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# Price Formation in the World Soybean Oil Market - An Econometric Analysis

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ABSTRACT

The present study attempts to analyze the price formation mechanism in the world soybean oil market in a competitive framework. The determinants of world soybean oil price are identified by estimating the equations for exports/imports and the border prices of the major exporting and importing countries, using a structural simultaneous equations model. The results of the study indicate that the major determinants of world soybean oil price are the world palm oil price (substitute) and the level of soybean oil exports in the world market. The simulation results of the impact of projected trends in the world soybean oil production for medium term (2015) show the following. The increase in supply-demand gap (due to increases in consumption and decreases in production) in the major exporting countries, combined with a likely fall in world palm oil price (due to an increasing trend in palm oil production), are likely to result in a decline in the world exports and world price of soybean oil. The likely fall in the world palm oil price is expected to result in much larger quantum of palm oil imports into India in future, which in turn, may have implications for the livelihood security of soybean farmers in the dry regions of the country.

**Key words:** Price Formation; World Soybean Market; Edible Oil Price

**JEL Classification:** C3, C5, Q17

## 1. INTRODUCTION

Soybean oil imports constitute bulk of the edible oil imports in India. Domestic production was sufficient to meet the major portion of India's edible oil consumption requirements during the 1960s and 1970s. But since the early 1980s, the imports began to play a significant role (except for a brief period of 1988-1993) in meeting the growing consumption requirements. With the liberalization of imports in the mid 1990s, imports rose rapidly and currently more than 50% of the consumption requirements are met through imports. Therefore, the developments in the world soybean oil market, particularly the price formation mechanism, have major implications for India's edible oil consumption.

The present paper attempts to analyze the price formation mechanism in the world soybean oil market and identify the major determinants of world soybean oil price in a competitive framework.

The objectives of the study are

i) to identify the major determinants of world price of soybean oil
ii) to draw implications for India's policy on soybean oil sector

After a brief introduction in section 1, a brief overview of the international and Indian soybean oil markets is presented in section 2. A review of the relevant literature is outlined in section 3. The analytical framework of the study is presented in section 4. followed by a description of the empirical methodology and data in section 5. Section 6. presents the results of the analysis. Section 7 provides the concluding observations and policy implications.

## 2. SOYBEAN OIL – INTERNATIONAL AND INDIAN SCENARIO

Soybean occupies more than 50 percent of the total world production of oilseeds and soybean oil is considered the most important source of proteins among vegetable oils. It accounts for nearly 25 percent of world's total oils and fats. Active support from major producing countries through production / export subsidies and growing health awareness in consuming nations has led to an increasing trade of soybean-based products around the world. As a result, soybean oil has emerged as one of the leading edible oils in the international markets along with palm oil. Presently, these two oils together constitute about 65-70 percent of the global edible oil trade volume. Although, soybean consumption is primarily in three forms – beans, meal and oil, we confine our focus to soybean oil in the present study.

### *2.1 World Soybean Oil Market – An Overview*

US is the largest exporter of soybean oil with an average share of 35 per cent in quantity terms and 36 per cent in value terms during the period 1961-2003 (FAO). US is followed by Brazil (15%, 14%) and Argentina (14%, 13%). The other major exporters are Netherlands (8%, 8%) and Germany (6%, 6%). The five major exporters together had a combined share of 78% in quantity terms and 77% in value terms during this period. Although Germany and Netherlands are not major producers of soybeans in the world, they emerged as major exporters of soybean oil mainly through re-exports.

Few changes have taken place in the world soybean oil market during the last 15 years. During the period from 1990 to 2003, Argentina has emerged as the major exporter with a share of 33% in quantity terms and 30% in value terms of the world exports. . Brazil has come to occupy the second place with shares of 21% and 19% respectively. These increases in market shares of Latin American countries are mainly due to some favourable policy environment in these countries. US has dropped to third place with shares of 13% and 14% respectively. Germany and Netherlands have managed to maintain their earlier positions. The combined shares of all five major exporters during this period are 79% in quantity terms and 76% in value terms.

During 1970s, US accounted for more than 95 percent of world soybean trade. Due to increased competition from Brazil and Argentina, US share in the global soybean trade is less than 50 percent and less than 8 percent in soybean oil market by late 1990s. The decline in US share in the global soybean exports resulted mainly from phenomenal production growth in Brazil and Argentina.

Brazil has availability of quality lands, which under appropriate policy can be used for increasing soybean production. However, Brazilian policy of domestic sales tax on soybean shipments between states has adversely affected soybean oil production and exports. Recent growth in Argentina's soybean yields, production and exports is impressive. The country is predominantly an exporter of soy meal and soybean oil. Argentina has limited potential for increasing production through area increases and production growth is possible only through yield improvements and diversion of land from other crops. The policy of differential export tax in favour of soybean oil has helped Argentina to emerge as a major exporter of soybean oil.

On the imports side, the market is less concentrated. Iran has been the largest importer of soybean oil during the period 1961-2003 with an average share of 9 per cent in quantity terms and 5 per cent in value terms, followed by India (7%, 4%), China (6%, 3%) and Pakistan (6%, 3%). Other importers are Bangladesh (4%, 2%), Morocco (4%, 2%), Egypt (2%, 1%), Peru (2%, 1%) and Venezuela (2% and 1%). Some major changes have taken place in the soybean import market since early 1990s. China has emerged as the world's leading importer with a average shares of 13% in quantity terms and 7% in value terms respectively during 1990-2003. Iran dropped to second place with shares of 10% and 5% respectively, followed by Bangladesh (6%, 3%) and India (5%, 2%).

