CHAPTER - III
THE CONCEPTUAL MODEL

Simple economic theory discussed in Chapter II has provided the guidelines about the functioning of the commodity market if price stabilization is introduced. The theoretical implications can be presented in the form of a model so that the structure of the oils and oilseeds market is empirically estimated. The first step, of course, is model specification, which is attempted in section I of the present chapter while the derivation of the various structural relations of the model and their specification is attempted in Section II. The model and the choice of estimation procedure are described in brief in Section III.

I. MODEL SPECIFICATION

A model is a simplified picture of reality and it abstracts from reality certain characteristics in order to focus our attention on the essentials of the phenomenon of interest. The model used for the analysis of oils and oilseeds economy is the one suggested by the theory of pure competition at both the ends and traders'/oil millers' behaviour at the middle, i.e.
at the wholesale level, where price formulation takes place. This model can be considered as a good approximation to reality for most of the initial producers of oilseeds and the final consumers of oils. In the production-consumption chain, these individuals or entities do not appear to be able to affect market prices perceptibly, which is the essential condition of pure competition to hold. To the extent that there are exceptions in the form of large participants in the markets in the middle of the chain in the form of large firms, traders' associations etc., it is assumed that the existence of limit pricing due to possible new entrants, substitutes and Government's indirect measures like actions against illegal traders and the recent emergence of the N.D.D.B.¹ to restructure the oils and oilseeds sector, all these result in approximately competitive behaviour. The desirability of considering such purely competitive model lies in its ability to predict the behaviour of endogenous variables and not because of any normative value associated with this particular market model.

In spite of close approximation of competitive behaviour with reality, a separate price relation is

introduced in the middle of the production-consumption chain where price formulation takes place. This is a behavioural relation for the merchants (traders/oil millers) on the assumption that the merchants have a two-fold economic function of bringing supply and demand into contact and of regulating prices.

An outline of the various components of the model is presented below:

Production:

The production process is characterised as recursive in nature and this involves two behavioural equations and one identity. The first equation represents the area response equation, while the second represents the production of oilseeds explained by acreage and non-acreage factors. The third equation is an identity which gives the domestic supply of oil after applying fixed conversion formula to derive oil from oilseed.

Consumption:

The fourth equation explains the per capita domestic consumption of oil. This is explained by the wholesale price, prices of substitutes/complements, per capita real income and other relevant explanatory variables. Regarding the structural specification for consumption component,
some researchers use price dependent mixed demand functions. For example, Jean-Paul and Johnson, Roy and Johnson, Madhoo Pavaskar, specify quantity dependent demand equations. Jhala specifies price dependent demand function taking quantity of oil consumed as an independent variable which also stands for the price formulation at wholesale level. As Wold and Jureen, rightly pointed out, such inverse demand functions tell nothing about the price mechanism. At best, such equations explain that if demand is known what is the price that would give rise to this demand. In this study, the quantity dependent consumption component is preferred in order to know how consumers react to changes in prices and income.

Wholesale, Farm and Retail Prices:

Preliminary time-series analysis of the farm, wholesale and retail prices showed that the wholesale prices lead both the farm and retail prices. Thus, the price formulation in the model is explained at the wholesale level. This is explained by the fifth equation on the understanding that wholesalers (oil millers/traders) act as regulators of price raising or price lowering depending upon whether the supply falls short or exceeds demand. The farm harvest price relation of oilseeds is specified as the sixth equation, expressing farm harvest prices of oilseeds as a function of the wholesale prices of oil. Another relation (seventh equation) gives retail oil prices as the function of the wholesale prices of oil. Both the equations (sixth and seventh) explain the price variation from wholesale to farm level and wholesale to retail level, respectively. The conceptual working of oils and oilseeds system is shown in Figure 6.

II. THE SPECIFICATION OF STRUCTURAL RELATIONS

The derivations of various structural relations of the model and their specification is attempted in this section.
FIG. 6 OILS AND OILSEEDS SYSTEM

Supply of oils

- Total Demand for oil for various purposes
- Production of oilseeds
- Traders role in bringing the supply and demand into contact
- Weather during growing season
- Fertiliser etc.
- Acreage under oilseeds
- Wholesale prices of oils
- Consumers Income
- Weather during Sowing season
- Relative Farm Prices
- Retail prices of oils

Total Demand for oil for various purposes

Consumers Income

Retail prices of oils

Relative Farm Prices

Weather during Sowing season

Acreage under oilseeds

Wholesale prices of oils

Traders role in bringing the supply and demand into contact

Weather during growing season

Fertiliser etc.

Production of oilseeds

Supply of oils
1. Acreage Response Equation

Farmers face a decision problem while allocating their land to various crops in response to price and non-price factors. The nature of acreage response to price in underdeveloped agriculture has been debated at length in the past. Various hypotheses have been formed. Behrman classified these hypotheses into three groups.

1) The farmers in underdeveloped agriculture respond quickly, normally and efficiently to relative price changes.

2) The marketed production of subsistence farmers is universally related to price and

3) The institutional constraints are so inhibiting that any price response is insignificant.

