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AN ECONOMETRIC STUDY OF WORLD SUGAR MARKETS

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AN ECONOMETRIC STUDY OF WORLD SUGAR MARKETS

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I. INTRODUCTION

Sugar is recognized to be one of the most important part of diet throughout the world. It is consumed directly as well as indirectly as ingredient in processed food and drink. The world's sugar industry is today rapidly expanding its overall production to meet with the ever increasing demand for sugar. Morever, in many countries, sugar is an important source of government revenue. However, the price of sugar is fluctuating widely. It depends largely on the demand and supply of sugar in the world market. Even though the world tried to organize and succeeded in setting up the Internation Sugar Agreement (ISA) to stabilize the world price by controlling the world supply of sugar in the markets, ISA prospect appears dull, partly, since the USA and the EEC have not yet ratified this Agreement.

The main objective of this study is to understand and quantify the process of price formation in world sugar markets. As in any commodity market, the price of sugar is given the role of an equilibrating factor in clearing the market. Accordingly, the observed world market price represents the equilibrium price at which total world supply is equal to total world demand for sugar. It is necessary, therefore, to estimate world supply and demand functions for sugar and to use these relationships in explaining and predicting world price changes. Once the process of world price formation is specified, it is possible to derive volumes of exports and imports of individual countries from their domestic supply and demand functions. Proper estimation of world market price can serve as a guide for individual countries in production planning so that the right amount of sugar will be produced with no over-production or under-production. Moreover, the trend price provides one of the best criteria for investment decisions, especially in sugar-exporting developing countries.

II. SOURCE OF DATA

In this model of world sugar markets, the analysis is based on annual world sugar production, international trade, carryover stocks, domestic prices and world price data published regularly in I.S.O. Sugar Year Book by the International Sugar Organization. Other information such as population, income, cost of living index, exchange rates and interest rates are obtained from IMF International Financial Statistics; FAO Gross Domestic Product, Private Consumption Expenditure and Agricultural GDP at 1975 Constant Prices Historical Series, 1960-1975, and Projected, 1975-1990; FAO World Population Estimates and Projections 1950-2000 and individual country sources. The study covers a period of about 20 years starting from 1955 to 1974.

For the convenience of data collection and the improvement of the simulation result, the nine countries 1/ of the EEC, Guadeloupe,

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1/ The 9 countries included are : Belgium/Luxembourg (1), Netherland (2), West Germany (3), France (4), Italy (5), U.K. (6), Denmark (7), Ireland (8) and Guadeloupe, Martinique and Reunion (9).

Martinique and Reunion are grouped together. Forty-one other countries[2/] - whose regression equations when run separately initially gave R^2 of less than or equal to 0.50 - are also grouped together into one equation. Consequently, in total, we have 96 equations representing 146 countries[3/]. These 146 countries account for about 99.31 per cent of world sugar output and consumption.

However, according to the accounting error, there is a difference of about 0.69 per cent between the total of world export and import of sugar. To correct for this discrepency, we add the difference into the domestic disappearance of the above mentioned 41-countries-combined equation which will be treated as the 96th country. By doing so, the forecasting ability of the model is improved.

2/ The 41 countries included are : Algeria (1), Benin (2), C. Africa Rep. (3), Congo (Brazzaville) (4), Ghana (5), Guinea (6), Malagasy Rep. (7), Mali (8), Mauritania (9), Mauritius (10), Niger (11), St. Helena (12), Agentina (13), Bahamas (14), Barbados (15), British Honduras (16), Cuba (17), Dominican (18), Guyana (19), Haiti (20), Jamaica (21), Maldives Rep. (22), Netherland Antilles (23), Uruguay (24), Afghanistan (25) , Hong Kong (26), Khmer Rep. (27), Kuwait (28), Taiwan (29), Czechoslovakia (30), E. Germany (31), Gibralta (32), Iceland (33), Malta (34), Norway (35), Sweden (36), Fiji (37), Upper Volta (38), Chile (39), Singapore (40) and Yugoslavia (41).

3/ Here the word "Countries" is used to mean countries or territories as appropriate.

III. DEFINITION OF VARIABLES

Annual production data are recorded in crop years, whereas the time basis for the rest of the data is generally the calendar year. The reference period for crop years depends on the date on which the sugar campaign begins, and all harvests starting any time between March of the year t - 1 and February of the year t have been shown under the reference period t-1/t. Figures for centrifugal sugar are generally expressed in terms of its "raw value" which must contain at least 96 degrees of sugar contents as examined by a polariscope. The conversion rate from refined to raw is 92 to 100 parts.4/

Let i be the superscript representing country i

t be the subscript representing year t

$Q^{i}_{t-1/t}$ = sugar output during the t-1/t crop year of country i expressed in thousands of metric tons.

X^{i}_{t} = volume of sugar export from country i during calendar year t expressed in thousand of metric tons.

M^{i}_{t} = volume of sugar import into country i during calendar year t expressed in thousand of metric tons.

$X^{i}_{t} - M^{i}_{t}$ = volume of net export (+) or net import (-)

4/ See Quality Basis in Sugar Year Book, International Sugar Organization.

DD_t^i = $Q_{t-1/t}^i - (X_t^i - M_t^i)$ = volume of domestic disappearance of sugar in country i during calendar year t, calculated from known values of $Q_{t-1/t}^i$, X_t^i and M_t^i.

DU_t^i = volume of domestic use (human consumption + industrial use + seeding requirement) of sugar.

$\triangle ST_t^i$ = volume of change in domestic stocks of sugar.

ST_t^i = year - end volume of carryover domestic sugar stock.

ST_t^i = $ST_{t-1}^i + \triangle ST_t^i$

DD_t^i = $DU_t^i + \triangle ST_t^i$

Domestic Disappearance (DD_t^i) can be disaggregated into domestic use (DU_t^i) and change in domestic stock($\triangle ST_t^i$). The first part is used up during the year while the second part represents addition (+) or depletion (-) of the existing sugar stock.

Determinants of total domestic demand for sugar (DD_t^i) are

N_t^i = population of country i in calendar year t expressed in million.

RY_t^i = real GDP or GNP of country i in calendar year t expressed in million of US dollars at 1975 exchange rates.

PR_t^i = domestic retail price of sugar in real term (PR_t^i is deflated by the national cost-of-living index based on 1975 = 100) and on average expressed in US cents per Pound.

WP_t = world price of sugar in unit of US cents per lb. (deflated by the national cost-of-living index based on 1975 = 100).

WPR_t^i = $(WP_t \cdot \rho_t^i) \div 100$ = proxy of domestic price of sugar.

CPI_t^i = consumer price index of country i in calendar year t (1975 = 100).

$EXPR_{t/t+1}^i$ = expected price of sugar in domestic markets (Expectation is formed in calendar year t but the price to prevail in calendar year t+1), also expressed in US cents.

$EXWP_{t/t+1}^i$ = expected price of sugar in the world market.

r_t^i = interest rate (Central Bank Discount Rate at the end of period) of country i.

r_t^w = proxy of the interest rate (Euro-Dollar Rate of Interest, London).

Other notations which are necessary to complete the model are as follows.

ρ_t^i = exchange rate of country i expressed in units of local currency per one US dollar, except where otherwise stated.

MM_t^i = gross "mark - up" representing the difference between WP_t and PR_t^i. This "mark - up" includes transportation costs, marketing margins and government imposed taxes, measured in US cents per pound. MM_t^i can be negative for sugar exporting countries in which domestic prices are lower than the world price because of export taxes and other kinds of market intervention. For importing countries domestic prices are generally higher than the world price because of transportation costs and, in certain cases, the imposition of import taxes and/or quantitative restrictions. Export or import taxed can be used to partially insulate domestic markets from world market fluctuations, especially in periods of abnormally low or high world price.

Note that $PR_t^i \equiv \rho_t^i \, (WP_t \div MM_t^i)$

IV. THEORETICAL FRAMEWORK [5/]

By nature, sugar output depends heavily on weather conditions. Since we are mainly interested in explaining and predicting sugar price movement and its volumes in international trade during marketing calendar years, sugar production figures will be treated as exogenous variables, i.e., their values must be known prior to any forecasting exercises. This assumption is realistic in view of the fact that the size of world sugar output for the current crop year can be roughly estimated by September or November prior to the beginning of the post - harvest marketing calendar year. By March or April actual figure of world sugar output can be known with high degree of accuracy. Once this figure is estimated, it is possible to use the model to predict price and volume of international sugar traded during the calendar year.

