COWLES COMMISSION DISCUSSION PAPER: ECONOMICS: NO. 252

Inventory Fluctuations in Flaxseed and Linseed Oil

by S. G. Allen

1. The Choice of Subject

Many conditions, economic and noneconomic, are so particularized to individual industries that the relation between aggregate stocks and outputs is a highly variable one. Thus in a recent paper[1/] Abramovitz suggests that our general understanding of the role of inventories in business cycles will profit most by thorough study of the behavior of inventories in individual industries. On following this suggestion, I desired to study a homogenous commodity of highly specialized use, one whose behavior in stocks depends on economic relations which can be specified in a reasonably simple model. Yet it was desired that the production, consumption, and stocks of the commodity be highly dependent on the general trend in business activity in order that the broader interest in the role of inventories in business cycles be preserved.

The choice of linseed oil promises to present many interesting problems of inventory behavior for empirical study, e.g., the relations among linseed oil stocks, the activity of the linseed oil consuming industries, and fluctuations in building activity, the relation between stocks of linseed oil and those of the basic raw material, flaxseed, which is seasonably produced.

2. Brief Summary of Information of the Interwar Period

2.1 From a technical point of view, flaxseed and flax fiber are not joint products of the flax plant. Generally a different variety of flax

---

1/ Moses Abramovitz: The Role of Inventories in Business Cycles, New York, 1948.

is grown for fiber than that grown for seed. The large flax-producing countries which are important in the international trade of flaxseed are Argentina, the United States, India, and Canada, all of which grow flax primarily for the seed. Among the latter, only the U.S. is an important importer of seed—typically importing about half of domestic seed consumption. 85% to 95% of such imports have been furnished by Argentina, and total U.S. imports constitute about 20% of the flaxseed traded in the world market. Following the U.S. in order of importance as importers are the Netherlands, Germany, the United Kingdom, France, and Belgium, who depend chiefly on India and Argentina for seed supplies. All the large importers consume flaxseed in the production of linseed oil.

2.2 About 95% of domestic seed is grown in the North Central United States. In this region flaxseed competes most strongly with spring wheat for the farmers' acreage at planting time. Domestic as well as Canadian flaxseed is planted in the spring, harvested in late July or August, and the bulk of it marketed before the end of the calendar year. The Minneapolis Grain Exchange is the leading pricing agency of domestic seed. Because of the tariff on flaxseed and relatively inexpensive Lake shipment, Canadian exports of seed usually move toward consumers in the Cleveland and Buffalo areas rather than toward the Minneapolis area, i.e., the area of domestic supply. Imports from a New Argentine seed crop do not become available to U.S. consumers until after the first of the calendar year. Large-scale purchases of Argentine seed are usually made directly on the Buenos Aires exchange for U.S. consumers by their brokers. The bulk of this seed is then shipped directly to the plants of the consumers.

The Minneapolis price of seed and the Buenos Aires price, i.e., that of the chief supplier of imports, vary within a surprisingly small range of each other, typically much less than the amount of the tariff plus the cost of ocean shipment to the U.S. East Coast linseed oil plants, which consume Argentine seed most advantageously, obtain a drawback on the tariff when exporting products produced from imported seed. Since these plants export large quantities of linseed cake, the by-product of crushing the seed for its oil, to Europe, the cost of using imported seed is effectively reduced to them. Furthermore, the typical firms of the linseed oil industry (or the "crushing" industry as it is called) have plants at each source of seed supply. When the Minneapolis price of seed tends to be high relative to the cost of imported seed and the distribution costs of seed products, crushing operations can be shifted to plants at an import supply source, thereby weakening the Minneapolis price. On the other hand, U.S. seed production has never been large enough to render the tariff prohibitive to imports. Thus, in a general way, plants in the Minneapolis area consume domestic seed, East Coast plants consume Argentine seed, and plants in the Buffalo area consume domestic, Canadian, or Argentine seed with the prices of all three tending to parity here.

2.3 At the crushing plant, raw linseed oil is expressed from flaxseed according to a fairly rigidly prescribed technique. The oil is collected from seed crushed under hydraulic presses while the remainder of the "crush" is left in the form of cake. This technique secures all but about 6% of the oil content of the seed. The cake is most extensively used as a livestock feed, and its quality as such is not dependent on its oil content. The raw oil may be boiled or further refined to many specifications although there is a substantial market for the raw oil itself.

The crushing operations require both heavy equipment and highly skilled labor. The labor and equipment can also be used in the production of certain other vegetable oils, e.g., castor, cocoanut, and soybean oils. However, the most extensive crushing operations of the small number of firms which dominate the linseed oil industry have been in the production of linseed oil The other oils which might be considered competitors in production with linseed oil have fairly distinct uses from linseed oil in consumption.

2.4 The so-called drying-oils industries, i.e., the paint and varnish, linoleum, oil-cloth, and printing inks industries, account for over 95% of linseed oil consumption. Oils next in importance to linseed oil as drying oils are perilla and tung oils, which are not produced domestically.