However, Behrman himself says that these groups are not mutually exclusive. The major proponent of the first hypothesis, namely that farmers respond positively and effectively, are Schultz, Raj Krishna, and Dharm Narain.

According to Schultz, "the doctrine that farmers in poor countries are either indifferent or respond perversely to changes in price .... is patently false and harmful".  

There are other important studies in India which have shown that Indian farmers are responsive to price changes. Most of these studies are based on Nerlovian distributed lag model either in its original form or in its modified form. These studies include Jai Krishna and Rao, Kamala Devi and Rajagopalan, Sheti, Kaul and Sidhu, Venkataramanan and others, Tyagi.

However, it can be postulated that variations in oilseeds acreage are induced by changes in relative prices and non-price variables like yield, rainfall during sowing season, availability of water during summer season, price risk and yield risk etc. More specifically, the purpose is to get acreage response to relative prices, non-price variables and risks arising from price and yield variations in oilseeds.

Farmers find it difficult to make a hundred per cent adjustment while responding to various economic factors or to adjust instantaneously. This indicates that distributed lag model can be used for measuring farmer's response behaviour. In the Nerlovian framework, the long run equilibrium supply $Y^*$ is assumed


to be a linear function of the expected price $P_t^*$,

$$Y_t^* = a + bP_t^* + u_t \quad \ldots \quad (1)$$

The expected price $P_t^*$ is adjusted in each time period by a proportion $\beta$ of the difference between the previous period's actual price $P_{t-1}^*$ and its expected price.

This is described as

$$P_t^* - P_{t-1}^* = \beta (P_{t-1} - P_{t-1}^*), \quad 0 < \beta < 1, \quad \ldots \quad (2)$$

Here $\beta$ is the rate of adjustment associated with price uncertainty and is termed by Nerlove as the "co-efficient of expectations."

In a similar manner, the way in which supply is adjusted towards the long-run equilibrium supply is by

$$Y_t - Y_{t-1} = \gamma (Y_{t-1}^* - Y_{t-1}), \quad 0 < \gamma < 1, \quad \ldots \quad (3)$$

Where $\gamma$ is the co-efficient of adjustment representing the proportion of the adjustment towards equilibrium which occurs in one time period. If there is no price uncertainty, which means $\beta = 1$, then farmers' expected price will be equal to previous year's price $P_{t-1}$ i.e.

$$P_t^* = P_{t-1}$$
Substituting this and value of $Y_t^*$ in equation (3) the reduced form can be shown as:

$$Y_t = A + B \cdot P_{t-1} + CY_{t-1} + V_t \quad \text{.... (4)}$$

Where $A = a \gamma$, $B = b \gamma$, $C = (1 - \gamma)$ and $V_t = \gamma u_t$

This equation (4) is the computational equation. Basically, this form would remain the same even if more independent variables are included. This model helps in the estimation of both the short and long-run supply elasticities.

The ordinary Least Squares (OLS) technique cannot be employed to the above reduced form of the equation because:

1) estimates will be inefficient as the disturbance term in the reduced form is likely to be serially correlated.

ii) estimates will be inconsistent as the equation contains lagged values of the dependent variable

iii) the equation is overidentified.

Hossein Askari and John T. Cummings have suggested Maximum Likelihood method to get asymptotically unbiased, consistent and efficient estimates.
Using Nerlove's adjustment lag model as the basic framework, the acreage response relationship can be estimated with the help of the following equation -

\[ Y_{it} = a_{10} + a_{11}X_{1,t-1} + a_{12}X_{2,t-1} + a_{13}X_{3,t} + a_{14}X_{4,t} + a_{15}X_{5,t-1} + a_{16}X_{6,t-1} + a_{17}Y_{1,t-1} + \epsilon_{it} \] .... (I)

where - \( a_{11}, a_{12}, a_{13}, a_{14}, a_{17} > 0, a_{15}, a_{16} < 0 \) and

\( Y_{1t} = \) area under concerned oilseed in '000' hectares in the year \( t; \)

\( Y_{1,t-1} = \) lagged area of concerned oilseed;

\( X_{1,t-1} = \) lagged relative farm harvest price index of concerned oilseed;

\( X_{2,t-1} = \) lagged yield per hectare of concerned oilseed;

\( X_{3,t} = \) actual average rainfall (in millimetres) during sowing months of concerned oilseed;

\( X_{4,t} = \) percentage of area under irrigation by all crops;

\( X_{5,t-1} = \) price risk measures by ratio of the standard deviation of farm harvest price of concerned oilseed to the standard deviation of farm harvest price index of its competing crops measured over the three preceding years;
$x_{8,t-1}$ = yield risk represented by the standard deviation of yield per hectare of concerned oilseed measured over the three preceding years;

$u_{it}$ = disturbance term.