The basic balance sheet of sugar for each country indicates that domestic output is equal to domestic disappearance plus net export :

$$(1) \quad Q^{i}_{t-1/t} = DD^{i}_{t} + (X^{i}_{t} - M^{i}_{t}) \; ; \; i = 1,2,3,---,n \quad \text{countries.}$$

Summing identity (1) over all n countries of the world yields the world sugar balance sheet indicating that world output is equal to world domestic disappearance plus world export minus world import :

5/ See, Chaipravat, Olarn and Sayan Parivat, "An Econometric Model of World Rice Markets", Bank of Thailand, Paper No. DP/76/14, May 1976.

$$\sum_{i=1}^{n} Q^{i}_{t-1/t} = \sum_{i=1}^{n} DD^{i}_{t} + \sum_{i=1}^{n} X^{i}_{t} - \sum_{i=1}^{n} M^{i}_{t}$$

That is :

$$WQ_{t-1/t} = WDD_{t} + WX_{t} - WM_{t}$$

Since volume of world sugar export (WX_t) must be equal to world import (WM_t), it follows that world output must finally be equal to world domestic disappearance :

$$WQ_{t-1/t} = WDD_{t}$$

Assuming that sugar outputs of individual countries of the world are exogenous variables ($\bar{Q}^{i}_{t-1/t}$), we may postulate behaviors of domestic demand functions in these countries (DD^i_t). The first component of domestic demand is to satisfy domestic use (DU^i_t) for human consumption and industrial use. As stated previously population (N^i_t), real income (RY^i_t), domestic sugar price (PR^i_t) relative to the general price level (CPI^i_t) and factors specific to each country (Z^i_t) are main determinants of demand for domestic use. Thus we have :

(2) $$DU^{i}_{t} = f(N^{i}_{t}, RY^{i}_{t}, PR^{i}_{t}, Z^{i}_{t}, U^{i}_{t})$$ where U^i_t is a stochastic disturbance.

The economic relationships between DU^i_t and some explanatory variables can be expressed in terms of partial derivatives as follows.

$$\frac{\partial DU^{i}_{t}}{\partial N^{i}_{t}} = + ; \quad \frac{\partial DU^{i}_{t}}{\partial RY^{i}_{t}} = + ; \quad \frac{\partial DU^{i}_{t}}{\partial PR^{i}_{t}} = -$$

The second component of domestic disappearance is to fulfill the stock building demand for sugar($\triangle ST_t^i$). This is dependent on the level of carryover stock of old sugar at the end of the previous marketing calendar year (ST_{t-1}^i) and the relative value between the expected price of sugar ($EXPR_{t/t+1}^i$ or $EXWP_{t/t+1}$) and its current price (PR_t^i or WP_t) as well as the interest rate (r_t^i or r_t^w) which measures the cost of keeping the stock of sugar.

$$(3) \qquad \triangle ST_t^i = f(ST_{t-1}^i, EXPR_{t/t+1}^i/(PR_t^i \cdot r_t^i), V_t^i)$$

V_t^i is a random disturbance.

$$\frac{\partial \triangle ST_t^i}{\partial ST_{t-1}^i} = - \quad ; \quad \frac{\partial \triangle ST_t^i}{\partial EXPR_{t/t+1}^i/(PR_t^i \cdot r_t^i)} = +$$

The anticipation of future price is constructed under the "adaptive expectations hypothesis" which, after a series of derivation, yields a simplified result which says that the expected price is a weighted average of current and past periods' prices with the weights (w_j) declining geometrically and summing up to unity [6/]

6/ P.D. Jonson and D.M. Mahoney, Price Expectations in Australia, The Economic Record, Vol. 49, No. 125, March 1973, p. 50 - 61.

(4) $$EXPR^{i}_{t/t+1} = \sum_{j=0}^{m} w_j PR^{i}_{t-j} \quad ; \quad j = 0,1,2,---, m$$

and $$\sum_{j=0}^{m} w_j = 1$$

For empirical estimations, the longest lags involved in forming price expectations are 2 or 3 years,[7/] i.e.,

$$EXPR^{i}_{2t} = 0.62\ PR^{i}_{t} + 0.38\ PR^{i}_{t-1} \qquad \text{for 2-year lag}$$

and

$$EXPR^{i}_{3t} = 0.5437\ PR^{i}_{t} + 0.2956\ PR^{i}_{t-1} + 0.1607\ PR^{i}_{t-2}$$

for 3-year lag

These formulas can be applied to WP_t as well as WPR^{i}_{t}.

The total domestic demand equation for sugar therefore depends on population, real income, domestic price of sugar relative to the cost of living index, carryover stock of old sugar, the ratio of expected price to the product of current price and interest rate, other specific factors and random disturbances :

(5) $$DD^{i}_{t} = DU^{i}_{t} + \triangle ST^{i}_{t} = f(N^{i}_{t}, RY^{i}_{t}, PR^{i}_{t}, ST^{i}_{t-1}, EXPR^{i}_{t/t+1}/(PR^{i}_{t} \cdot r^{i}_{t}), Z^{i}_{t}, U^{i}_{t}, V^{i}_{t})$$

7/ For further detail, see Olarn Chaipravat, Aggregate Structures of Production and Domestic Demand for Rice in Thailand, A Time Series Analysis, 1951-1973, Bank of Thailand, Paper No. 4, April 1975, p. 16 - 18.

Due to inadequacy of data, it is not possible to estimate DU_t^i and $\triangle ST_t^i$ equations separately. Indeed, only DD_t^i equations for individual countries are empirically estimated in this study. All variables which could theoretically explain total domestic demand for sugar in each country were tried in the estimation process but only variables with statistically significant coefficients are reported in this study.

The world sugar markets are in equilibrium when total world output or supply is equal to total world domestic demand :

$$(6) \qquad \sum_{i=1}^{n} Q_{t-1/t}^{i} = \sum_{i=1}^{n} DD_t^i$$

Substituting all behavioral domestic demand equations from (5) into (6) yields the global equilibrium condition :

$$(7) \qquad \sum_{i=1}^{n} Q_{t-1/t}^{i} = \sum_{i=1}^{n} f^i(N_t^i, RY_t^i, PR_t^i/CPI_t^i, ST_{t-1}^i, \sum_{j=0}^{m} w_j PR_{t-j}^i/(PR_t^i \cdot r_t^i), Z_t^i, U_t^i, V_t^i)$$

Where $\bar{Q}_{t-1/t}^i$, $\bar{N}_t^i$, $\overline{RY}_t^i$, $\overline{CPI}_t^i$, $\overline{ST}_{t-1}^i$, $\overline{PR}_{t-j}^i$ $(j \neq 0)$, $\bar{r}_t^i$ and $\bar{Z}_t^i$ can be treated as exogenous variables, the values of which must be explained by other processes outside the equation or taken as given. Only domestic price of sugar or its substitutes, WP_t and WPR_t^i is to be solved as endogenous variable from equation (7).

Since there are n domestic prices (PR_t^i) or its proxy (WPR_t^i) to be solved we must add n additional equations of domestic price relationships with the "world price (WP_t)" :

$$(8) \qquad PR_t^i = \rho_t^i (WP_t + MM_t^i) \; ; \quad i = 1,2,3,---, n$$

$$WPR_t^i = (WP_t \cdot \rho_t^i) \div 100$$

Gross mark-ups (MM_t^i) can be taken as exogenous or policy variables (in case of export or import tax changes) and exchange rate ($\bar{\rho}_t^i$) are obviously policy instruments of individual countries.

Substituting n equations of PR_t^i from (8) into (7) yields one single equation of the following form (omitting random disturbances) :

$$(9) \qquad WP_t = f(\bar{N}_t^i\text{'s}, \overline{RY}_t^i\text{'s}, \overline{CPI}_t^i\text{'s}, \overline{ST}_{t-1}^i\text{'s}, \overline{PR}_{t-j}^i\text{'s}, \bar{r}_t^i\text{'s}, \bar{\rho}_t^i\text{'s}, \overline{MM}_t^i\text{'s}, Z_t^i\text{'s})$$

Since all right-hand-side variables of (9) are exogenous or policy instruments, the world price of sugar (WP_t) can be determined once the values of these exogenous or policy variables are specified.
Substituting the solved value of WP_t into each of the n equations from (8) yields equilibrium values of some domestic sugar prices in individual countries (PR_t^i). Substituting each value of PR_t^i in domestic demand function (5) for each country yields the value of domestic disappearance (DD_t^i) of that country. Once the value of DD_t^i is determined together with the known value of domestic output ($\bar{Q}_{t-1/t}^i$), volume of net export (+) or net import (-) of each country can be obtained from the following identity :

(10) $(X_t^i - M_t^i) \quad = \quad \bar{Q}_{t-1/t}^i - DD_t^i$

The values of world price, domestic prices and values of exports or imports of sugar for all countries are therefore solved simultaneously from this model once the values of exogenous and policy variables such as population, real income, cost of living indices, past years' sugar prices, carryover stocks, exchange rates, export or import taxes of individual countries are specified.

It should be noted that there is no need to estimate coefficients of export or import function of individual countries because such functions can be derived from appropriate substitution of the structural equations in this model. The partial analysis of export or import functions of a number of selected countries with-out explicitly introducing individual countries' sugar balance sheets and the global equilibrium condition such as equations (1) and (6) fails to capture the general equilibrium character of world sugar markets and makes it difficult to understand the process of price formation. It is clear from the specification of this model that the world and individual countries' prices are formed as a result of the conventional supply - demand mechanism in the world sugar markets.

V. MODEL FORMULATION

A. Assumptions

Our model of world sugar markets are based on the following assumption.

a. Sugar[8/] is a homogenous commodity with few direct substitutes.[9/]

b. There is a single world market for sugar with all sales being made at the world price. Although major spot and futures markets for sugar exist in New York and London, arbitrage between the markets ensures that prices remain close. Thus for this study, the International Sugar Agreement (ISA) Daily Price[10/] is taken as the world price.

c. Price of sugar is determined by its market mechanism of demand and supply.