China is world's fourth largest producer of soybeans. However, rapid growth in population and income has spurred food consumption and a consequent demand for soybean and its products. Presently in China, 55-60 percent of the consumption needs are met through imports. Although China has massive crushing capacity, it is one of the major importers of soybean oil.

India's production growth in soybeans has been very slow. Indian yields are among the lowest in the world. Large population and inadequate production have resulted in a continuous supply-demand gap (except for a brief period from 1986 to 1993) and necessitated large imports of soybean oil. India imposes high tariffs on imports of soybeans mainly to protect poor farmers in the dry regions of the country, where the crop is mostly grown. As a result, India needs large imports to meet its soybean oil requirements. Consequently, India has emerged as one of the largest importers of soybean oil in the world market.

World trade in soybean oil is highly influenced by developments in palm oil market. Exporters of soybean oil face stiff competition not only from one another but also from the exporters of palm oil. Price of palm oil makes it an attractive substitute to soybean oil in the consumption basket. Malaysia and Indonesia are the major exporters of palm oil and these countries also enjoy the advantage of lower freight cost to primary Asian import markets. The potential for higher palm oil production is almost exhausted in Malaysia but Indonesia still has a lot of untapped potential.

### *2.2 Soybean Oil Sector in India*

Soybean crop in India is around thirty years old. The production and consumption of soybean oil took place at a fast rate in absolute as well as relative terms after mid 1980s (Table 1). Soybean oil imports constituted bulk of the edible oil imports during the early 1970's and 1980's (Table 1, col 4). The major portion of the consumption requirements of the edible oils were met through domestic production during the 1960s and 1970s (Table 2) but by early 1980s, the imports rose to 40% of the consumption requirements (93% in case of soybean oil). Consequently, Technology Mission on Oilseeds and Pulses (TMOP) was launched and the imports of soybean oil came down to about 5% of consumption by the late 80's. With the liberalization of imports again in the mid 1990s, imports rose rapidly and currently more than 50% of the consumption requirements are met through imports. Thus, it is clear that imports have always been a major instrument of meeting the consumption requirements of soybean oil in India, except for a brief period from late 1980s to mid 1990s. Therefore, the developments in the world soybean oil market, particularly the price formation mechanism, have major implications for India's edible oil consumption.

TABLE 1
GROWING SHARE (%) OF SOYBEAN OIL IN PRODUCTION, CONSUMPTION AND IMPORTS OF EDIBLE OILS IN INDIA

| | Production | Consumption | Imports |
|---|---|---|---|
| 1961 | 0.03 | 0.14 | 4.21 |
| 1971 | 0.07 | 4.19 | 99.01 |
| 1981 | 1.30 | 20.48 | 48.08 |
| 1991 | 9.53 | 8.76 | 7.59 |
| 2002 | 28.25 | 27.08 | 26.60 |

TABLE 2
SHARE OF IMPORTS IN INDIA'S CONSUMPTION: ALL EDIBLE OILS AND SOYBEAN OIL

| | Edible Oils | Soybean Oil |
|---|---|---|
| 1961 | 2 | 75 |
| 1971 | 4 | 98 |
| 1981 | 40 | 93 |
| 1991 | 6 | 5 |
| 2002 | 53 | 52 |

Source: *Trade Yearbook and Food Balance Sheets* various issues, Food and Agriculture Organization, Rome and www.faostat.org

## 3. LITERATURE REVIEW

The theoretical underpinnings of the general competitive model are well established in literature. A good review may be found in Labys (1973). Some of the important studies on the major components of competitive model are the following – demand (Schultz 1928, 1938), Supply (Nerlove, 1958), Inventory (Goodwin, 1947; Lovell, 1961; Brennan, 1958; Wickens *et al.* 1971) and price (Working 1934, 1949, 1958, 1962; Weymer 1968; Breimyer 1961; Desai 1966).

Houck *et al.* (1972) provide a comprehensive account of the soybean products and markets. Love (1979) and Lockeretz (1988) underline the importance of soybean to the stability of the world oilseed markets in general and to the developing countries' cropping systems in particular. The assumption of a single world market for soybean oil has been tested in Uri *et al.* (1993). The findings of the study uphold the validity of the assumption, which in turn, has implications for the continued presence of production subsidies in various countries and the consequent discussions to reduce the same on various international fora, like WTO.

*Tharaen et al.* (1992) explored the linkage of the US macroeconomic policies with its soybean trade competition with other exporters like Argentina and Brazil, to the import markets of Japan and EC-12. Their results indicate that a weak dollar increases imports of soybean products, which in turn, increases both US and Argentina/Brazil exports in the long run. Just (1990) analyzed the US soybean market in an interlinked commodity model that has implications for Mexico. Dromme and Tavera (1990) examined the impact of EU subsidies on imports of US soymeal. They conclude that the EU milling subsidies have little impact on the soymeal imports from US. A similar exercise for Canada by Griffith and Meilke (1983) shows that Canada gains if tariffs in EEC are reduced only for rapeseed oil, but loses from tariff cuts only for soybean oil. Canada also loses if tariffs on both the oils are reduced in EEC. These results can be understood as resulting from the high degree of substitutability in consumption between rapeseed oil and soybean oil and, competition from other soybean oil exporters like Argentina and Brazil. Margarido *et al.* (2004) investigated the transmission of world soybean oil prices into Brazilian market, based on the law of one price (Mundlak and Larsson, 1992). Their results validate the theory of one price. A good review of other interesting studies on Brazilian soybean market may be found in this study.