2. Production behaviour of Oilseeds:

The use of acreage as an approximation to planned output may not be a good procedure. Though acreage under cultivation is not the same thing as the actual output, it is one of the determinants of the actual output. As Nerlove argues, approximation of planned output by acreage is far from being an ideal approximation. In the case of oilseeds, more than 90% of the area under oilseeds depends on the vagaries of monsoon. Once farmers allocate area (land) for oilseeds the production of oilseeds would depend on a number of non-acreage factors like rainfall during growing season, use of fertilizer and pesticides, Government's subsidy programmes and availability of quality (improved) seeds etc. Production of oilseeds also depends significantly on the extent of irrigation for oilseed crops. This is evident from the fact that for the year 1979-80, yield per hectare of groundnut was

846 kg. for kharif (rain-fed) and 1447 kg for rabi (irrigated) in Gujarat State. Thus, the production of oilseeds can be explained by the following equation.

\[ Y_{2t} = a_{20} + a_{21}Y_{1t} + a_{22}X_{7t} + a_{23}X_{8t} + a_{24}X_{9t} + a_{25}T + U_{2t}. \]  

where: \( a_{21}, a_{22}, a_{23}, a_{24}, a_{25} \geq 0 \) and

- \( Y_{2t} \) = production of concerned oilseed in '000' tonnes;
- \( Y_{1t} \) = area under concerned oilseed in '000' tonnes;
- \( X_{7t} \) = actual average rainfall during growing season of concerned oilseed (in millimetres);
- \( X_{8t} \) = fertilizer consumption i.e. the consumption of N.P.K. in '000' tonnes in the year 't';
- \( X_{9t} \) = percentage of irrigated area to total cropped area under oilseeds;
- \( T \) = trend variable, (taking 1952-53 = 0, 1953-54=1, 1954-55= 2, ..., 1978-79 = 27)
- \( U_{2t} \) = disturbance term.

3. Domestic Supply of Oils:

Entire oilseeds output is not consumed directly, only a small portion is used for final consumption. The bulk of oilseeds is crushed to prepare oil and oilcake. The production figures of oilseeds are adjusted for seeds, direct consumption and export of kernels/seeds etc., to
derive the quantum of kernels/seeds available for crushing. The estimate of domestic production of oils is then obtained by applying the average oil recovery rate to the estimated kernels/seeds available for crushing. These adjustments and conversions are presented in the form of the following identity:

\[
Y_{3t} = \frac{\alpha_1}{N} \left( \alpha Y_{2t} - \text{Seeds Purpose - Direct Consumption - Export of Seeds} \right) \quad \text{(III)}
\]

where:

- \( Y_{3t} \) = estimate of domestic supply of oil under question (in kgs), on per capita basis;
- \( Y_{2t} \) = domestic production of oilseed under question (in '000' tonnes);
- \( N \) = estimates of mid year Population.
- \( \alpha_1 \) = average oil recovery rate of concerned oilseed (exogenously determined)
- \( \alpha \) = conversion rate of groundnut in shell into kernels = 0.70 (exogenously determined).

The conversion rate \( \alpha \) is estimated as 0.70 on the basis of information available with Government Publications. This rate is valid for groundnut only, since for other oilseeds such conversion does not take place. For the remaining oilseeds, therefore, the value of \( \alpha \) is taken to be equal to 1.
4. Demand Function:

Demand function represents a functional relationship between quantity demanded of a commodity and price of that commodity for a given time period. The quantities purchased by a consumer are supposed to be optimal quantities, i.e., the quantities determined by maximising his utility function under a budget constraint. Supposing a consumer purchases quantities $x_1, x_2, \ldots, x_n$ from a bundle of goods, then he is supposed to maximise his utility,

$$U = f(x_1, x_2, \ldots, x_n) \quad \ldots \ldots (1)$$

subject to the linear constraint

$$p_1x_1 + p_2x_2 + \ldots + p_nx_n = y \quad \ldots \ldots (2)$$

where $p_1, p_2, \ldots, p_n$ are prices of goods 1, 2, \ldots, n and Y represents his total expenditure or income.

All prices are supposed to be given and the consumer cannot influence them. To find the first order condition for a maximum we form the Lagrangian function

$$L = U - \lambda \left( \sum_{i=1}^{n} p_i x_i - y \right) \quad \ldots \ldots (3)$$

where $\lambda$ is a Lagrangian multiplier. Differentiating $L$ with respect to $x_i$'s and $\lambda$, we get

$$\frac{\partial L}{\partial x_i} = \frac{\partial U}{\partial x_i} - \lambda p_i, i=1,2,\ldots,n \quad \ldots (4)$$

$$\frac{\partial L}{\partial \lambda} = \sum_{i=1}^{n} p_i x_i - y$$
putting all the derivatives equal to zero, we obtain
the \((n+1)\) first order conditions.

\[
\begin{align*}
\frac{\partial u}{\partial x_i} &= \lambda P_i \quad \text{for all } i \\
\sum_{i=1}^{n} P_i x_i &= Y \quad i = 1, \ldots, n
\end{align*}
\] (5)

On the assumption that the conditions for global maximum
are satisfied, system (5) gives us the 'n' optimal values
of \(x_i\) and the equilibrium value of \(\lambda\). The 'n'
equilibrium values of \(x_i\)'s appear as functions of all
prices and income i.e.