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8/ The sugar data in this paper refers to centrifugal sugar only and are measured in thousand metric tons. The centrifugal sugar is produced from both cane and beet; production in Europe and North America being almost entirely from beet and production elsewhere from cane. The non-centrifugal sugar such as coconut-palm sugar is locally produced and consumed.

9/ Substitute goods for sugar are High Fructose Corn Syrup (HFCS) and non-centrifugal or locally made sugar. However, there are limits to its substitutability. See The World Bank Commodity Paper No. 25, "High Fructose Corn Syrup : Its Significance as a Sugar Substitute and Its Impact on the Sugar Outlook", April 1977.

10/ The International Agreement Daily Price is the arithmetic average of the New York Coffee and Sugar Exchange Contract No. 11 spot price and the London Daily Price after conversion of the latter to US cents per pound avoirdupois f.o.b. and stowed Caribbean Port in bulk or, if the difference between these two f.o.b. prices is more than ten points (six points until the end of 1973) the lower of the two prices plus five (three) points. See ISO Sugar Year Book 1976, p. 364.

B. Specification of Models

The specification of models can be expressed in many forms depending upon the empirical data available and the purposes of constructing such models. However, in this study we select the semi-log type to form the model because the result of our experiment indicates that the semi-log type give a good fit and better forecasting properties than either linear or double log[11/] forms.

The general form of the relation can be expressed as follows.

$$Y_t = a + b \ln X_{1t} + c \ln X_{2t} + d \ln X_{3t} + --- + U_t \qquad (I)$$

Where Y_t is an endogenous variable; a is a constant term; $X_{1t}, X_{2t}, X_{3t}, ..$ are exogenous variables; U_t is a ramdom variable; b, c and d are coefficients or weights on the exogenous variables; t subscript refers to the period of a particular observation.

In case of the equations having autocorrelation in the disturbance terms after Cochrane - Orcutt[12/] iterative technique is utilized to correct it, the relationship is of following form.

11/ See also FAO, Commodity Bulletin Series No. 32, "Trends and Forces of World Sugar Consumption", by A. Vinton and F. Pignaloza, 1961, p. 26, and FAO, Monthly Bulletin of Agricultured Economics and Statistics, "A Statistic Analysis of Sugar Consumption and Future Demand" by F. Pignaloza Vol. 26, December 1977.

12/ See G.H. Orcutt and D. Cochrane, A Sampling Study of Merits of Autoregressive and Reduced Form Transformation in Regress Analysis, Journal of the American Statistical Association 44 (1949), p. 356-372.

$$(1-\rho_o L)Y_t = a(1-\rho_o) + b(1-\rho_o L)\ln X_{1t} + c(1-\rho_o L)\ln X_{2t} + d(1-\rho_o L)\ln X_{3t} + \text{---} + V_t \qquad \text{(II)}$$

Where ρ_o is a final value of rho

L is a lag operator

V_t is non-autocorrelated random term

However, for convenience sake, in the reporting of the results these equations will only be in the form of equation (I) with the values of rho given. The readers should bear in mind that in this case the adjusted relationship is in the form of equation (II).

A special property of this non-linear form is that scale changes in the basic units of measurement have no essential effect on any of the logarithmic terms except the constant a. Therefore, this function is convenient in international or inter-industry comparisons. Since b, c and d --- etc. are elasticity coefficients they are pure numbers and can easily be compared among different samples using varied units of measurement.[13/]

Another property of this semi-log form has practical relevance in that the elasticity of demand with respect to income and price diminishes when per capita consumption increases. This is in

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13/ Lawrence R. Klein, An Introduction To Econometrics, Prentice Hall, Inc., (Reprinted in Japan), N.J. 1962, p. 90-92.

contrast with other types of equations such as linear or log form neither of which agrees with what we believe to be the nature of sugar consumption.[14/]

14/ The income elasticities of demands $\left[\varepsilon(Y, X_1) = \frac{\partial Y}{\partial X_1} \cdot \frac{X_1}{Y}\right]$ obtained from each type of equations can be derived as follows :

1) Linear - equation : $Y = a + bX_1 + cX_2$

$$\frac{\partial Y}{\partial X_1} = b$$

$$\therefore \varepsilon(Y, X_1) = b \cdot \frac{X_1}{Y}$$

Linear - equation indicates that the elasticity of demand with respect to income may not diminish when consumption increases.

2) Simi-log equation : $Y = a + b \ln X_1 + c \ln X_2$

$$\frac{\partial Y}{\partial X_1} = \frac{b}{X_1}$$

$$\therefore \varepsilon(Y, X_1) = \frac{b}{X_1} \cdot \frac{X_1}{Y} = \frac{b}{Y}$$

Simi-log equation shows that the elasticity of demand with respect to income diminishes when consumption increases.

3) Log - equation : $\ln Y = a + b \ln X_1 + c \ln X_2$

$$\frac{1}{Y} \frac{\partial Y}{\partial X_1} = \frac{b}{X_1}$$

$$\frac{\partial Y}{\partial X_1} = \frac{b\,Y}{X_1}$$

$$\therefore \varepsilon(Y, X_1) = b \cdot \frac{Y}{X_1} \cdot \frac{X_1}{Y} = b$$

The log equation gives constant income elasticity.

Where Y = consumption of sugar

X_1 = deflated income

X_2 = deflated retail price

VI. EMPIRICAL EVIDENCES

All domestic demand equation are estimated by Ordinary Least Square (OLS) method. In case of the equations having autocorrelation in the disturbance terms, Cochrane - Orcutt iterative technique is utilized to correct it.

For the sake of brevity the superscript is omitted when it is clear that the reported variables belong to a specific country or territory. The t - ratios are shown in parenthesis under their estimated parameters. The results for 96 countries or territories are shown at the end of this chapter.

1) Interpretation of the results

The regression equation provides an empirical check on the theory, by measuring economic behavior in the economy in equation format over the time period under study.

The correlation coefficient of regression (R^2) is above 0.90 in 21 countries and between 0.70 and 0.90 in 46 countries. The rest of the equations has R^2 of between 0.51 and 0.70. Although, the values of R^2 for most equations are moderate they do not affect the final simulation results to any great extent because of the random nature of the errors which tend to offset each other.

The standard errors of the regression coefficients are small.

The factors which largely determine the demand for sugar are population (N_t), world price (WP_t), income (RY_t) and carryover stock (ST_{t-1}), respectively.

Note that, income variable may be as good as population variable in determining the demand for sugar but there is a high multicollinearity between these two variables. We select one that give the higher R^2 and/or which is statistically more significant. In this study population variables are found to give a better result than income variables. We also found that domestic price (PR_t) was statistically less significant than world price (WP_t) in the domestic disappearance models. This may be explained by two main reasons. Firstly, the domestic disappearance of sugar will not be affected by the domestic price if that country is a sugar exporter. Secondly, most of sugar importing countries control their domestic prices by subsidy to protect the domestic consumers.

If we analyze the factors that determine the domestic disappearance by looking in term of net importing countries, net exporting countries, industrial countries, other developed countries, major oil exporters and developing countries, we note that, in general,

• Net Importing Countries : The main determinants of domestic consumption of sugar are population and world price. Income is the second best factor. Stock and domestic price are not as important as the first three factors.

• Net Exporting Countries : The important factors which determine the domestic consumption of sugar are population, income and expected price of sugar in the world market. Stock, world price and domestic price have little effects on the models.

• Industrial Countries : The main factor which determines the domestic consumption of sugar is population, as we know that per capita consumption reached a saturation point in many countries at about 45-50 kilogrammes and that further gains in income will not lead to additional sugar being consumed.

• Major Oil Exporters : The domestic consumption of sugar depends upon income and world price more than the population factor.

• Developing Countries : The domestic consumption of sugar in developing countries depends upon population, world price and income, respectively.

In summary, the results of the study correspond closely with what has been expected.

2) Simulation Procedures

Model simulation is simply the process of drawing together all the equations and/or identities which comprise the model as a whole, solving them as a set of simultaneous relationships, and determining the model-generated values (the endogenous variables). The value of exogenous variables must be supplied and determined outside the system.

