looking at the net situation in the developed countries of the West, the European Economic Community would gain $70 million, most of which would accrue to the United Kingdom ($55 million) and Italy ($21 million). Together producers in the European Economic Community would lose $300 million and consumers would gain $370 million. The United States as a whole would gain $66 million resulting from a gain to consumers of $273 million, a loss to producers of $140 million, and a loss of tariff revenue of $67 million. The big losers in this and all situations of freer trade are Japan and Canada, where losses are $107 million and $64 million, respectively. These two nations have regularly profited from the low price that resulted from protection elsewhere.

Considering unilateral action by the United States in ending its Sugar Act (experiment III), there would be an overall world loss of $20 million. In this experiment Cuban sugar was allowed access to the

Table 6–9. Summary of Gains in Thousands of 1974 Dollars

Region	*Free Trade II*	*No U.S. Protect. III*	*No EEC Protect. IV*	*No U.S. or EEC Protect. V*	*10 Cent Tax Xc*
Argentina	+ 16,823	− 6,618	+ 13,939	+ 11,983	− 19,852
Brazil	+ 36,559	− 9,636	+ 43,495	+ 21,541	− 97,541
Cuba	+392,285	+313,664	+179,238	+441,811	+551,795
Dominican Republic	− 1,113	− 15,986	+ 25,826	+ 6,200	− 34,835
Mexico	+ 22,771	+ 5,007	+ 36,442	+ 23,637	− 84,661
Peru	− 23,261	− 31,631	− 599	− 24,923	− 52,225
EEC	+ 70,059	0	+184,331	+140,848	− 32,873
U.S.S.R.	− 31,917	− 12,368	− 37,143	− 59,791	+ 3,740
United States	+ 66,406	+ 33,125	0	+ 26,004	−245,142
Developed Countries	+ 1,402	− 90,572	+ 49,089	− 40,468	−440,934
Less Developed Countries	+328,557	+ 71,951	+123,022	+147,277	−482,635
Cane-Sugar Exporters	+638,622	+171,703	+405,622	+432,133	−454,574
World	+329,959	− 20,053	+172,111	+107,380	−923,569
Free-Market Price[a]	10.85	10.23	9.17	11.24	13.77

Source: Based on the author's computations.

[a]Cents per pound f.o.b. New York.

United States, and hence Cuba had a large gain of $314 million, which was offset by the $377 million that was the gross premium previously paid by the United States to quota-holding countries. For example, Argentina, Brazil, Dominican Republic, Peru, and the Philippines lose under this policy because of the end of the U.S. quotas. The losses are not great, however. Importers from the free market, particularly Japan and Canada, are again the main losers. Turning to the United States, the net gain from an end of the sugar act is estimated to be $33 million, resulting from gains to consumers of $330 million and losses to government of $67 million and to producers of $230 million.

The third welfare comparison concerns experiment IV, the unilateral end of protection by the European Economic Community. There is an estimated international gain of $172 million, divided into $123 million to the LDCs and $49 million to the developed countries. As before, the gainer of greatest magnitude is Cuba, benefiting by an estimated $179 million. Because of the increase in world free market price, exporters of sugar gain and importers lose. However, because there is no longer any Commonwealth premium, since all countries receive the same price from the European Economic Community (although the experiment maintained 1,383,000 tons of Commonwealth imports to the United Kingdom), Commonwealth countries such as Barbados, Guyana, Jamaica, Mauritius, and Trinidad and Tobago suffer small losses. The premium transferred to favored nations under the Commonwealth Sugar Agreement was estimated to be worth $126 million. The major Latin American exporters, except Peru, gain substantially from access to the EEC market. The European Economic Community itself also has large gains of $181 million, chiefly due to the consumer gain of $709 million, while the producers' loss is $525 million. The gains would particularly accrue to the importers in the European Economic Community, that is, to the United Kingdom ($120 million), Italy ($41 million), and Ireland ($26 million).

The fourth set of welfare measurements was made in experiment V in which both U.S. and EEC protection cease. The international gain of $107 million is less than under unilateral EEC action because there was previously an international gain from the U.S. Sugar Act. However, gains to LDCs of $142 million exceed those under unilateral action by the European Economic Community or United States, mainly because the free market price is raised more by this bilateral action. Cuba is again the chief beneficiary, to the extent of $442 million. So large a gain by Cuba implies that other LDCs lose under this policy. The major Latin American exporters, except Peru, are gainers in this particular policy situation. The European Economic

Community as a whole gains an estimated $141 million under this policy, but the United States a mere $26 million.

The final welfare measurements of this kind were made for policy Xc, a 10 cent per pound export tax that is imposed by all cane sugar exporters. It has already been noted that many exporters would simply become producers for their domestic markets under this policy, and as a group, they are estimated to lose $455 million. As under other policies, however, Cuba is a large gainer, this time to the extent of $552 million. Other substantial gainers are China ($107 million) and the large beet producers of Eastern Europe, mainly East Germany ($154 million), Czechoslovakia ($152 million); and Poland ($92 million). The total world loss would be a huge $924 million, resulting both from the cessation of exports by certain countries such as the Philippines (loss of $156 million) and from the higher free market price to be paid by all importers. Under this policy developing countries as a group would lose $483 million and developed countries $441 million. The major Latin American exporters, apart from Cuba, have their share of these losses, including $98 million by Brazil and $85 million by Mexico. The United States would lose $245 million because of the high cost of 3,443,000 tons of imports, but the European Economic Community would lose only $33 million because of its low dependence on imported sugar (only 322,000 tons).