Although these latter oils have specialized uses in the drying-oils industries, particularly in paint and varnish manufacture, it may be well to consider them as strong competitors in consumption with linseed oil, for they have displaced linseed oil in total drying oil consumption to some extent as their prices relative to that of linseed oil have declined.

Large-scale users of linseed oil, i.e., the paint and varnish and linoleum and oil-cloth industries contract directly with the crushers for deliveries over a three- to six-month period for a price set at the time of contracting. Approximately 90% of linseed oil sales are handled in this manner.

The price of linseed cake is tied very closely to feed material prices, even for large fluctuations in the output of linseed cake: domestically all forms of oil cake constitute less than 5% of all livestock feed materials; abroad U.S. linseed cake must compete with all other feed materials as well as the linseed cake produced by the large European linseed oil industry.

3. The Construction of a Model

We wish to devise a model suitable for use with aggregate, quarterly data for the Interwar Period. The equations of primary interest in such a model are the demand equations for flaxseed and linseed oil carryover in the U.S. We are not concerned with separating these demands into demands by particular groups of firms. Nor are we concerned with separating demands for flaxseed and linseed oil in the U.S. into demands for the domestically produced and for the imported commodities. Our interest is rather in specifying consumption equations and carryover demand equations for these commodities; and as far as the firms which determine U.S. consumption and carryover of these commodities are concerned, the domestically produced and imported commodities are homogeneous. Thus for our purpose it does not appear essential to inquire into the adjustment process by which domestic and foreign prices of a commodity are brought into an equilibrium relationship. We shall presuppose that the average domestic and foreign prices over time satisfy such a relationship (an average relationship over time) and that we may use as the price variable in the equations of our model the average price in the U.S. of the commodity.

As an illustration of our point, suppose the following equations represent the demand and supply of a commodity:

(1) $S_d = f_1(p_d)$ = behavior of domestic suppliers, excluding "importers."

(2) $D_d = f_2(p_d)$ = behavior of domestic demanders.

(3) $I = f_3(p_d, p_f, X)$ = behavior of importers.

(4) $S_f = f_4(p_f)$ = behavior of foreign suppliers.

(5) $D_f = f_5(p_f)$ = behavior of foreign demanders.

where p_d and p_f are domestic and foreign prices, respectively, and where X is a complex of tariffs, freight rates, currency exchange rates, etc.

Then if we assume:

(6) $D_f + I - S_f = 0$ (equilibrium in the foreign market),

we obtain a solution from the system (3) - (6),

$$p_f = p_f(p_d, X)$$

and then consider the new system composed of (1), (2),

(3') $I = h(p_d, X)$

and

(7) $D_d - I - S_d = 0.$

The latter system is the type we shall use in our model.

First we shall inquire into the nature of the variables entering the decision equations of a firm with regard to consumption of raw materials and carry over of raw materials and products under particular assumptions.

3.1 Let us suppose that at the beginning of a time period (t, τ), where t = year and τ = period within the year, an entrepreneur has complete knowledge of the demand and supply conditions in his product and raw material markets, and suppose further that these conditions remain stable for the duration of this period. He can only anticipate market conditions in periods beyond (t, τ), and the entrepreneur must make decisions about his operations during the present period in view of his anticipations about market conditions in the next period. Omitting the time-script t, let

$$U_\tau = U(c_\tau, \tilde{w}_\tau)$$

be his preference function for his withdrawals of cash c_τ from the firm and for anticipated change in the value of the firm's assets $\tilde{w}_\tau$ during the period τ. ($\tilde{w}_\tau$ might be viewed as potential future withdrawals.) To insure an uncomplicated symbolism in the following, we exclude borrowing and lending by the firm; otherwise $\tilde{w}_\tau$ should be anticipated change in the firm's net worth.

The following symbols are row vectors whose components are defined:

(1) $X_\tau = (X_{1\tau}, \dots, X_{m\tau})$, stocks of m raw materials used by the firm as of the beginning of τ.

(2) $Y_\tau = (Y_{1\tau}, \dots, Y_{n\tau})$, stocks of the firm's n products at the beginning of τ. (For a non-storable raw material or product: $X_{i\tau}, Y_{j\tau} = 0$.)

(3) $x_\tau = (x_{1\tau}, \dots, x_{m\tau})$, purchases of raw materials during τ.

(4) $x_\tau^{(j)} = (x_{1\tau}^{(j)}, \dots, x_{m\tau}^{(j)})$, consumption of raw materials in the production of the j-th product during τ.

(5) $x_\tau^* = \sum_j x_\tau^{(j)}$, consumption of raw materials.

(6) $y_\tau = (y_{1\tau}, \dots, y_{n\tau})$, sales of products during τ.

(7) $y_\tau^* = (y_{1\tau}^*, \dots, y_{n\tau}^*)$, production during τ.