As mentioned in Chapter IV., we know that the volume of world sugar export (WX_t) must equal world import (WM_t), and world output ($WQ_{t-1/t}$) must equal world domestic disappearance (WDD_t). We can find the value of WDD_t by the process just mentioned above. Then, we can get the world equation as mentioned in equation (7) in Chapter IV. and employ it to solve the world prices of sugar. However, because of the complexity of this exercise, it is necessary to employ an iterative technique to obtain the solution. The world equation is written in an operational form as follows :

$$V = WC_t - 2950.132 \ln WP_t + S_1 + S_2 + S_3 + S_4 + S_5 + S_6 + S_7 + S_8 - WQ_{t-1/t}$$

Where $V = 0$

WC_t = constant term of the world equation in period t

WP_t = world sugar price (ISA Daily Price, f.o.b. and stowed Caribbean Port) in period t

S_1, S_2, S_3, S_4, S_5, S_6, S_7 and S_8 are subroutines of the model and their values are represented as :

$$S_1 = 12.167 \ln(.5437\, WP_t + .2956\, WP_{t-1} + .1607\, WP_{t-2})$$

$$S_2 = -129.437 \ln(MM_t/CPI_t + WP_t/CPI_t) - 23.034 \ln(MM_t/CPI_t + WP_t/CPI_t)$$

$$S_3 = -174.102 \ln(MM_t/CPI_t + WP_t/CPI_t)$$

$$S_4 = 111.015 \left[\ln(0.62(MM_t/CPI_t + WP_t/CPI_t) + 0.38\, PR_{t-1}/CPI_{t-1}) - \ln(MM_t/CPI_t + WP_t/CPI_t)\right] + 4.098 \left[\ln(0.5437\, WP_t + 0.2956\, WP_{t-1} + 0.1607\, WP_{t-2})\right]$$

$$S_5 = 51.857 \ln(0.5437\, WP_t + 0.2956\, WP_{t-1} + 0.1607\, WP_{t-2})$$
$$+ 53.717 \ln(0.62\, WP_t + 0.38\, WP_{t-1})$$
$$- 642.630 \ln(MM_t/CPI_t + WP_t/CPI_t)$$

$$S_6 = 10.068 \ln(0.62\, WP_t + 0.38\, WP_{t-1})$$
$$+ 147.813 \left[\ln\left\{0.5437\, (MM_t/CPI_t + WP_t/CPI_t)\right.\right.$$
$$\left.+ 0.2956\, PR_{t-1}/CPI_{t-1} + 0.1607\, PR_{t-2}/CPI_{t-2}\right\}$$
$$\left.- \ln(MM_t/CPI_t + WP_t/CPI_t)\right]$$

$$S_7 = -94.823 \ln(MM_t/CPI_t + WP_t/CPI_t)$$
$$- 173.665 \ln(MM_t/CPI_t + WP_t/CPI_t)$$

$$S_8 = 1140.806 \ln(0.5437\, WP_t + 0.2956\, WP_{t-1} + 0.1607\, WP_{t-2})$$

$WQ_{t-1/t}$ = World sugar supply in period t-1/t

RESULTS OF TIME SERIES CORRELATIONS FOR WORLD SUGAR MARKET

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho (ρ_0)
	AFRICA						
1	Angola	20	1955-74	$DD_t = -242.342 + 174.040 \ln N_t$ (8.82920)	.92	2.0366	0.372194
2	Cameroon	14	1961-74	$DD_t = -153.631 + 98.942 \ln N_t$ (7.12061)	.77	2.0454	-0.218060
3	Cape Verde Rep.	20	1955-74	$DD_t = 14.442 + 7.519 \ln N_t$ (12.1353)	.89	2.0758	
4	Chad	14	1961-74	$DD_t = -23.353 + 35.018 \ln N_t$ (4.11332)	.59	2.3515	
5	Egypt	20	1955-74	$DD_t = -1801.930 + 711.595 \ln N_t - 34.640 \ln ST_{t-1}$ (7.646871) (-2.46638)	.90	1.9015	0.384735

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho(ρ_0)
6	Ethiopia	20	1955-74	$DD_t = -803.295 + \underset{(11.55090)}{268.970}\ln N_t + \underset{(2.28579)}{12.167}\ln EXWP^*_{3t}$ $^*\ln EXWP_{3t} = \ln(0.5437WP_t + 0.2956WP_{t-1} + 0.1607WP_{t-2}) - \ln WP_t - \ln r^W_t$	.95	1.8643	
7	Gabon	14	1961-74	$DD_t = -14.197 + \underset{(3.76714)}{2.427}\ln RY_t - \underset{(-1.39891)}{0.367}\ln WPR^*_t$ $^*\ln WPR_t = \ln(WP_t \cdot \rho_t + 100)$	.60	2.3673	
8	Gambia	20	1955-74	$DD_t = 24.841 + \underset{(5.47551)}{18.658}\ln N_t - \underset{(-6.39150)}{3.169}\ln WP_t$	.75	1.6868	
9	Ivory Coast	14	1961-74	$DD_t = -610.016 + \underset{(6.66311)}{501.749}\ln N_t - \underset{(-4.91166)}{21.477}\ln WPR_t - \underset{(-4.92538)}{15.392}\ln ST_{t-1}$	.93	1.37262	

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho(ρ_0)
10	Kenya	13	1962-74	$DD_t = -1776.780 + \underset{(6.91371)}{251.865} \ln RY_t$	.93	2.1730	0.474543
11	Liberia	20	1955-74	$DD_t = -2.691 + \underset{(16.6979)}{20.060} \ln N_t$	.94	1.5460	
12	Libya	20	1955-74	$DD_t = -3.702 + \underset{(6.65108)}{101.365} \ln N_t$	.71	2.2382	
13	Morocco	20	1955-74	$DD_t = -463.026 + \underset{(4.80767)}{330.148} \ln N_t$	.56	1.6426	
14	Mozambique	15	1960-74	$DD_t = -806.734 - \underset{(-2.09725)}{50.340} \ln ST_{t-1} + \underset{(6.02529)}{132.819} \ln RY_t$	.82	1.76542	

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho(ρ_0)
15	Nigeria	13	1962–74	$DD_t = -1660.010 + 175.399 \ln RY_t - 30.611 \ln WPR_t$ (11.0724) (-4.50952)	.87	1.7419	-0.584262
16	Rhodesia	20	1955–74	$DD_t = -601.642 + 295.563 \ln N_t$ (7.40641)	.75	1.7142	
17	Senegal	14	1961–74	$DD_t = -225.652 + 171.013 \ln N_t + 17.102 \ln EXWP^{*}_{3t}$ (5.02433) (2.73031)	.73	1.4952	
18	Seychelles	20	1955–74	$DD_t = 16.966 + 4.762 \ln N_t - 0.542 \ln WP_t$ (4.38796) (-2.72539)	.54	2.1561	

$$^{*}\ln EXWP_{3t} = \ln(0.5437WP_t + 0.2956WP_{t-1} + 0.1607WP_{t-2}) - \ln WP_t - \ln r^W_t$$

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho(ρ_0)
19	Sierra Leone	20	1955-74	$DD_t = -28.143 + 63.711 lnN_t - 5.185 lnWP_t$ $(13.6101) \quad (-5.91982)$	.92	2.1334	
20	Somalia	14	1961-74	$DD_t = -637.695 + 116.420 lnRY_t - 3.529 lnWPR_t$ $(7.66001) \quad (-1.46764)$	.86	2.1360	
21	South Africa	13	1962-74	$DD_t = -6055.930 + 689.373 lnRY_t$ (9.27574)	.83	1.8512	-0.319493
22	St. Thome' & Principe'	20	1955-74	$DD_t = 5.006 + 1.499 lnN_t - 0.098 lnWP_t$ $(3.03137) \quad (-2.10986)$	.52	1.9119	0.286933
23	Sudan	14	1961-74	$DD_t = -2647.990 + 386.942 lnRY_t - 29.806 lnST_{t-1}$ $(5.91287) \quad (-2.75693)$	.78	1.8561	

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho(ρ_0)
24	Tanzania	17	1958–74	$DD_t = -652.029 + 315.475 \ln N_t - 20.487 \ln ST_{t-1}$ $(16.3298) \quad (-5.97082)$	.96	1.5979	
25	Togo	14	1961–74	$DD_t = 2.880 + 16.387 \ln N_t - 2.555 \ln WPR_t$ $(3.00605) \quad (-3.04878)$	.52	1.8359	
26	Tunisia	20	1955–74	$DD_t = -266.509 + 228.817 \ln N_t$ (2.67683)	.65	2.3140	0.633454
27	Uganda	14	1961–74	$DD_t = -706.441 + 113.098 \ln RY_t - 26.726 \ln WP_t$ $(3.20236) \quad (-3.07215)$	.57	1.4784	
28	Zaire	20	1955–74	$DD_t = -323.175 + 126.411 \ln N_t - 12.186 \ln ST_{t-1}$ $(9.07090) \quad (-2.77457)$	.84	1.6100	

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho(ρ)
	AMERICA						
29	Bermuda	20	1955-74	$DD_t = 10.907 + 2.868 \ln N_t$ (6.48988)	.58	1.7437	-0.404752
30	Bolivia	20	1955-74	$DD_t = -212.648 + 210.308 \ln N_t$ (6.74659)	.72	2.3308	
31	Brazil	14	1961-74	$DD_t = -15367.900 + 1703.460 \ln RY_t$ (5.22385)	.70	2.1875	
32	Canada	14	1961-74	$DD_t = -3468.260 + 416.563 \ln RY_t - 129.439 \ln(PR_t/CPI_t)$* (7.84175) (-3.82408)	.85	2.2010	

* $\ln(PR_t/CPI_t) = \ln(MM_t/CPI_t + WP_t/CPI_t)$

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho (ρ_0)
33	Columbia	14	1961-74	$DD_t = N_t(-194.741 + 35.694\ln(RY_t/N_t))$ (10.5752)	.90	2.2368	
34	Costa Rica	14	1961-74	$DD_t = -379.978 + 63.711\ln RY_t$ (6.93951)	.80	2.2754	
35	Ecuador	20	1955-74	$DD_t = -329.400 + 279.073\ln N_t$ (8.04663)	.89	1.8721	0.372593
36	El Salvador	17	1958-74	$DD_t = -11.561 + 121.250\ln N_t - 23.034\ln(PR_t/CPI_t)^*$ (3.93398) (-1.27357)	.58	2.2103	