## 4. ANALYTICAL FRAMEWORK

There is little evidence of market power for any of the major exporters of soybean oil in the literature. Also, competitive framework has been employed in studies analyzing markets relating to other oils too, mainly because of the substitutability and possibilities for blending among different oils (Tewari, 1998). Therefore, the analysis in the present study is also carried out in a competitive framework. The determinants of world price are identified in this study by formulating a competitive equilibrium model without inventories, on the lines of Labys (1973).

A general form of the Labys model with inventories is as follows.

Consumption: $c_t = f(p_t, p_s, y_t, z_{ct}, u_{ct})$

Production: $q_t = g(p_t, p_{t-1}, p_s, z_{qt}, u_{qt})$

Changes in Inventories: $\Delta s_t = s_t - s_{t-1} = q_t - c_t$

where $c_t =$ consumption in t

$q_t =$ production in t

$p_t =$ price of the commodity in t

$p_s =$ price of the substitute commodity in t

$z_{it} =$ vector of other relevant explanatory variables where i = c,q

$u_{it} =$ error term where i = c,q

A specific form of the model is when $\Delta s_t = 0$ or when $s_t$ ; $s_{t-1}$ ; $0$. The model then reduces to the following.

$$c_t = f(p_t, p_{t-1}, y_t, z_t, u_t)$$
$$q_t = f(p_t, p_{t-1}, z_t, u_t)$$
$$q_t = c_t$$

Price behaviour in this case is explained by the inversion of either the demand or supply function. This is the broad framework used for modeling world price equation in the present study.

The endogenous variables in the model are the following: (i) imports to and exports from each of the major importing and exporting countries (ii) border prices in the respective countries and, (iii) the world price. The complete model is given below. A set of two behavioural equations is estimated to explain exports (or imports) and border price of each of the major importing and exporting countries. The aggregate world flows are derived by summing the estimates of individual countries. The major exporting countries are Argentina, Brazil, US, Germany and the Netherlands. The major importing countries are Bangladesh, China, Egypt, India, Iran, Morocco, Pakistan, Peru, and Venezuela. Notation of the variables is given at the end of the sub-section. The expected signs of the coefficients are given below the respective variables.

Exports from the i th exporting country: $X_{it} = f(\underset{+}{X_{it-1}}, \underset{+}{p_{it}^{ex}}, \underset{+}{q_{it}^{ex}}, \underset{+}{ER_{it}})$

Imports of the i th importing country: $M_{it} = f(M_{it-1}, p_{it}^{im}, p_{it}^{ims}, y_{it}, c_{it-1}, q_{it-1}^{im})$

$$\qquad + \quad - \quad + \quad + \quad + \quad -$$

Border Price of the i th Exporting / Importing Country: $p_{it}^{ex} = f(p_{it-1}^{ex}, p_t)$

$$+ \quad +$$

$$p_{it}^{im} = f(p_{it-1}^{im}, p_t)$$

$$+ \quad +$$

World Price: $p_t = f(p_{t-1}, TX_t, X_t^{row}, p_s)$

$$+ \quad - \quad - \quad +$$

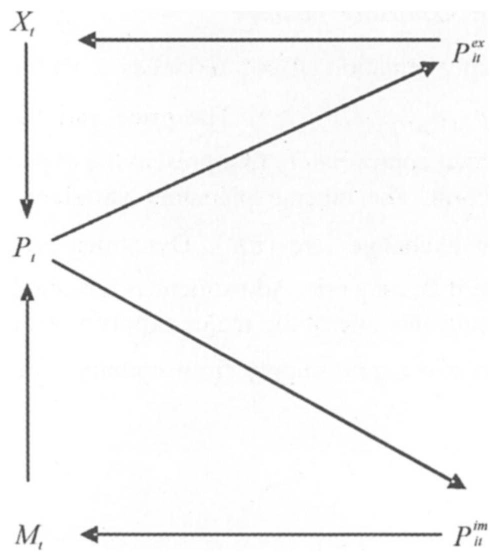


Fig. 1: Pattern of Simultaneity and Recursiveness in the Model

Fig. 1 depicts the schematic flow diagram of the competitive model. Border price ($p_{it}^{ex}$) in the i th exporting country is expected to influence export supply ($X_{it}$) during the current period. Similarly import demand ($M_{it}$) in the i th importing country is influenced by $p_{it}^{im}$. Total trade flows ($\sum_i X_{it}$ + rest-of-the-world exports) determine world price ($p_t$). World price has an influence on border price through price transmission mechanism. Therefore simultaneity is expected in the current period between world Price ($p_t$), border prices ($p_{it}^{ex}, p_{it}^{im}$) and the trade flows ($X_{it}, M_{it}$). Since there are two endogenous variables for each country, a set of two behavioural equations is estimated to explain exports (or imports) and border price of each of the major importing and exporting countries. For the purpose of the study, world price denoted by a location-specific price, like *Rotterdam* soybean oil price, may not be appropriate as it may not account for the wide differences in transportation and other costs. The idea conceived and explored in this study is of a notional world market. Therefore, world price is calculated as the unit value of the soybean oil traded (exported + imported), thus internalizing the insurance and freight charges. Although in a competitive model, price can be calculated by equating supply and demand, in our model behavioural equations are not estimated for all the countries that constitute world market. Due to this, a separate behavioural equation for world price is needed, which also incorporates the rest-of-the-world effects. The details of each of the behavioural equations are given below.