\[x_i = f (P_1, P_2, \ldots, P_n, Y) \quad \ldots \quad (6)\]

These functions are the demand functions which describe
the behaviour of the consumer in the market.26

Applied consumption analysis can be undertaken
with the help of two types of data, namely cross section
data and/or time-series data. The cross section data
relate to household budgets showing all expenditures on
consumer goods and services made by individual families.
They relate to one point of time so that prices do not

and Economic Theory. Englewood Cliffs, Prentice-Hall,
have any scope for change. They are supposed to be constant. It is assumed in this mode of analysis that there are no spatial variations in prices. On the other hand, time-series data give information about the numerical values from period to period i.e., at different points of time. With the change in time, prices as well as income vary. Thus in the case of cross-section data, demand function is primarily a function of income and in the case of time series data, demand function is primarily a function of prices.

For estimating demand functions a number of studies have used time-series data. Schultz, Stone, Klein and Rubin and Wold and Jurcaen provide some illustrations of demand analysis based on time-series data. Schultz's book - "The Theory and Measurement of Demand" - is generally considered as the pioneering and monumental work in the field of time-series analysis. It contains studies on demand in the United States for agricultural products, viz., sugar, wheat, cotton and potatoes. The observed relationship between quantities and prices can be identified as demand equation when the demand curve is stable while the supply curve is subject to shifts. Thus, Schultz's estimated relations belong

to demand equations as supply of agricultural products is subject to large variations due to uncertain weather conditions. His two alternative specifications of the demand equation are -

(a) Linear:

\[ X_{it} = a_i + b_iP_{it} + c_it + \epsilon_{it} \]

(b) Log-linear:

\[ X_{it} = A_iP_{it} \exp\left(b_i't\right) + \epsilon_{it} \]

where \( X_{it} \) is the per capita consumption of \( i \)th commodity, \( P_{it} \) is price index of the commodity divided by a general price index and \( 't' \) measures time (\( t=0,1,2... \)). Time trend \( 't' \) catches the influence of all other variables like changing tastes, prices of other commodities, income and change in the population.

Stone\(^{29}\) considered that the use of time trend to catch the influence of all variables, other than the price of the commodity, is not appropriate. He has introduced along with the trend, a number of prices of complementary and substitute goods, and per capita income in his regression equation.

His double logarithmic demand functions are as follows:

\[
\log x_i = \log y_i + r_i \log y_t^* + \sum_{j} B_{ij} \log P_{jt} + \epsilon_t + \varepsilon_{it}
\]

where \( y_t^* \) is ratio of nominal income to a general price index.

As income and prices move together over time, Stone uses the extraneous information to get statistically significant estimates of both \( r_i \)'s and \( B_{ij} \)'s. He replaced \( r_i \) by estimate of income coefficient obtained from surveys on British household budgets. This use of extraneous estimates has been criticised by Kuh and Meyer on the ground that the income elasticities derived from budget studies are simple (total) elasticities while \( r_i \)'s are partial elasticities. Similarly, Wold and Jureen in their Demand Analysis used both time-series and cross-section data to estimate demand for agricultural products. In the absence of proper data on consumption, market statistics i.e. time-series data on quantities bought and sold, prices, income etc., have been used. Thus, national totals which refer to production after making necessary corrections for imports, exports and changes in stocks have been taken as quantities consumed.

The estimation of demand function in the present study also based itself on Wold's market statistics approach to arrive at data on consumption as we have the same difficulty of obtaining direct data on consumption. So the production data have been adjusted for seeds, other purposes, imports and exports to arrive at data on consumption demand since no significant stocks have been maintained in the case of oils and oilseeds.

Thus, using consumer demand theory, by maximising consumer's utility function subject to his total budget constraints, a complete demand equation can be obtained. Due to large number of independent parameters entering these equations, direct estimation of a complete demand system is generally not feasible. This needs reduction in the number of independent parameters. The usual approach is to include only certain variables in the specified relation i.e. to set some of the cross derivatives equal to zero. Thus, economic theory suggests that the demand for a commodity is a function (homogeneous of degree zero) of price of that commodity, prices of all other commodities and of consumer's income. The demand function for commodity $X_i$ is given by

$$X_i = f(P_i, P_j, P_k, T, U)$$

where $P_i$ is the price of $i^{th}$ commodity, $P_j$ and $P_k$ are prices of close substitutes and close complements.
respectively. \( Y \) is consumer's income, \( T \) is trend variable and \( U \) is disturbance term. The latter represents the influence of omitted variables. In the demand function specified presently the prices are relative prices and income is real income to satisfy the homogeneity condition, i.e., the quantities demanded remain unchanged when all prices and income increase or decrease proportionately. To take account of changes in tastes and preferences, a time trend is introduced to represent the effect of continuous unidirectional changes in tastes.