$^*\ \ln(PR_t/CPI_t) = \ln(MM_t/CPI_t + WP_t/CPI_t)$

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho(ρ_0)
37	Guatamala	17	1958-74	$DD_t = 281.997 + 169.190 \ln N_t - 174.102 \ln(PR_t/CPI_t)^*$ $(4.97474) \quad (-3.45879)$	.91	2.4741	
				$^* \ln(PR_t/CPI_t) = \ln(MM_t/CPI_t + WP_t/CPI_t)$			
38	Honduras	20	1955-74	$DD_t = -14.847 + 65.555 \ln N_t$ (7.68718)	.78	1.7534	
39	Leeward & windward Is.	19	1956-74	$DD_t = 15.397 + 4.032 \ln N_t$ (2.70572)	.71	1.8843	0.522761
40	Mexico	14	1961-74	$DD_t = -12926.400 + 1352.350 \ln RY_t$ (11.4698)	.92	1.5738	
41	Nicaragua	20	1955-74	$DD_t = -4.855 + 114.235 \ln N_t$ (10.1218)	.85	2.3912	

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho(ρ_0)
42	Panama	20	1955-74	$DD_t = 18.193 + \underset{(15.3939)}{61.241} \ln N_t$	.93	1.8731	
43	Panama (Canal Zones)	16	1959-74	$DD_t = 14.674 + \underset{(9.97604)}{3.727} \ln N_t - \underset{(-4.09129)}{0.096} \ln WP_t$	.97	1.6181	0.533393
44	Paraguay	14	1961-74	$DD_t = -235.114 + \underset{(4.23459)}{40.778} \ln RY_t$	.60	2.2370	
45	Peru	12	1963-74	$DD_t = -3709.730 + \underset{(2.70185)}{420.770} \ln RY_t + \underset{(1.73994)}{111.015} \ln(EXPR_{2t}/CPI_{2t}^{i})^{*}$	.78	1.6441	0.595066

$$^{*} \ln(EXPR_{2t}/CPI_{2t}^{i}) = \ln(0.62(MM_t/CPI_t + WP_t/CPI_t) + 0.38(PR_{t-1}/CPI_{t-1})) - \ln(MM_t/CPI_t + WP_t/CPI_t) - \ln r_t^{i}$$

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho($\hat{\rho}_0$)
46	Trinidad & Tobago	11	1964-74	$DD_t = -104.031 + \underset{(1.62673)}{19.709 \ln RY_t} + \underset{(1.46539)}{4.098 \ln EXWP^*_{3t}}$ $^* \ln EXWP_{3t} = \ln(0.5437WP_t + 0.2956WP_{t-1} + 0.1607WP_{t-2}) - \ln WP_t - \ln r^w_t$	.61	1.9601	0.589415
47	U.S.A.	20	1955-74	$DD_t = -51370.400 + \underset{(18.8130)}{11555.500 \ln N_t}$	.95	2.1432	
48	Venezuela	20	1955-74	$DD_t = -1264.350 + \underset{(6.27656)}{647.600 \ln N_t} + \underset{(1.09739)}{51.857 \ln EXWP^*_{3t}}$ $^* \ln EXWP_{3t} = \ln(0.5437WP_t + 0.2956WP_{t-1} + 0.1607WP_{t-2}) - \ln WP_t - \ln r^i_t$	.83	1.8704	

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho (ρ_0)
49	Virgin Is. (U.K.)	20	1955-74	$DD_t = 2.027 + 0.343 \ln N_t$ (2.22641)	.73	1.8395	0.613504
	ASIA						
50	Brunei	20	1955-74	$DD_t = 13.175 + 4.148 \ln N_t$ (6.15513)	.68	1.5071	
51	Burma	20	1955-74	$DD_t = -893.160 + 254.214 \ln N_t + 53.717 \ln EXWP^{*}_{2t}$ (6.7575) (4.94967) $^{*} \ln EXWP_{2t} = \ln(0.62WP_t + 0.38WP_{t-1}) - \ln WP_t - \ln r^{w}_t$	.73	2.1537	
52	China, People's Rep. of	20	1955-74	$DD_t = -68488.400 + 10802.100 \ln N_t$ (11.8240)	.94	1.8862	0.292466

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho(ρ_0)
53	India	20	1955–74	$DD_t = -23590.800 + \underset{(5.18464)}{4293.730} \ln N_t$	.60	1.5784	
54	Indonesia	13	1962–74	$DD_t = -10371.900 + \underset{(25.1393)}{1133.330} \ln RY_t - \underset{(-2.74741)}{35.452} \ln WP_t$	.97	2.5400	−0.763482
55	Iran	14	1961–74	$DD_t = -154.384 + \underset{(3.95923)}{273.966} \ln RY_t - \underset{(-2.53051)}{642.630} \ln(PR_t/CPI_t)^*$ $^* \ln(PR_t/CPI_t) = \ln(MM_t/CPI_t + WP_t/CPI_t)$	.81	1.8290	
56	Iraq	20	1955–74	$DD_t = -563.708 + \underset{(5.13732)}{392.929} \ln N_t$	.60	2.3415	
57	Israel	14	1961–74	$DD_t = -715.124 + \underset{(6.10275)}{95.993} \ln RY_t$	.76	2.3311	

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho (ρ_0)
58	Japan	20	1955-74	$DD_t = -57424.100 + \underset{(15.4851)}{12959.200 \ln N_t}$	.97	2.1903	0.332832
59	Jordan	17	1958-74	$DD_t = -73.449 + \underset{(1.99264)}{48.347 \ln N_t} - \underset{(-8.70649)}{29.422 \ln (WPR_t/CPI_t)^{*}}$ $^{*} \ln(WPR_t/CPI_t) = \ln\left[(WP_t/CPI_t) \cdot \rho_t \div 100\right]$	.69	2.1840	-0.739174
60	Korea (North)	20	1955-74	$DD_t = -912.460 + \underset{(3.50676)}{408.478 \ln N_t} - \underset{(-1.75630)}{23.637 \ln WP_t}$	.86	2.0578	0.614852
61	Korea (South) Rep.	13	1962-74	$DD_t = -2003.290 + \underset{(6.90425)}{232.914 \ln RY_t}$	.93	1.8058	0.476426
62	Loas	20	1955-74	$DD_t = -4.839 + \underset{(2.81137)}{8.963 \ln N_t} - \underset{(-1.68576)}{0.792 \ln WP_t}$	.51	1.7215	0.276643

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho (ρ_0)
63	Lebanon	20	1955–74	$DD_t = -36.128 + \underset{(5.80069)}{112.989} \ln N_t$	.65	1.8727	
64	Malaysia	20	1955–74	$DD_t = -626.194 + \underset{(10.3390)}{418.636} \ln N_t - \underset{(-1.65427)}{16.453} \ln WP_t$	.87	1.6898	
65	Mongolia	19	1956–74	$DD_t = -17.678 + \underset{(7.55195)}{65.174} \ln N_t + \underset{(3.26672)}{10.068} \ln EXWP^{*}_{2t}$	.84	2.3611	
				$^{*} \ln EXWP_{2t} = \ln(0.62WP_t + 0.38WP_{t-1}) - \ln WP_t - \ln r^{W}_{t}$			
66	Nepal	20	1955–74	$DD_t = -88.390 + \underset{(4.73302)}{42.678} \ln N_t$	.56	1.9608	
67	Pakistan & Bangladesh	17	1958–74	$DD_t = -6044.050 + \underset{(11.3735)}{1407.290} \ln N_t - \underset{(-2.50117)}{71.954} \ln(WP_t/CPI_t)$	.90	1.9569	

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho(ρ_0)
68	Philippines	20	1955-74	$DD_t = -3317.250 + 1108.270 \ln N_t$ (8.52961)	.80	2.2549	
69	Saudi Arabia	19	1956-74	$DD_t = -244.318 + 208.241 \ln N_t$ (3.39706)	.69	1.7029	0.420664
70	Southern Yemen Rep.	20	1955-74	$DD_t = -56.453 + 63.987 \ln N_t - 8.681 \ln WP_t$ (5.73248) (-3.40855)	.67	2.0363	
71	Sri Lanka	17	1958-74	$DD_t = -717.212 + 348.260 \ln N_t - 86.939 \ln(WPR_t/CPI_t)$ (2.82090) (-3.94183)	.51	1.7843	-0.145594
72	Surinam	20	1955-74	$DD_t = 23.905 + 12.216 \ln N_t - 0.521 \ln WP_t$ (10.2359) (-1.93744)	.87	1.9571	

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho (ρ_0)
73	Syria (Syrian Arab Rep.)	15	1960–74	$DD_t = -2134.050 + \underset{(8.32566)}{230.738 \ln RY_t} + \underset{(2.59493)}{147.813 \ln (EXPR_{3t}/CPI_{3t})^{*}}$ $^{*} \ln(EXPR_{3t}/CPI_{3t}) = \ln\{0.5437(MM_t/CPI_t + WP_t/CPI_t) + 0.2956(PR_{t-1}/CPI_{t-1}) + 0.1607(PR_{t-2}/CPI_{t-2})\} - \ln(MM_t/CPI_t + WP_t/CPI_t) - \ln r_t^i$	.86	1.9477	
74	Thailand	20	1955–74	$DD_t = -2341.190 + \underset{(7.33297)}{750.436 \ln N_t}$	.75	2.0030	
75	Vietnam	20	1955–74	$DD_t = -2711.140 + \underset{(3.65575)}{841.696 \ln N_t} - \underset{(-2.41291)}{72.155 \ln WP_t}$	.78	2.0889	0.497807
76	Yemen	20	1955–74	$DD_t = 30.299 + \underset{(6.63910)}{101.407 \ln N_t} - \underset{(-4.81925)}{16.535 \ln WP_t}$	.74	1.9020	