*4.1 Exports from the ith exporting country*

The static export supply equation in our model is a variant of the static domestic supply equation $q_t^s = f(p_{it}, p_{jt}, \ldots\ldots, p_{nt}, z_t)$. The price variable of the standard supply function needs to be modified appropriately to represent the export price of the commodity in the export supply function. The other explanatory variables included are the current production ($q_{it}^{ex}$) and the exchange rate ($ER_i$). Dynamics are introduced through the Nerlovian partial adjustment framework. Adjustment is assumed to be partial in view of the infrastructural bottlenecks in some of the major exporting countries like Argentina and Brazil. Let $X_{it}^*$ be the desired export supply from country i in time t.

$$X_{it}^* = f(p_{it}^{ex}, q_{it}^{ex}, ER_i)$$

$$X_{it} - X_{it-1} = \delta(X_{it}^* - X_{it-1})$$

$$X_{it} = (1-\delta)X_{it-1} + \delta f(p_{it}^{ex}, q_{it}^{ex}, ER_i)$$

$$\Rightarrow X_{it} = f(\underset{+}{X_{it-1}}, \underset{+}{p_{it}^{ex}}, \underset{+}{q_{it}^{ex}}, \underset{+}{ER_i})$$

All the explanatory variables are expected to have a positive effect on export supply.

*4.2 Imports from the i th importing country*

The static import demand function is derived from the standard static demand function $c_{it} = f(p_{it}, p_{jt}, \ldots\ldots, p_{nt}, y_t)$. In addition to the current endogenous variable $p_{it}^{im}$, we have also included $q_{it-1}^{im}$ and $c_{it-1}$ to account for the supply-demand gap in the previous period, which is expected to have a sizeable effect on the import demand in the current period. Income ($y_t$) is the other demand shifter. Dynamics are introduced through Nerlovian partial adjustment framework. Adjustment is assumed to be partial because of rigidities on the import side like foreign exchange availability, infrastructure bottlenecks etc. Proceeding as in the case of export function we get,

$$M_{it} = f(\underset{+}{M_{it-1}}, \underset{-}{p_{it}^{im}}, \underset{+}{p_{it}^{ims}}, \underset{+}{y_i}, \underset{+}{c_{it-1}}, \underset{-}{q_{it-1}^{im}}).$$

*4.3 Border Price*

Border prices of exporters ($p_{it}^{ex}$) and importers ($p_{it}^{im}$) are modeled as simple transmission functions with lagged border price and world price ($p_t$) as explanatory variables.

$$p_{it}^{ex} = f(\underset{+}{p_{it-1}^{ex}}, \underset{+}{p_t})$$

$$p_{it}^{im} = f(\underset{+}{p_{it-1}^{im}}, \underset{+}{p_t})$$

The reasoning for such a formulation is as under. The idea conceived and explored in this study is of a notional world market (see the schematic diagram below in fig. 2). BPE1, BPI1 are the border prices of exporter1 and importer1 respectively and so on for other exporters/importers. IMP and EXP are the imports and exports respectively. Border prices of a country, together with other factors, influences the country's exports (or imports) and imports. Total world exports (or imports), in combination with other factors, determines the level of world price. World price, in turn again, influences the prices received, in the form of border prices, by importers and exporters.

*4.4 World Price*

The derivation of price relationship in case of soybean oil is slightly different (from a standard competitive model with inventories) since stocks do not play a major role in determining the world price of this commodity. This can be judged from the substantially low levels of stocks held by major exporters. Also, substitutability with other oils ensures that this market is predominantly a buyers' market. This implies that increased world exports normally have a dampening effect on the world price.

Therefore, world price of soybean oil is derived from the inverted import demand (or export supply since supply equals demand) function in the following way (Breimyer, 1961). Price adjustment is modeled in a Nerlovian partial adjustment framework since the adjustment on the demand side (imports) is assumed to be partial (Nerlovian).

$$p_t^* = f^{-1}(X_t, p_s) = g(TX_t, X_t^{row}, p_s)$$

where $X_t = TX_t + X_t^{row}$; $TX_t = \sum_i X_{it}$ (total exports from all major exporting countries)

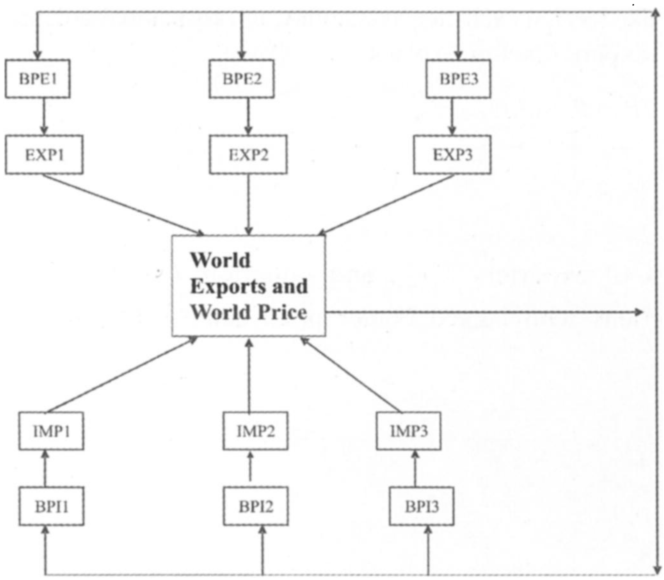


Fig. 2: Schematic Diagram of a Notional World Market

where $X_{it}$ = exports from the i th exporting country in time t and $X_t^{row}$ = Total exports of rest-of-world in t

$$p_t - p_{t-1} = \delta(p_t^* - p_{t-1})$$

$$p_t = (1-\delta)p_{t-1} + \delta g(TX_t, X_t^{row}, p_s)$$

$$\Rightarrow p_t = g(p_{t-1}, TX_t, X_t^{row}, p_s)$$

$$\qquad + \quad - \quad - \quad +$$

$M_t = X_t = TX_t + X_t^{row}$ *(Supply equals Demand)*

**Notation of the Variables Used**

$X_{it}$= Exports from i th exporting country

$X_t^{row}$ = Total exports in rest-of-world in t

= World Exports – (Exports of major exporting countries)