The demand for each of the edible oils may be divided into four categories:

i. Direct demand for food i.e. liquid consumption

ii. Demand for vanaspati preparation

iii. Demand for industrial use in preparation of soap, paints and varnishes

iv. Demand for exports

There have been frequent changes in Government's policy since 1960 regarding the use of edible oils and oilseeds products in vanaspati and other industries. This is reflected in the introduction of various restrictions and quota systems because of short supply of these oils and oilseeds in the country. For instance, in the early 1960's the groundnut oil accounted for over 85
per cent of the total oil output used in the manufacture of vanaspati. Later, to meet the groundnut oil shortage, the industry was supplied with cheaper imported oils like soybean and palm oils from 1965 onwards. Since 1976, the vanaspati industry was required to restrict its usage of groundnut oil to only 25 per cent of its total consumption. Very recently, i.e., from 1977–78 onwards the vanaspati industry has been virtually prohibited from using groundnut oil. The industry was also prohibited from using the indigenous rape/ mustard oils altogether. The use of sesame oil is also fixed at the statutory minimum level of 5 per cent. At present, the bulk of its requirements is met by S.T.C. through the supply of cheaper imported oils. As a result of these measures, even the exports of various oilseeds and their products are exogenously determined. Therefore, the estimation of demand function for these oils for each of the components, such as vanaspati preparation, industrial use and exports is not a fruitful exercise. Hence, it is decided to estimate the per capita total domestic consumption for each of the specified oils under question. This domestic consumption includes edible oil consumed for direct consumption for food, in vanaspati preparation, in soap, paints, varnish industries etc.
Following economic theory, the total domestic demand for specific oil under question is hypothesized as negatively related to the price of that oil and the price of complements and positively related to close substitutes and disposable income. Population, a demand shifter, can be introduced directly as a variable or indirectly by expressing the relevant variables on per capita basis. A trend variable is introduced in the demand equation to represent the shifts in quantity demanded due to changes in non-economic factors such as increasing knowledge about nutritional content of diets and dietary requirements, quality and convenience factors, tastes and preferences.

Thus, per capita total domestic demand for each of the specific oils under question is explained by the following equation -

\[ Y_{4t} = a_{40} + a_{41}Y_{5t} + a_{42}X_{10t} + a_{43}X_{11t} + a_{44}X_{12t} + a_{45}T + U_{4t} \]  (IV)

where \( a_{44}, a_{45} > 0 \), \( a_{41} < 0 \) and

\( Y_{4t} \) = per capita domestic consumption of concerned oil in Kg. in the year 't' (domestic production of concerned oil - exports + imports, divided by mid year population);

\( Y_{5t} \) = real wholesale price index of concerned oil;
\[ X_{10t} = \text{real wholesale price index of related oil} \]
\[ \text{(substitute/complements);} \]
\[ X_{11t} = \text{real wholesale price index of another related oil;} \]
\[ X_{12t} = \text{per capita real income at 1970-71 prices;} \]
\[ T = \text{time-trend variable (taking 1952-53 = 0, 1953-54 = 1, 1954-55 = 2, ... 1978-79 = 27);} \]
\[ U_{4t} = \text{disturbance term.} \]

5. Price Formulation:

The prices of most farm products particularly of oilseeds and oils vary considerably within the season as well as from one season to another as supply varies in response to changes in weather, etc. These fluctuations confuse the farmers and quite often the Government has taken ad-hoc measures to stabilize the prices. But these efforts have been in vain. One possible method is the cost of production approach. For this, Shepherd argues that the cost of production has continued to be a fruitful source of controversy but has not been found adequate or workable as a basis for agricultural prices. He further pleads that under free competition, business

does not start with the cost of production. It starts with what the consumer wants and will pay for.

The realistic and economic basis for setting prices according to Shephered is the supply and demand price. This equilibrium price is based not on dozens of estimates of production but upon supply and demand of related products in the market. This is based upon action of producers, traders/oil millers (distributors) and consumers. In the case of edible oils market, traders'/oil millers' speculative operations are very strong and they make undue profit. Because the traders are few in number with sizeable control on market, they operate under conditions of oligopsony rather than free competition. In such a case there is free enterprise but not free competition.

The behaviour of foodgrain prices in India have been examined by a number of research workers. All of them have come to the conclusion that the demand functions for foodgrain are price inelastic and past upward trends and price fluctuations are largely due to steadily rising demand.

pressure and change in the quantity supplied. Jhala has analysed the price behaviour of edible oils using general equilibrium approach and partial equilibrium approach for the period 1962-69. He has concluded that variation in prices were largely due to excess demand and particularly in 1966, the edible oils prices shot up by 21 per cent, of which as much as 18 per cent was accounted for by demand pull. In the case of edible oil markets, it appears that the domestic production of oil i.e., domestic supply of oil, plays a crucial role in determining as well as stabilizing the prices of edible oils. For instance, within a fortnight in the month of October 1981, the price of groundnut oil tumbled to 1.20/- from 1.30/- per 16 kg tin. This fall in price is not associated with any sudden decrease in demand or shift in consumer's preferences from consumption of groundnut oil to other edible oils. In fact, this fall in price is due to the fact that new groundnut crop started appearing in the markets in greater quantities during this period. Even in case of off season when supply was short, the Government's decision to import edible oil made sufficient impact on edible oil prices in the market. It happened in the case of sugar when the Government made available

sufficient quantity of imported sugar to the market during September 1981 and thus the prices of sugar remained stable even during the Dasara and Diwali festival season when there was great demand for sugar.