POLICY IMPLICATIONS FOR LATIN AMERICAN COUNTRIES

The policy experiments of this chapter have addressed two kinds of questions relevant to Latin American nations. First, how much do they gain or lose from the systems of preference and protection practiced now, or in the recent past, by the United States and the European Economic Community. Second, how effective would concerted action by cane sugar exporters be in raising the price of sugar and improving their (grossly measured) welfare?

The policy of the United States until 1975, with its country-specific quotas on imports, was a curious mixture of aid and protection. The domestic industry was protected from low free market prices while substantial transfers were made to many Latin American countries through the allocation of quotas. The net effect on the United States itself was minimal, while quota-holders gained an estimated $177 million (net) per annum.[9] With the obvious exception of Cuba, whose sugar continues to be banned from the United States, most Latin American countries did not lose from the U.S. Sugar Act. This may be contrasted with the effect of EEC policy on Latin America, which is

definitely harmful. The key difference between U.S. and EEC policies lies in the distribution of tariff revenue. By using auctioned quotas or a tariff, the United States could have captured the $377 million that was the gross transfer to quota-holders. The European Economic Community does make transfers to a few Commonwealth countries, but its variable levy is so high that other imports do not occur—instead the European Economic Community disrupts the world market by subsidized exports.

Turning to the second question, a cartel of cane sugar exporters is likely to be ineffective. The elastic international supply of beet sugar insures that a restriction on cane sugar exports, at least at the level equivalent to a 10 cent per pound export tax, hurts the exporters (except Cuba) as much as the importers. Therefore, there is little likelihood of a strong cartel developing—the motivation of widespread gains in income is lacking. A minor restriction of exports, however, such as that accomplished under the international sugar agreements, might raise the free market price slightly while not affecting the U.S. and EEC prices (assuming the latter to have protective policies). The new international sugar agreement, especially as it includes the United States, may therefore be able to achieve a minor increase in price during surplus periods (such as the present).

On the whole the findings of this research are not very optimistic for the Latin American countries. The latter have allowed their sugar industries to expand following high-price periods only to find themselves thereafter with excess capacity. Similarly, the policy process in the European Economic Community has achieved the same short-sighted results. International sugar agreements shut the stable door after the horse has bolted—there is a new agreement whenever there is excess capacity. Latin America can gain by concerted action to limit expansion following high prices and by pressing the European Economic Community, through UNCTAD and GATT to dismantle its system of protection. Similarly, pressure should be put on the United States so that it does not lapse into protection.

SUMMARY AND CONCLUDING COMMENTS

A spatial equilibrium model of the world sugar economy has been developed to compare the effects of alternative national and international policies. Its main conclusions concerned the impact of U.S. and EEC policy on cane sugar exporting nations and the ability of such exporters to use concerted action to improve their welfare (as measured by Marshallian surplus). It was found that U.S. protectionism in the past had been largely offset by the implicit allocation of tariff revenue

to quota suppliers, particularly in Latin America. EEC protectionism, on the other hand, had a greater effect on international welfare, and its cessation would be correspondingly more important for cane sugar exporters as a group. These effects resulted not so much from changes in world production or its international distribution, although beet sugar production was shown to contract under freer trade, as from changes in the price at which sugar was traded internationally.

The country that is most heavily penalized by the present international system of sugar marketing is Cuba, mainly because of the cost of transporting its sugar to the Soviet Union, Eastern Europe and the Far East. Freer trade by the United States and the European Economic Community, assuming no discrimination, is particularly in Cuba's interest.

As to concerted action by cane sugar exporters, the possibilities found were limited to an increase of a few cents per pound (which could still be 20 to 50 percent). Beet sugar production in Western Europe and the United States is sufficiently price elastic to preclude any greater advances in price. The new international sugar agreement, which has rather modest price objectives, might be able to achieve such a price advance.

NOTES

1. Equations 6–1 and 6–2 will be expanded by including other exogenous variables in addition to price later in this section.

2. Equation 6–8 implies that actual shipments may exceed the quota. However, if so desired, the shipment may be limited to the quota by imposing a heavy tariff on additional imports; such a procedure was used in the United States.

3. Subsequent work, with this restriction removed, led to mixed results (see Gemmill, 1978).

4. This is particularly the case in South Africa, as explained by Frans Oosthuizen, Local Market Manager of the South African Sugar Association.

5. See Gemmill (1976: Table 8–1) for retail/wholesale margins used, which included taxes on consumption.

6. While New York U.S. prices rise from II to V, U.S. production does not rise due to slightly lower prices in the other U.S. regions.

7. The welfare measure is Marshallian surplus, summed over all individuals in any one nation. The limitations of such a measure are well known. For a review of the concept of surplus, see Currie et al. (1971). A breakdown into separate producers' and consumers' surplus and government revenue may be found in Gemmill (1976).

8. See Table 6–3 for countries grouped under this and other headings.

9. $377 million in government revenue plus $368 million in consumers' surplus less $568 million in producers' surplus.

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