$X_t$= World Exports

$X_{it}^*$, $M_{it}^*$ denote respectively the desired export supply and import demand of country i in time t

$TX_t = \Sigma_i X_{it}$ = total exports from all major exporting countries included in the model

$p_{it}^{ex}$ = Export price of the commodity in ith country in time t (unit value of exports)

$q_{it}^{ex}$ = Production in the i th exporting country
$ER_i$ - Exchange rate in the ith exporting country
$M_{it}$ = Imports from i th importing country
$M_t$ = World Imports
$y_i$ - Real income in $ of the I th importing country (const 1995 US$)
$c_{it}^{im}$ = Consumption in the i th importing country

$q_{it}^{ex}$ = Production in the i th exporting country

$p_t^*$ = Expected equilibrium world price of soybean oil in time t

$p_{it}^{im}$ = Import price of soybean oil in ith country in time t (unit value of imports)

$p_{it}^{ims}$ = Import price of the substitute commodity (palm oil) in ith country in time t (unit value of imports)
$P_t$ = Actual world price of soybean oil in time t (unit value of exports + imports)
$P_s$ = World price of the substitute commodity (palm oil) in time t (unit value of exports + imports)

## 5. ECONOMETRIC METHODOLOGY AND DATA

We have used the Hsiao (1997a, 1997b) framework in empirical estimation of our model. Hsiao model is an improvement to the Cowles Commission's structural approach which incorporates the advances in time series regression analysis (with integrated regressors) taking into account non-stationarity and cointegration. In this model, the link between the multiple time series model and the structural dynamic simultaneous equations model is explored. It is shown that even if the variables are non-stationary, the standard Simultaneous Equation Model (SEM) estimation methods, like the 2SLS and the 3SLS and, testing procedures can be applied provided the variables are cointegrated. For details see Sekhar (2003). We have used this framework of Hsiao in the econometric estimation of our model.

The following step-wise procedure has been followed in estimating the models.

i) All the variables in each of the equations are tested for stationarity and order of integration (if non-stationary) using Augmented Dickey-Fuller (1979) and Phillips-Perron (1988) Tests

ii) Variables of similar order of integration are tested for cointegration using Johansen method (Johansen, 1988) after determining the appropriate lag length.

iii) In the presence of cointegration, the structural equations are estimated using 2SLS method and interpreted as cointegrating relations (Hsiao, 1997a, 1997b). 3SLS is prone to specification error even if one equation in the system is misspecified. Therefore, 2SLS is used in the estimation of our model, where the number of behavioural equations is much larger (about 30) and consequently the possibility of misspecification is high.

iv) Evaluation of the model is carried out using standard diagnostic tests – B-G LM test and the Ljung-Box Q statistic for serial correlation; Ramsey RESET test for functional form; RMSE and Theil's U for evaluating model performance.

v) Finally, residuals of the estimated equations are tested for stationarity.

Data on trade flows are mainly drawn from the various issues of *Trade Yearbook of FAO* and FAO website www.fao.org. The period of analysis is 1965 to 2000, subject to data availability for individual countries. Considerable changes in economic conditions, technology and policy are expected to take place over such a long period of time. However, it is assumed that these changes are gradual and can be captured by appropriate variables like lagged endogenous variables and time trend. We have mainly relied on data on real variables like exports, imports, production and consumption. Data on monetary variables like expenditures on subsidies and policy-related variables like tariffs are not used for two reasons. First, such a dataset, according to our knowledge, is not available over a long time period across countries in a comparable form. Second, and the more important reason, is that the effect of all types of policies and technology changes has to finally manifest in terms of real variables. Therefore, real variables are used in this study. The idea conceived and explored in this study is of a notional world market for soybean oil. Therefore, world price is calculated as the unit value of the soybean oil traded (exported + imported), thus internalizing the insurance and freight charges.

## 6. ANALYSIS AND RESULTS

A competitive model without inventories has been formulated on the lines of theoretical model outlined section 4. Functions are estimated to explain exports/imports and border prices of each of the major exporting and importing countries. Two equations are, therefore, estimated for each major country in the international market. The estimated exports of all the countries are added to obtain the aggregate exports by the major countries ($EXPORTS^{Majexp}$), which forms an important variable in explaining the world price in our model. All the behavioural equations satisfied the order condition for identification. The estimates of the complete model are presented and discussed in Appendix A. Here we discuss the estimates of the *world price*[1] equation, which is the main focus of our analysis. The descriptive statistics of the important variables in the *world price* equation are provided in Table 3.

1 For reasons of brevity, the results of stationarity tests, cointegration and the diagnostic statistics are not presented in the paper. The same can be had from the author upon request.