Following Herman Wold\textsuperscript{35} who argues that although it is possible to determine the market price by equating supply and demand, a more penetrating exploration of price formation requires formulation of an explicit price strategy and a separate price equation. The changes in edible oil prices are mostly explained by the likely changes in the supply over the previous year's demand. If the change is positive then there will be a downward pressure on the edible oil prices. If the change is negative, then there will be an upward pressure on the edible oil prices.

This kind of price mechanism is a behaviour relation for the merchants (traders/oil millers), on the assumption that the merchants have a two-fold economic function of bringing supply and demand into contact and of regulating prices. This price formulation is explained at the wholesale level since the wholesale prices lead both the farm and the retail prices.

The price level desired to be brought about by traders/oil millers in any period is determined as a linear function of the likely difference between the quantity supplied in any period and the quantity demanded in the previous period i.e.

\[ P_t^* = a_0 + a_1 (S_t - D_{t-1}) + U_t \quad \ldots \ldots \quad (1) \]

where:
- \( P_t^* \) = wholesale price of concerned oil intended to be set by traders in the year 't'
- \( S_t \) = supply of concerned oil to traders/oil millers in the year 't'
- \( D_{t-1} \) = demand for concerned oil in the year t-1

It is assumed that given the level of difference between domestic supply in any period (\( S_t \)) and domestic demand in its previous period (\( D_{t-1} \)), traders/oil millers tend to determine prices with negligible error in line with supply relation basing their approximation on the belief that the consumer demand in the current period would be the same as during the previous period.

The actual change brought about in the price level however, is only a partial realization of the desired change. This may happen because of the structural difficulties, imperfect market conditions and other
factors outside the control of traders. Thus, the partial
adjustment mechanism towards desired changes can be
expressed in a linear form as follows:

\[ P_t - P_{t-1} = \lambda (P^*_t - P_{t-1}) \quad \ldots \ldots \quad (2) \]

or

\[ P^*_t = \lambda P_t + (1-\lambda) P_{t-1} \quad \text{where} \quad \lambda' = \frac{1}{\lambda} \]

Here \( \lambda \) measures the magnitude of adjustment that could
be made by traders. Generally \( \lambda \) can be expected to
very between zero and unity. If \( \lambda = 1 \), traders have
realised their desired level of price and if \( \lambda = 0 \),
no change in the prices over the previous level. However,
various policy measures taken by the Government at times
of continuous rise in prices, prevent traders/oil
millers from realising the desired increase in the price
level. This requires \( \lambda \) to be less than unity.

The above equations (1) and (2) can be reduced to
a single equation in terms of observable variables in the
following form

\[ P_t = a_0 + a_1 (S_t - D_{t-1}) + a_2 P_{t-1} \quad \ldots \ldots \quad (3) \]

where \( a_2 = 1 - \lambda \).

In the actual working out of the model, \( D_{t-1} \) is considered
as gross availability of concerned oil to the consumers in
the previous year. The price equation, therefore, is expressed in the following form along with other explanatory variables:

\[
Y_{5t} = a_50 + a_51 (Y_{3t} - Y_{4,t-1}) + a_52 X_{12t} + a_53 X_{13t} + a_54 Y_{5,t-1} + a_55 X_{14t} + U_{5t} \quad \cdots \cdots \quad (V)
\]

Where \(a_{52}, a_{54}, a_{55} > 0\), \(a_{51}, a_{53} < 0\) and:

- \(Y_{5t}\) = real wholesale price index of concerned oil in the year 't';
- \(Y_{3t}\) = per capita domestic supply of concerned oil (in kgs.) in the year 't';
- \(Y_{4,t-1}\) = per capita domestic consumption of concerned oil (in kgs.) in the year (t-1);
- \(X_{12t}\) = per capita income at 1970-71 prices;
- \(X_{13t}\) = quantity of palm and soybean oils imported in the country (in '000' tonnes);
- \(X_{14t}\) = dummy variable representing the number of traders/oil millers involved in illegal activities like hoarding, speculation, daba-trading etc. takes the value:
  - 1 if there are large number of traders/oil millers are involved;
  - 0 otherwise;

* Equation (V) is also tried alternatively by including \(Y_{3t}, Y_{4,t-1}\) separately in the equation.
The coefficients of this equation show the short term effect on price level. The equilibrium price or long term effect of the variables on the price level can be obtained by equating $Y_{5,t-1}$ to $Y_{5,t}$ or dividing the coefficients of the right hand side variables (other than $Y_{5,t-1}$) by the difference between the coefficient of $Y_{5,t-1}$ and unity. The importance of this relation, however, rests on the fact that (i) it gives an idea of the probable levels of each of these oil prices that can in general be obtained under various hypotheses about the level of major factors that are influencing them and (ii) in turn, given the magnitude of future price line, say at certain level, the changes that may be required in the influencing factors to bring about the desired price level can be estimated.