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho (ρ_0)
	EUROPE						
77	Albania	20	1955-74	$DD_t = -4.103 + \underset{(6.16400)}{45.967}\ln N_t$	.68	2.4460	
78	Austria	13	1962-74	$DD_t = N_t\left[-7.253 - \underset{(-5.12346)}{43.144}(\ln ST_{t-1} - \ln ST_{t-2}) + \underset{(1.82872)}{189.438}(\ln RY_t/N_t - \ln RY_{t-1}/N_{t-1}) + DD_{t-1}/N_{t-1}\right]$	.73	2.4504	
79	Bulgaria	20	1955-74	$DD_t = -6987.330 + \underset{(10.0163)}{3513.250}\ln N_t - \underset{(-1.86503)}{44.296}\ln WP_t$	.86	1.5655	
80	Cyprus	13	1962-74	$DD_t = -38.464 + \underset{(5.10507)}{7.403}\ln RY_t - \underset{(-2.60063)}{1.422}\ln WPR_t$	.69	1.9800	-0.264163

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho(ρ_0)
81	Finland	17	1958–74	$DD_t = -453.531 + \underset{(4.09925)}{1033.500\ln N_t} - \underset{(-3.60305)}{116.868\ln ST_{t-1}}$	.68	1.9479	-0.511583
				$- \underset{(-3.50833)}{94.823\ln(PR_t/CPI_t)^{*}}$			
				$^{*}\ln(PR_t/CPI_t) = \ln(MM_t/CPI_t \div WP_t/CPI_t)$			
82	Greece	14	1961–74	$DD_t = -358.216 \div \underset{(5.35617)}{122.272\ln RY_t} - \underset{(-2.80272)}{173.665\ln(PR_t/CPI_t)^{*}}$	.86	2.0493	
				$^{*}\ln(PR_t/CPI_t) = \ln(MM_t/CPI_t \div WP_t/CPI_t)$			
83	Hungary	14	1961–74	$DD_t = -2005.940 \div \underset{(6.01084)}{341.183\ln RY_t} - \underset{(-2.73274)}{162.471\ln ST_{t-1}}$	.80	1.6352	
				$- \underset{(-2.21081)}{35.619\ln WP_t}$			

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho($\hat{\rho}_0$)
84	Poland	20	1955-74	$DD_t = -12446.400 + \underset{(7.67051)}{3973.920} \ln N_t$	.67	2.3068	-0.314616
85	Portugal	13	1962-74	$DD_t = N_t\left[-114.661 - \underset{(-1.63082)}{10.447} \ln(ST_{t-1}/N_t) + \underset{(1.76192)}{22.294} \ln(RY_t/N_t)\right]$	.73	1.7591	0.477632
86	Romania	20	1955-74	$DD_t = -6238.160 + \underset{(7.20218)}{2235.660} \ln N_t$	.74	1.8773	
87	Spain	15	1960-74	$DD_t = N_t\left[-117.081 + \underset{(11.04697)}{20.492} \ln(RY_t/N_t) - \underset{(-4.04407)}{6.081} \ln(ST_{t-1}/N_t)\right]$	.91	2.29553	
88	Switzerland	17	1958-74	$DD_t = -270.526 + \underset{(4.12762)}{300.391} \ln N_t - \underset{(-2.12831)}{19.808} \ln(WPR_t/CPI_t)$	.54	2.0376	-0.209592

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho (ρ_0)
89	Turkey	17	1958–74	$DD_t = -3594.550 + \underset{(6.57500)}{2300.130\ln N_t} - \underset{(-3.88090)}{550.029\ln ST_{t-1}} - \underset{(-2.17554)}{153.606\ln(WP_t/CPI_t)}$	.78	2.1114	
90	U.S.S.R.	20	1955–74	$DD_t = -151743.000 + \underset{(9.72257)}{29767.300\ln N_t} - \underset{(-2.25581)}{805.307\ln WP_t}$	.85	1.9693	
91	E.E.C.	20	1955–74	$DD_t = -103271.000 + \underset{(6.36184)}{20559.700\ln N_t}$	.69	2.1371	
	OCEANIA						
92	Australia	17	1958–74	$DD_t = 1476.610 + \underset{(3.57544)}{2535.720\ln N_t} - \underset{(-3.25471)}{987.173\ln ST_{t-1}} - \underset{(-2.00886)}{142.529\ln(WP_t/CPI_t)}$	.52	2.1369	-0.160354

No.	Countries and Territories	Number of Observations	Periods Covered	Equations	R^2	D.W. Statistics	Final Value of rho (ρ_0)
93	British Oceania	20	1955-74	$DD_t = 21.078 + 9.035 \ln N_t - 0.343 \ln WP_t$ $(8.35338)_t \quad (-2.16967)_t$	.93	1.7953	0.377457
94	New Zealand	14	1961-74	$DD_t = -901.771 + 113.737 \ln RY_t$ (6.98264)	.80	1.5463	
95	Western Samao	20	1955-74	$DD_t = 8.837 + 2.529 \ln N_t - 0.291 \ln WP_t$ $(4.82243)_t \quad (-2.80312)_t$	.74	1.9377	0.255476
96	The Rest of the World	15	1960-74	$DD_t = -65080.541 + 12680.356 \ln N_t + 1140.806 \ln EXWP^*_{3t}$ $(5.94191) \quad (3.53042)$	.77	2.13172	

$$^* \ln EXWP_{3t} = \ln(0.5437 WP_t + 0.2956 WP_{t-1} + 0.1607 WP_{t-2}) - \ln WP_t - \ln r^W_t$$

Figure I SIMULATED AND ACTUAL VALUES OF WORLD SUGAR PRICE (STATICS)