TABLE 3

DESCRIPTIVE STATISTICS OF VARIABLES IN WORLD PRICE EQUATION: 1964 2000

| | World Soybean Oil Price ($/ton) | Exports of Major Exporters (Mt) | (World Palm Oil Price($/ton) |
|---|---|---|---|
| Mean | 490.98 | 2686407.00 | 411.46 |
| Median | 497.74 | 2800252.00 | 419.23 |
| Maximum | 737.74 | 6585068.00 | 674.49 |
| Minimum | 228.70 | 493813.00 | 152.14 |
| Std. Dev. | 154.05 | 1690564.00 | 151.70 |
| Skewness | -0.17 | 0.59 | -0.07 |
| Kurtosis | 1.85 | 2.56 | 1.87 |
| Jarque-Bera | 2.20 | 2.41 | 2.00 |
| Probability | 0.33 | 0.30 | 0.37 |
| Observations | 37 | 37 | 37 |

Stocks do not play a major role in determining the world price of soybean oil. This can be judged from the substantially low levels of stocks held by major exporters. Also, substitutability with other oils ensures that this market is predominantly a buyers' market. This implies that increased world exports normally have a dampening effect on the world price.

$$WORLDPRICE^{SOIL} = 2.06 + \underset{(2.17^*)}{0.15^*\ WORLDPRICE^{SOIL}(-1)} - \underset{(-4.57^*)}{0.12^*EXPORTS^{Majexp}}$$

$$+ \underset{(13.51^*)}{0.78^*\ WORLDPRICE^{POIL}}$$

$\bar{R}^2 = 0.97$ B-G LM Test[2] = 2.36 (0.09) Sample Period = 1965-2000

where $WORLDPRICE^{SOIL}$ – Real World soybean oil price in $, obtained from the unit values of Soybean oil traded deflated by CPIUS

$EXPORTS^{Majexp}$ - Aggregate soybean oil exports of major exporters (ton), which is the sum of the estimated exports of individual exporting countries

$WORLDPRICE^{POIL}$ – Real World Palm oil Price in $, obtained from the unit values of palm oil oil traded deflated by CPIUS.

CPIUS – Consumer price index in US

The results are on the expected lines *apriori*. The exports variable has a significant negative effect while the substitute price has a significant positive effect on the world price. Price of the substitute (palm oil), with an elasticity of 0.78, appears to be the major

2 B-G refers to Breusch-Godfrey LM test for serial correlation. It is not possible to estimate Durbin's h statistic in certain cases (when n.Var($b_1$)>=1). See Breusch(1978), and Godfrey(1978)

determinant of the world soybean oil price followed by exports of major countries and the lagged price. The diagnostic statistics are satisfactory (Table 4). Tests for serial correlation, the Q-stat and the B-G test, show little evidence of serial correlation. The Ramsey RESET test shows that the fitted functional form is appropriate and the null hypothesis of 'no specification error in the functional form' cannot be rejected. The tests of stationarity, ADF and PP, show that the residuals of the equation are stationary indicating that the good fit shown by $\bar{R}^2$ is not spurious.

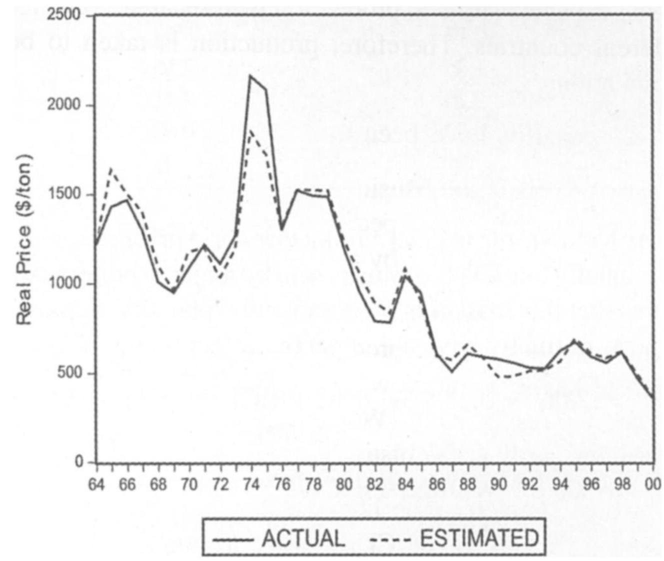


Fig. 3: World Soybean Oil Price: 1964-2000

Three types of model simulations are carried out. In the first type, the single-equation simulation, dynamic forecasts of each of the *individual equations* are generated using the sample data (that is used for estimation) and these forecasts are compared with the actual values of the endogenous variables. In the second type of simulation, the *entire model* is solved over the sample period and the equilibrium values, as generated by the model solution, are compared with the actual values of the endogenous variables. This is called the 'Historical Simulation' The third type, the out-of-sample simulation, is very similar to historical simulation, but extended to data points outside the sample range used in the estimation of the model.

The very low values of PRMSE suggest that the simulation performance of the equation is good (Table 4). Theil's inequality coefficient, which is a measure of the equation's ability to track turning points in the data, is very low in all the simulations – almost equal to zero, indicating a very good turning point performance of the equation.

This inference is also supported by the very low values of bias and variance proportion of U. Together these two components account for less than 2% of the variance in U.

*Counter-Factual Simulations*

A few forecasting simulations of our model have been carried out to assess the impact of estimated increases/decreases in global food production on exports and price in the world markets. Agricultural trade liberalization is expected to lead to a relatively more competitive international market and an increase in world exports. These changes are mainly due to the expected shifts in production patterns in accordance with comparative advantage of different countries. Therefore, production is taken to be the main impact variable in our simulations.

The following three scenarios have been examined.

Baseline Scenario – This is the 'Business-as-Usual' scenario where all the exogenous variables, including production, are expected to grow at the historical growth rates. The historical growth rates are calculated by fitting an exponential growth function to data from 1965 to 2000.

Scenario I – In this scenario, the production (of food), as a result of complete trade liberalization by 2015, is expected to grow at –5.3% and 2.2% per annum in the high-income and developing countries respectively (World Bank, 2005). All the remaining exogenous variables are expected to grow at the historical growth rates as in the baseline scenario.

Scenario II – After complete trade liberalization by 2015, production is expected to grow at rates projected by OECD (OECD, 2006). All the remaining exogenous variables are expected to grow at the historical growth rates as in the baseline scenario.