6. Farm Prices and Retail Prices:

Since farm prices and retail prices are made to depend on wholesale prices, the price variation aspect is studied firstly at farm-wholesale level and secondly at retail-wholesale level. Thus, the equations explaining the prices at farm and retail levels in terms of wholesale prices are as follows:
Farm prices of oilseed:

\[ Y_{6t} = a_{60} + a_{61}Y_{5t} + U_{6t} \quad \ldots \quad (VI) \]

where \( a_{61} > 0 \) and

\( Y_{6t} \) = real farm harvest price index of concerned oilseed;

\( Y_{5t} \) = real wholesale price index of concerned oil;

\( U_{6t} \) = disturbance term.

Retail prices of oil:

\[ Y_{7t} = a_{70} + a_{71}Y_{5t} + U_{7t} \quad \ldots \quad (VII) \]

where \( a_{71} > 0 \) and

\( Y_{7t} \) = real retail price index of concerned oil;

\( Y_{5t} \) = real wholesale price index of concerned oil;

\( U_{7t} \) = disturbance term.

III. THE MODEL IN NUTSHELL AND ESTIMATION PROCEDURE

The equations of the model discussed so far are put together in a nutshell (in functional form) along with the expected direction of influences of explanatory variables over the dependent variables as under:

Equations of the Model:

I. Acreage Response (supply) Relation for concerned oilseed

\[ Y_{1t} = F(X_{1,t-1}, X_{2,t-1}, X_{3,t}, X_{4,t}, X_{5,t-1}, X_{6,t-1}, Y_{1,t-1}) \]
II. Domestic Production of concerned oilseed

\[ Y_{2t} = F(Y_{1t}, X_{7t}, X_{8t}, X_{9t}, T) \]

III. Domestic Supply of concerned oil (Identity)

\[ Y_{3t} = \frac{\alpha}{N} \left[ Y_{2t} - \text{Seeds Purpose - Direct Purpose - Export of seeds} \right] \]

IV. Demand for concerned oil

\[ Y_{4t} = F(Y_{5t}, X_{10t}, X_{11t}, X_{12t}, T) \]

V. Price Formulation or Market Clearance Equation of concerned oil *

\[ Y_{5t} = F \left[ (Y_{3t}, Y_{4,t-1})/ \text{or } Y_{3t}, Y_{4,t-1}, X_{12t}, X_{13t}, X_{14t}, Y_{5,t-1} \right] \]

VI. Farm Price Relation with Concerned Wholesale Price of oil.

\[ Y_{6t} = F(Y_{5t}) \]

VII. Retail Price Relation with Concerned Wholesale Price of oil.

\[ Y_{7t} = F(Y_{5t}) \]

All the behavioural relations of the model involve additive disturbance terms.

* In the case of Castor oil, variables like exports, and population have also been tried.
Variables of Model

I. **Endogenous Variables**

1. \( Y_{1t} \) = Area under concerned oilseed (in '000 hectares)
2. \( Y_{2t} \) = Production of concerned oilseed (in '000 tonnes)
3. \( Y_{3t} \) = Per capita domestic supply of concerned oil (in Kg.)
4. \( Y_{4t} \) = Per Capita domestic consumption \((Y_{3t} - \text{Exports + Imports of oil})\) of concerned oil (in Kg.)
5. \( Y_{5t} \) = Real wholesale price index of concerned oil based to 1970-71 = 100
6. \( Y_{6t} \) = Real farm harvest price index of concerned oilseed based to 1970-71 = 100
7. \( Y_{7t} \) = Real retail price index of concerned oil based to 1970-71 = 100.

II. **Exogenous Variables**

1. \( X_{1,t-1} \) = Relative lagged farm harvest price index of concerned oilseed based to 1970-71=100
2. \( X_{2,t-1} \) = Lagged yield per hectare of concerned oilseed (in kg.)
3. \( X_{3t} \) = Average rainfall during sowing months of concerned oilseed (in millimeters)
4. \( X_{4t} \) = Percentage of area under irrigation by all crops
5. $X_{5,t-1}$ = Price risk measured by ratio of standard deviation of farm harvest price of concerned oilseed to the standard deviation of farm harvest price of competing crops measured over past three years.

6. $X_{6,t-1}$ = Yield risk represented by standard deviation of yield per hectare of concerned oilseed measured over past three years.

7. $X_{7t}$ = Average rainfall during growing season of concerned oilseed (in millimetres).

8. $X_{8t}$ = Fertilizer consumption in India i.e. consumption of N.P.K. (in '000' tonnes).

9. $X_{9t}$ = Percentage of area irrigated area to the total cropped area under oilseeds.

10. $X_{10t}$ = Real wholesale price index of related (substitute/complement) oil.

11. $X_{11t}$ = Real wholesale price index of another related oil.

12. $X_{12t}$ = Per capita real income at 1970-71 prices.

13. $X_{13t}$ = Quantity of Palm & Soybean oil imported in the country (in '000' tonnes).