1966 - 1980

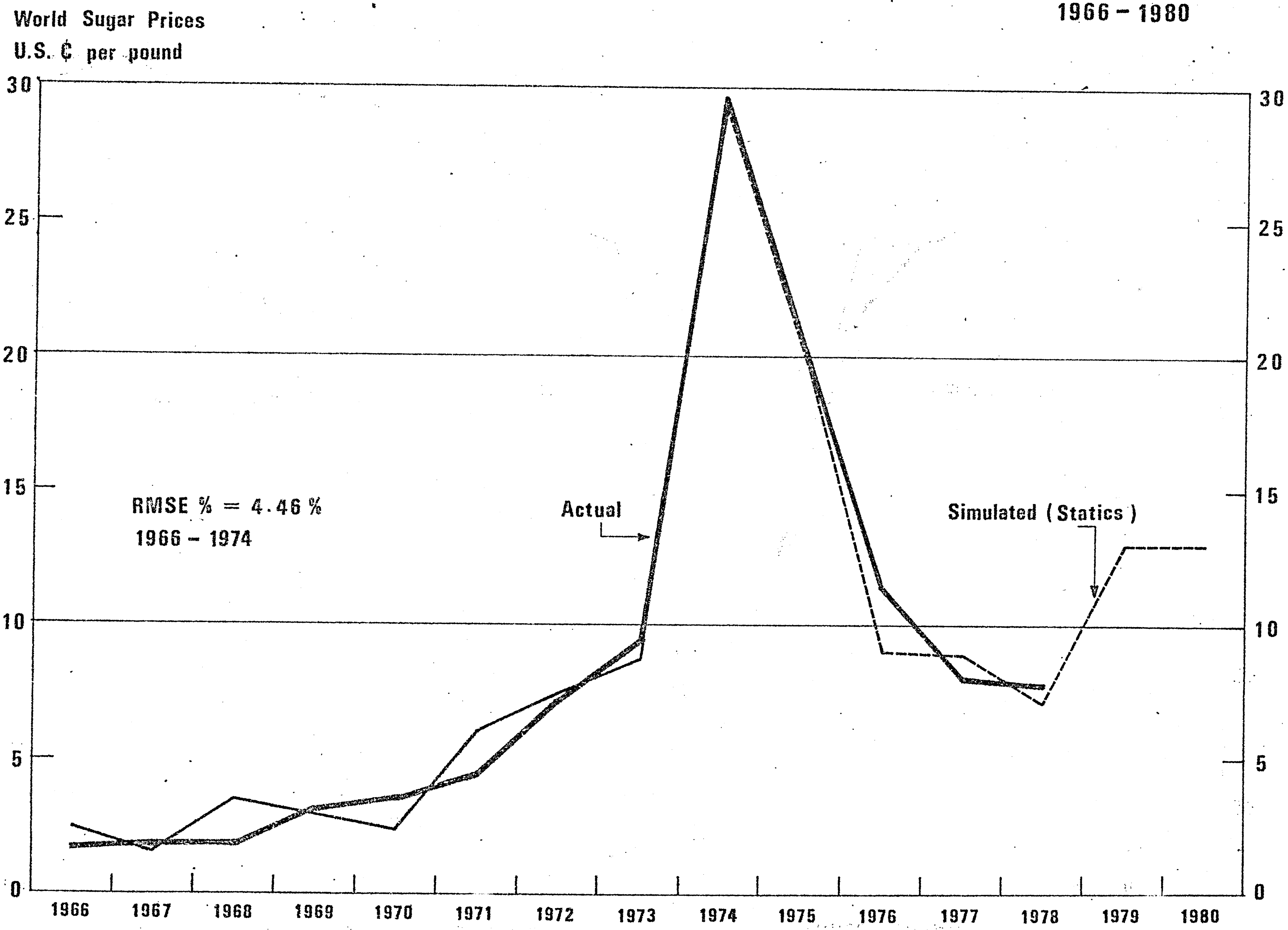
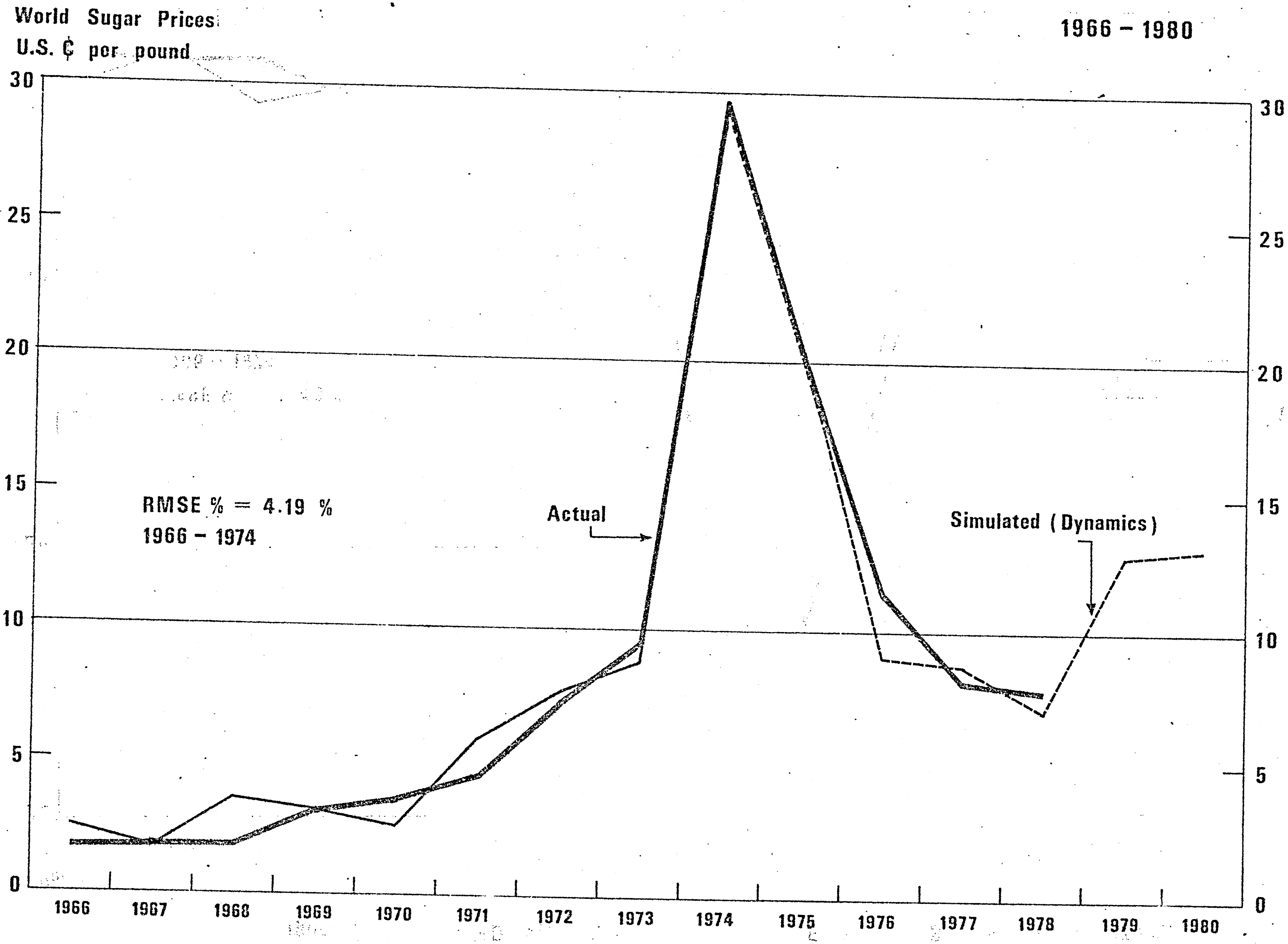


Figure II SIMULATED AND ACTUAL VALUES OF WORLD SUGAR PRICE (DYNAMICS)

1966 – 1980



VII. SIMULATION RESULTS

Historical Simulation of World Sugar Price Movements.

Using actual values of all exogenous variables (population, real income, sugar prices in the previous year, carryover stocks of sugar, cost of living indices, interest rates, exchange rates, gross mark-ups and domestic disappearances of sugar in the previous year) both static and dynamic[15/] simulations of the world sugar prices are obtained for a period of 9 years, from 1966 until 1974. The results are plotted against their actually observed values in Figure I and Figure II respectively. Despite the extremely sensitive nature of world price fluctuations, the model seems to track actual movements of the world sugar prices (I.S.A. Daily Price, f.o.b. and stowed Caribbean Port) reasonably well. In particular, major turning points corresponding to the year of sugar crisis, 1974 are adequately captured by the model even though the percentage differences between the actual and simulated values in some of the simulated periods are still large. The root mean square error as the percentage of the mean (RMSE%) of dynamic simulation of the world sugar price for the 1966-74 period is about 4.19 per cent. The dynamic simulation model, therefore, is able to explain, on average, about 95.81 per cent of the world price variation. The remaining 4.19

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15/ Static : Actual values are used for the lagged endogenous variables.

Dynamic : Previously simulated values are used for the lagged endogenous variables.

per cent can be explained, perhaps, by noneconomic factors.[16/] Note that, no commodity market today is purely competitive as defined in economic literature. There are always factors, whether they be oligopolistic, oligopsonistic or governmental, which modify the working of a purely competitive market. Here, too, sugar is no exception. In fact, it contains many more non-competitive factors than the average commodity,[17/] which tend to influence theoretical interaction between supply and demand, and therefore should not be overlooked. This is perhaps unfortunate since they are the factors that reduce the accuracy of any statistical analysis. Our study, however, shows that economic factors seem to explain most of world price movements and thus lend support to the analysis of world sugar markets by means of conventional economic mechanism of supply and demand relationships. We hope that the "political economic" approach adopted by other authors will add further explanation to the portion of world price variations which is left largely unexplained in this study.

16/ Note that, the world market is made up of exporting countries, importing countries, operators, brokers and speculators. All of these parties influence the price of raw sugar. In analyzing any given piece of news it is wise to consider its effect on all of these groups.

17/ See, Inkeles, David M. "How to Analyze the World Sugar Futures Market". In Harry Jiler, ed., Forecasting Commodity Prices : How the Experts Analyze the Market, Commodity Research Bureau, Inc. N.Y. 1977, p. 167-177.

a) Forecasts

We have here chosen the forecast horizon to be the off - sample period[18/] which starts from 1975 and ends in 1980.

As of May 1978, it was reported by FAO, ISO, USDA and F.O. Licht that world sugar production would rise by 2.6 per cent yearly from 1976 to 1985. Therefore, the world sugar output from 1975 to 1980 are estimated to be as follows.

Table I : Estimated Values of World Sugar Production in 1975-80

Year	Production ('000 Metric Tons) (Raw Value)
1975	81,545.442
1976	86,393.000
1977	87,737.000
1978	90,600.000
1979*	93,238.000
1980*	95,662.188

* Estimated Value based on the 2.6 per cent increase as estimated by the FAO.

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18/ The Sample Period is the length of time over which the behavioural equations in the model are derived.

Using these figures together with our well-informed estimates of population, real income, sugar prices of previous years, carryover stocks of sugar, cost of living indices, interest rates, exchange rates, gross mark-ups and other exogenous variables, we predict the world sugar price (US cents per pound f.o.b. and stowed Caribbean Port) by using dynamic simulation for 1975-1980 to be as follows.

Table II : Simulated Values of World Sugar Prices for 1975-80

Year	WP_t^* (US cents/lb.)
1975	20.36
1976	9.00
1977	8.73
1978	7.04
1979	12.89
1980	13.11

* Simulated Values.

It can be seen that the simulated values for 1975-1978 track the actual values both in the direction and magnitude reasonably well. But we do not have the actual figures for 1979 and 1980 to check with. Nevertheless, we feel that these simulated values are not unlikely. At least, it does support a report by the Organization of American States (OAS) which forecasts that world sugar prices might approximate and possibly exceed 11 cents per lb. near the end of 1979 or early 1980. Especially, if the US and EEC would ratify in the International Sugar Agreement, there would be a substantial improvement in the world sugar price.[19/]

b) Policy (Instrument) Simulations

We can compare our simulation results with the objectives of International Sugar Agreement, 1977 which contend to use a quota mechanism in maintaining the free market price within a range of 11 to 21 cents per pound[20/] during the period of this Agreement, 1978-1982. The basic concept of this Agreement is that the International Sugar Council (ISC) must provide the appropriate quantities of world supply so that the prices can reach the targets, by letting the world demand adjust itself. ISC can control the world supply by adjusting or reviewing the level of the global quota at any time during each quota year. It may adjust that level as it deems appropriate.