The model is solved under the three scenarios using the projected exogenous variables. Annual percentage growth rates of the endogenous variables are calculated for the year 2015, over the base year 2000.

TABLE 4

DIAGNOSTIC STATISTICS – 2SLS ESTIMATES OF THE WORLD PRICE EQUATION

| Diagnostic Statistic | Value |
|---|---|
| R Bar Sq | 0.97 |
| Ljung-Box Test for Serial Correlation | 2.71 (0.12) |
| B-G LM Test for Serial Correlation | 2.36 (0.09) |
| Ramsey RESET Test | 0.35 (0.72) |
| **Stationarity Tests of the Residuals** | |
| ADF | -3.18** |
| PP | -3.84** |

| | |
|---|---|
| **Single Equation Forecast** | |
| RMSE | 0.08 |
| Theil's Inequality Coefficient 'U' | 0.02 |
| Bias Proportion of 'U' | 0.00 |
| Variance Proportion of 'U' | 0.01 |
| **Historical Simulation of the Model (upto 2000)** | |
| PRMSE | 0.04 |
| Theil's Inequality Coefficient 'U' | 0.02 |
| Bias Proportion of 'U' | 0.00 |
| Variance Proportion of 'U' | 0.00 |
| **Out-of-sample Simulation of the Model (upto 2003)** | |
| PRMSE | 0.04 |
| Theil's Inequality Coefficient 'U' | 0.02 |
| Bias Proportion of 'U' | 0.00 |
| Variance Proportion of 'U' | 0.02 |

Note: Values in parentheses indicate p-values
** indicates significance at 5% level

The results in scenarios I and II of Table 5 appear unexpected at a first glance, with negative growth rates for both the world exports and world price of soybean oil. However, a closer look at the projected growth pattern of the exogenous variables, mainly of production/consumption in the major exporting countries and the world production & world price of palm oil, provides the possible explanation for this phenomenon. The average annual growth rate of the projected consumption of soybean oil in the major exporting countries is 5.8% whereas the production is estimated to increase by only -1% and 4% respectively according to the World Bank (2005) and OECD (2006) estimates. The resulting production-consumption gap is likely to manifest in the form of decreased exports in the world market. On the other hand, the world production of palm oil is estimated to increase at a rate of 8% per annum and consequently the world price of palm oil is expected to decline at the rate of 3% per annum. This fall in the world price of palm oil, with a high elasticity of 0.78 in our estimated equation, led to the fall of world soybean oil price witnessed in our results in Table 5.

TABLE 5
MODEL SIMULATIONS –MEDIUM TERM (UPTO 2015)
(Annual growth rates in %)

| Growth Rates | World Price | World Exports |
|---|---|---|
| **Baseline Scenario** | -7.02 | 29.47 |
| **Scenario I** | -2.30 | -3.95 |
| **Scenario II** | -2.49 | -2.61 |

Baseline Scenario - Business-as usual Scenario with historical growth rates
Scenario I - Growth rates from World Bank (World Bank, 2005)
Scenario II - OECD Growth Rates (OECD, 2006)

*Limitations of the model*

a) The model is partial in nature and does not take into account other crop sectors within agriculture or other sectors in the economy. General equilibrium / multi-commodity models may offer an alternate (and possibly more comprehensive) theoretical framework of analysis. Also, panel data methods may provide an alternate framework of estimation.

b) Effects of trade policy instruments like tariffs, quotas and subsidies are not incorporated, mainly because of the non-availability of time-series data in comparable form across countries.

c) Role of futures markets, private intermediaries and other possible price-influencing institutions is not analysed, again mainly because of data constraints.

## 7. CONCLUSIONS AND POLICY IMPLICATIONS

The results of the study indicate that the major determinants of world soybean oil price are the world palm oil price (substitute) and the exports of soybean oil into the world market. The simulation results for the medium term (2015) show a likely decline in the world price of soybean oil, due to increases in world palm oil production and a consequent fall in world palm oil price.

The projected decrease in world soybean oil price has some important implications for India. Given the share of soybean oil in the edible oil production in the country (Table 1), the fall in world price has possible adverse implications for the livelihood security of soybean farmers. This is more so, since the edible oil sector is completely liberalized (except for tariff protection) and no price support measures are in operation for soybean farmers. The soybean farmers are likely to be adversely affected also by the possible increase in palm oil imports. The average world price of palm oil has been lower than that of soybean oil (Table 3) and is projected to decline at a much faster rate due to a rapid increase in world palm oil production. This is likely to lead to a much larger quantum of imports of palm oil into India in future. The lower price of soybean oil combined with the increased imports of palm oil is certain to cause hardship to soybean producers. Since soybean cultivation is carried out mainly in the dry and resource-poor regions of the country, it is important to devise suitable policies to shift these farmers out of soybean cultivation into relatively more remunerative sectors.