14. $X_{14t}$ = Dummy variable representing the number of traders/oil millers involved in illegal activities like hoarding, speculation, ābā trading etc.
= 1 if there are large number of traders/oil million are involved.
= 0 otherwise.

15. \( T \) = Trend variable taking values 1952-53 = 0, 1953-54 = 1, 1954-55 = 2, ..., 1978-79 = 27.

16. \( N \) = Estimate of mid-year population.

17. \( Ex \) = Exports of Castor oil in (000' tonnes)

III. Parameters

\( \alpha \) = Conversion rate of groundnut in shell into kernels (seeds) which is equal to 0.70.
(Exogenously determined)

\( \alpha_1 \) = The average oil recovery rate of concerned oilseeds. (Exogenously determined)

The following table describes the expected direction of influences of explanatory variables over the dependent variables in the behavioural equations of the model:

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Hypothesized Explanatory Variables with Positive Influence</th>
<th>Hypothesized explanatory Variables with Negative Influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Y_{1t} )</td>
<td>( X_{1t-1}, X_{2t-1}, X_{3t-1}, X_{4t}, Y_{1t-1} )</td>
<td>( X_{5t-1}, X_{6t-1} )</td>
</tr>
<tr>
<td>( Y_{2t} )</td>
<td>( Y_{1t}, X_{7t}, X_{8t}, X_{9t}, T )</td>
<td>----</td>
</tr>
<tr>
<td>( Y_{4t} )</td>
<td>( X_{10t}, X_{11t}, X_{12t}, T )</td>
<td>( Y_{5t} )</td>
</tr>
<tr>
<td>( Y_{5t} )</td>
<td>( X_{12t}, X_{14t}, X_{4t}, Y_{5t-1}, Y_{5t-1} )</td>
<td>( X_{13t}, Y_{3t}, (Y_{3t}, Y_{4t}, t-1) )</td>
</tr>
<tr>
<td>( Y_{6t} )</td>
<td>( Y_{5t} )</td>
<td>----</td>
</tr>
<tr>
<td>( Y_{7t} )</td>
<td>( Y_{5t} )</td>
<td>----</td>
</tr>
</tbody>
</table>

1. Identity relation for \( Y_{3t} \) is not included in the table.

*\( x_{11t} \) and \( x_{11t} \) denote price of related goods. The positive influence is hypothesized if these are substitutes. However, if these happen to be complementary goods, the negative influence will be observed.
The model presented in this section describes the various relations of the oils and oilseeds economy of India. Since the model is of recursive type, the problem of identifying the structural relations does not arise. The relations of the model can be estimated sequentially by using Simple Classical Linear Regression Model and consistent and unbiased estimators may be obtained. But there is some serious and well known difficulty of finding an appropriate estimation procedure in estimating equations (I) and (V) of the model. Equation (I) is the reduced form equation of the area adjustment equation where the lagged acreage \( Y_{1,t-1} \) appears on the right hand side of the equation. Equation (V) is the reduced form equation of the price adjustment equation where lagged price \( Y_{5,t-1} \) appears on the right hand side of the equation. This causes the estimation problem of getting consistent estimators due to the possible correlation between the disturbance and the lagged endogenous variable.

The difficulty of the appropriate estimation procedure varies considerably with different assumptions about the disturbance term in the reduced form equations (I) and (V). If statistically consistent and unbiased estimators of the parameters in equations (I) and (V) are to be obtained by using Classical Linear Regression Model,
the residuals $U_{it}$'s and $U_{5t}$'s must be independent in the respective equations i.e. $U_{it}$'s are not serially correlated and so also are $U_{5t}$'s. It is this difficulty that forced Nerlove and most users of Nerlovian adjustment model (Rao, Jai Krishna, Tyagi etc.) to make the following set of assumptions about the reduced form disturbances terms $U_t$'s. They are: $U_t$ is distributed with zero mean, diagonal variance covariance matrix with a constant own variance and that this disturbance term and the contemporaneous elements of $Y_{it}$ matrix ($Y_{5t}$) are distributed independently.

In most studies the 'Durbin–Watson' test has been applied to test serial correlation. However, the Durbin–Watson test is inappropriate in those situations when lagged endogenous variables are presented on the right hand side of the equation. The serial correlation is therefore tested in the equations (I) and (V) through 'h' statistics. Since 'h' statistics in equations (I) and (V) revealed insignificance of serial correlation in the disturbance terms, the use of classical Linear Regression Model incorporating the above stated assumptions yielded satisfactory results. The relations of the model are tried in linear and log-linear forms based on annual

time-series observations covering the period 1952-53 to 1978-79. As time series data on retail prices are available only from 1963 onwards, it is decided to study the price variation aspect from 1963 onwards. The study covers the important oilseeds grown in India namely Groundnut, Rape/ Mustard, Sesamum, Linseed, Castorseed and Cottonseed. *

* For cottonseed, acreage response and production behaviour of cotton are analysed and remaining relations are not analysed for the reasons mentioned elsewhere in the study (Chapter IV).