In accordance with this view, we can use the simulated model to generate the world demand at different levels of prices as in the following Table III. At the equilibrium prices, world supply equals world demand. Consequently, in order to clear the market at the given

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19/ F.O. Licht, International Sugar Report, "The Supply and Demand Situation on the Free World Market in 1979", Vol. 111, No. 8, March 2, 1979. (p. 132-133).

20/ See, International Sugar Agreement, 1977, International Sugar Organization, 28 Hay Market, London, October 21, 1977.

world prices, ISC must try to maintain world sugar supply at the same level of world demand as shown in table III.

Table III : World Sugar Demand and its Prices, (1979-80)

World Prices (US cents/lb.)	World Sugar Demand ('000 Metric Tons : R.V.) 1979	1980
11 ¢	93,726.312	96,186.510
12 ¢	93,468.360	95,910.210
13 ¢	93,231.880	95,657.242
14 ¢	93,013.550	95,424.015
15 ¢	92,810.768	95,207.703
16 ¢	92,621.452	95,006.045
17 ¢	92,443.915	94,817.201
18 ¢	92,276.768	94,639.657
19 ¢	92,118.854	94,472.149
20 ¢	91,969.202	94,313.615
21 ¢	91,826.983	94,163.150

There are reasons to believe that it is possible to slowdown the world sugar supply of the 1979 and the 1980 to the required levels. The slowdown in production was primarily due to the following factors.

1. Low prices throughout the 1976's and 1978's which gave little incentive to expand production or to produce for the export market.

2. The tremendously rising cost of establishing new sugar factories.

3. Stronger competition of non sugar crops and other economic activities.

4. The quota structure of the 1977 Sugar Agreement which resulted in severe restrictions on production in those countries which possess the greatest natural and economic potential for rapid and solid expansion.

The increased cost of sugar production coupled with the decreased price of sugar put the pressure on the producers to adjust their production in the appropriate amounts or in line with ISA quota.

The analysis of any market in its simplest terms is the analysis of the factors that affect supply and demand of the commodity involved. The analysis of sugar prices is of no exception. Information related to world sugar supply is supplied accurately by many accredited institutes. We can estimate the world demand ourselves by using our world model. If we put the world supply figure against an estimated world demand in a corresponding year we can get the price and know about their future direction. We can then compare this trend with the forward prices in the futures market.21/

Suppose this month is July 1979. We know from our simulation that the trend in world prices (in average term) in the next few years will go up rather sharply, but the forward prices in the futures market for the next six months of this year go on next year are very low. In this situation, exporters would benefit by holding the product for a while until the forward price22/ moves up to a satisfactory level. It will not be wise to sell immediately.

It is clear that if we do not have any tool to help us foresee what will happen, especially in the near future we may make the wrong decision by selling the product at the lower prices in the futures market as we may fear that the prices will keep going down or remain steady for longtime and the gains from selling the stock late may not cover the cost of keeping them.

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21/ Futures market : Essentially a mean by which merchants or other large buyers hedge against price fluctuations of a commodity in which they deal. It is necessary that the goods concerned should be capable of being accurately graded, so that dealings can take place without their actually having to be seen and examined at the time.

22/ Note that forward prices will change everyday corresponded to the spot price. The difference of forward prices from spot price is normally because of interest rate and/or may be included exchange rate and shipping costs. By the way, changing in spot price (immediate price) reflects directly changing in demand and supply of sugar in the world market.

c) Simulation Application With Thailand's Equation

Thailand, indeed, is one of the five main sugar exporters of the world and has ratified in the International Sugar Agreement. She may take advantage from this research result by using the world model along with Thailand's equation for production planning in order that the appropriate amount of sugar may be produced with no over-production or under-production.

Thailand's equation :

$$DD_t = -2341.190 + \underset{(7.33297)}{750.436} \ln N_t$$

$$R^2 = .75 \qquad D.W. = 2.00$$

$$N = 20 \ (1955\text{-}74)$$

The domestic disappearance of sugar (DD_t) of Thailand largely depends upon population (N_t). World price does not affect her domestic consumption because the government controls both her domestic supply and price by subsidy to protect the domestic consumers. The correlation coefficient of regression (R^2) is rather moderate. Simulation results show that the equation tends to underestimate actual values slightly especially at the end of estimation period. We may formulate sugar production planning of Thailand as illustrated in Table IV.

Table IV : Thailand's Sugar Production Planning, (1978-80)

(Unit : Metric Tonnes)

Year	(1) Domestic Disappearance ($DD_t = DU_t + \Delta ST_t$) : Simulated values	(2) Basic Export Tonnages For Thailand	(3) Basic Stock-holding	(4) Planned Sugar Production	(5) Cane to be grown
1978	646,619	1,020,000 ($WP_t \leq 11¢$)	80,000	1,746,619	20,548,459
1979	680,905	1,140,000 ($WP_t = 12¢$)	160,000	1,900,905	22,363,588
1980	714,964	1,200,000 ($WP_t = 13¢$)	200,000	1,954,964	22,999,576

In column (1), we can estimate the value of domestic disappearance (DD_t) by substituting the values of exogenous variables into Thailand's equation. We know the tendency of world prices in the corresponding years from the world equation. With the application of Article 44[23/] we can get the values of Basic Export Tonnages of Thailand in column (2). Column (3) is the values of Basic Stockholding (as additional stock of each year) which Thailand must hold under Article 46 of the 1977 International Sugar Agreement.

23/ Article 44 concerns the price stabilization mechanism, quota mechanism and release of special stocks of the 1977 International Sugar Agreement. Specific export quotas are given in accordance with the level of world price.

Adding up these first three columns together, we get the amount of sugar that Thailand must plan to produce in each year in Column (4). The amount of sugar cane to grow in each year can be computed by converting sugar to cane using the ratio of 1 metric ton of cane to .085 metric ton of sugar to convert the value in Column (4). Then we get the value of cane to produce in Column (5).

VIII. CONCLUSIONS

The theoretical framework has been developed to estimate aggregate demand functions for sugar in the whole world. These estimated demand equations together with the specification of commodity balance identities, global equilibrium condition and relationships of domestic prices in individual countries or territories to the world price form the analytical model of world sugar markets. This model describes the process of world price determination through the conventional demand - supply mechanism of commodity markets. We have shown that the model is able to track the historical path of world sugar price reasonably well. Given best informed estimates of the exogenous and policy variables, interesting quantitative forecasts and policy simulations can be generated.

This simulation model can help us in the planning policy for sugar production in the future and also to deal wisely in the futures market. However, it shculd be borne in mind that this econometric model is only an additional tool of analysis. Subjective judgments, always important in model construction and use, become especially relevant in a forecasting situation.

BIBLIOGRAPHY

BOOKS

Klein, Lawrence R., "An Introduction to Econometrics", Prentice Hall, Inc. (Reprinted in Japan), N.J. 1962, p. 90-92.

ARTICLES

Brook, Ezriel M., "High Fructose Corn Syrup : Its Significance as a Sugar Substitute and Its Impact on the Sugar Outlook", The World Bank Commodity Paper No. 25, April 1977.

Chaipravat, Olarn, "Aggregate Structures of Production and Domestic Demand for Rice in Thailand, A Time Series Analysis, 1951-1973", Bank of Thailand, Paper No. 4, April 1975, p. 16-18.

-----------------, and Sayan Parivat, "An Econometric Model of World Rice Markets", Bank of Thailand, Paper No. DP/76/14, May 1976.

Inkeles, David M., "How to Analyze the World Sugar Futures Market", In Harry Jiler, ed., Forecasting Commodity Prices : How the Experts Analyze the Market, Commodity Research Bureau, Inc., N.Y. 1977. p. 167-177.

International Sugar Organization, "International Sugar Agreement, 1977", Memo (77) 23, 28 Haymarket, London, October 21, 1977.

Jonson, P.D. and D.M. Mahoney, "Price Expectations in Australia, The Economic Record, Vol. 49, No. 125, March 1973, p. 50-61.

Orcutt, G.H. and D. Cochrane, "A Sampling Study of Merits of Autoregressive and Reduced Form Transformation in Regress Analysis", Journal of the American Statistical Association 44 (1949), p. 356-372.

Pignaloza, F., "A Statistic Analysis of Sugar Consumption and Future Demand", FAO, Monthly Bulletin of Agricultural Economics and Statistics No. 12, Vol. 26, December 1977. p. 4-12.

Viton, A. and F. Pignaloza, "Trends and Forces of World Sugar Consumption", FAO, Commodity Bulletin Series No. 32 Commodities Division, Rome, 1961.

PERIODICALS

F.A.O., "World Population Estimates and Projections 1950-2000", Commodities and Trade Division, General Studies Group, February 1977.

------, "Gross Domestic Product, Private Consumption Expenditure and Agricultural GDP at 1975 Constant Prices Historical Series, 1960-1975, and Projections, 1975-1990", Commodities and Trade Division, General Studies Group, March 1977.

F.O. Licht, International Sugar Report, "The Supply and Demand Situation on the Free World Market in 1979", Vol. 111 No. 8, March 2, 1979. (p. 132-133).

International Sugar Organization, "Sugar Year Book", 28 Haymarket, London, 1961-1977.