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## APPENDIX A

### COMPETITIVE MODEL FOR SOYBEAN OIL – RESULTS

| S.No | Equation / Explanatory Variable | Lagged Exports | Border Price | Exchange Rate | Current Year Production | $\bar{R}^2$ | Sample Period |
|---|---|---|---|---|---|---|---|
| | EXPORTS | | | | | | |
| 1 | ARGENTINA | 0.18 | 0.15 | 0.15 | 0.99 | 0.99 | 1975-2000 |
| | t-value | 1.25 | 2.20* | 2.06** | 6.43* | | |
| 2 | BRAZIL | 0.02 | 0.42 | -0.01 | 1.81 | 0.95 | 1971-2000 |
| | t-value | 0.2 | 1.74** | -1.13 | 8.05* | | |
| 3 | GERMANY | 0.22 | -0.33 | -0.21 | 1.63 | 0.69 | 1965-2000 |
| | t-value | 1.27 | -0.98 | -0.45 | 2.69* | | |
| 4 | NETHERLANDS | 0.35 | 0.25 | 0.38 | 1 | 0.9 | 1965-2000 |
| | t-value | 2.23* | 1.02 | 1.07 | 3.27* | | |
| 5 | US | 0.09 | 0.54 | - | 1.07 | 0.41 | 1965-2000 |
| | t-value | 0.55 | 3.12* | | 4.41* | | |

| S.No | Variable | Lagged Export Price | World Price | $\bar{R}^2$ | Sample Period |
|---|---|---|---|---|---|
| | EXPORT PRICE | | | | |
| 1 | ARGENTINA | 0.85 | 2.73 | 0.99 | 1976-2000 |
| | t-value | 21.85* | 3.37* | | |
| 2 | BRAZIL | -0.25 | 1.32 | 0.99 | 1971-2000 |
| | t-value | -4.82* | 23.84* | | |
| 3 | GERMANY | 0.35 | 0.42 | 0.81 | 1965-2000 |
| | t-value | 3.05* | 5.95* | | |
| 4 | NETHERLANDS | -0.02 | 0.76 | 0.96 | 1966-2000 |
| | t-value | -0.33 | 11.25* | | |
| 5 | US | -0.02 | 0.96 | 0.99 | 1966-2000 |
| | t-value | 0.40 | 23.46* | | |

Appendix A (contd...)

IMPORT PRICE

| S.No | Explanatory Variable | Lagged Import Price | World Price | $\bar{R}^2$ | Sample Period |
|---|---|---|---|---|---|
| 1 | BANGLADESH | 0.73 | 0.48 | 0.90 | 1965-2000 |
| | t-value | 7.38* | 2.73* | | |
| 2 | CHINA | 0.68 | 0.48 | 0.84 | 1965-2000 |
| | t-value | 7.34* | 3.83* | | |
| 3 | EGYPT | 0.68 | 0.86 | 0.92 | 1965-2000 |
| | t-value | 7.15* | 3.73* | | |
| 4 | INDIA | 0.86 | 0.33 | 0.94 | 1965-2000 |
| | t-value | 8.78* | 2.32* | | |
| 5 | IRAN | 0.86 | 0.71 | 0.97 | 1965-2000 |
| | t-value | 11.98* | 3* | | |
| 6 | MOROCCO | 0.04 | 1.19 | 0.98 | 1966-2000 |
| | t-value | 0.65 | 14.50* | | |
| 7 | PAKISTAN | 0.56 | 0.71 | 0.89 | 1965-2000 |
| | t-value | 5.32* | 4.57* | | |
| 8 | PERU | 0.91 | 1.72 | 0.99 | 1966-2000 |
| | t-value | 17.37* | 2.56* | | |
| 9 | VENEZUELA | 0.81 | 0.52 | 0.83 | 1965-2000 |
| | t-value | 6.43* | 0.96 | | |

Appendix A (contd...)

| | IMPORT | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S.No | Explanatory Variable | Lagged Imports | Border Price | Border Price of Substitute (Palm Oil) | Income | Lagged Consumption | Lagged Production | $\bar{R}^2$ | Sample Period |
| 1 | BANGLADESH | -0.11 | -2.44 | 1.65 | 1.56 | 0.27 | - | 0.71 | 1968-2000 |
| | t-value | -0.28 | -1.5*** | 1.26 | 0.71 | 0.73 | - | | |
| 2 | CHINA | 0.17 | 1.52 | -1.57 | 1.90 | 2.37 | -2.95 | 0.68 | 1965-2000 |
| | t-value | 0.68 | 1.22 | -1.06 | 1.73** | 1.29 | -1.78** | | |
| 3 | EGYPT | 0.48 | -3.18 | 3.68 | 5.73 | -0.71 | -1.19 | 0.69 | 1978-2000 |
| | t-value | 1.7*** | -2.32* | 2.18* | 0.80 | -0.70 | -1.34 | | |
| 4 | INDIA | 0.63 | -1.96 | 2.04 | -2.04 | -0.40 | 0.64 | 0.70 | 1965-2000 |
| | t-value | 3.12* | -1.5*** | 3.22* | -0.78 | -1.31 | 2.33* | | |
| 5 | IRAN | -0.20 | -0.14 | - | 0.37 | 0.56 | - | 0.64 | 1974-2000 |
| | t-value | -1.14 | -1.35 | - | 0.60 | 2.19* | - | | |
| 6 | MOROCCO | 0.01 | 0.20 | 0.79 | 2.46 | - | - | 0.70 | 1965-2000 |
| | t-value | 0.04 | 0.27 | 1.12 | 3.84* | - | - | | |
| 7 | PAKISTAN | -0.02 | -0.58 | 1.13 | 0.82 | 1.13 | - | 0.79 | 1965-2000 |
| | t-value | -0.10 | -1.11 | 2.6* | 1.48*** | 4.15* | - | | |
| 8 | PERU | -0.05 | -0.01 | - | -0.76 | 1.20 | - | 0.77 | 1965-2000 |
| | t-value | -0.27 | -0.53 | - | -0.66 | 3.58* | - | | |
| 9 | VENEZUELA | 0.25 | 0.15 | - | 3.05 | 0.92 | -0.21 | 0.53 | 1965-2000 |
| | t-value | 1.10 | 0.40 | - | 1.07 | 1.18 | -0.27 | | |

Note: *, **, *** denote significant at 5%, 10% and 15% level of significance respectively