(8) $X_{\tau+1} = X_\tau + x_\tau - x_\tau^*$, stocks carried over into period $\tau + 1$.

(9) $Y_{\tau+1} = Y_\tau - y_\tau + y_\tau^*$, stocks carried over into period $\tau + 1$.

(10) $p_\tau = (p_{1\tau}, \dots, p_{m\tau})$, current raw material prices.

(11) $q_\tau = (q_{1\tau}, \ldots, q_{n\tau})$, current product prices.

(12) $S_\tau^{(i)} = (\ldots, S_{k\tau}^{(i)}, \ldots)$, factors external to the firm affecting current market supply of the i-th raw material. $i = 1, \ldots, m$.

(13) $D_\tau^{(j)} = (\ldots, D_\tau^{(j)}, \ldots)$, factors affecting current market demand for the j-th product. $j = 1, \ldots, n$. (We assume the $S_\tau^{(i)}$, $D_\tau^{(j)}$ to be independent of the $x_{i\tau}$, $y_{j\tau}$, respectively.)

(14) $r_\tau = (r_{1\tau}, \ldots, r_{m\tau})$, raw material storage costs for the period.

(15) $s_\tau = (s_{1\tau}, \ldots, s_{n\tau})$, product storage costs. (We assume storage costs are regarded as given to the firm.)

We have assumed the entrepreneur's knowledge of the supply and demand relations:

(16) $p_{i\tau} = p_{i\tau}(x_{i\tau}, S_\tau^{(i)})$. $i = 1, \ldots, m$,

(17) $q_{j\tau} = q_{j\tau}(y_{j\tau}, D_\tau^{(j)})$ $j = 1, \ldots, n$,

and we shall further assume independence of the commodities.

Let us also suppose that he forecasts future raw material prices by inserting in forecasting, i.e., regression, equations (computed using time series of p_i and $S^{(i)}$ as sample data), i.e.,

(18) $\tilde{p}_{i,\tau+1} = \tilde{p}_{i,\tau+1}(p_{i\tau}, S_\tau^{(i)})$ $i = 1, \ldots, m$,

present values $p_{i\tau}$, $S_\tau^{(i)}$. It may be that a particular component of $S_\tau^{(i)}$ will be regarded as having different influence in the market for different τ during t, i.e.,

$$S_\tau^{(i)} = (\ldots, \delta_{\tau\tau'} S_{k\tau}^{(i)}, \ldots, \delta_{\tau\tau''} S_{k\tau}^{(i)}, \ldots, \delta_{\tau\tau'} S_{r\tau}^{(i)}, \ldots),$$

where $\delta_{\tau\tau'}$ is the Kronecker symbol.

If the entrepreneur is a monopsonist with respect to the i-th raw material, he must be aware that his choice of $x_{i\tau}$ affects not only $p_{i\tau}$ but $p_{i,\tau+1}$. We assume he estimates the effect of his present choice by means of (16) and (18).

Analogous considerations apply to the

$$(19)\quad \tilde{q}_{j,\tau+1} = \tilde{q}_{j,\tau+1}(q_{j\tau},\ D_{\tau}^{(j)}) \qquad j = 1, \ldots, n.$$

The following scalars are defined:

(20) C_{τ}, stock of cash at the beginning of τ.

(21) $W_{\tau} = X_{\tau} p'_{\tau} + Y_{\tau} q'_{\tau} + C_{\tau}$, value of assets at the beginning of τ.

$$(22)\quad C_{\tau+1} = C_{\tau} - c_{\tau} + y_{\tau} q'_{\tau} - x_{\tau} p'_{\tau} - Y_{\tau+1} s'_{\tau} - X_{\tau+1} r'_{\tau},$$

~~anticipated~~ actual stock of cash at the beginning of $\tau + 1$.

(23) $\tilde{W}_{\tau+1} = X_{\tau+1} \tilde{p}'_{\tau+1} + Y_{\tau+1} \tilde{q}'_{\tau+1} + C_{\tau+1}$, anticipated value of $W_{\tau+1}$.

$$(24)\quad \tilde{w}_{\tau} = \tilde{W}_{\tau+1} - W_{\tau}.$$

Restraints upon his decisions in addition to the definitions in the preceding and to (16)-(19) are the following:

$$(25)\quad F\left\{y^{*}_{\tau},\ (x_{\tau}^{(j)})_{1}^{m}\right\} = 0,$$

$$(26)\quad (X_{\tau},\ X_{\tau+1},\ Y_{\tau},\ Y_{\tau+1},\ C_{\tau},\ C_{\tau+1}) \geqq 0.$$

We shall assume that the entrepreneur chooses x^{*}_{τ}, $X_{\tau+1}$, y^{*}_{τ}, $Y_{\tau+1}$, $C_{\tau+1}$ so as to maximize U_{τ} subject to the restraints. We shall call in particular the solutions

$$(27)\quad x^{*}_{i\tau} = x^{*}_{i\tau}\left\{p_{\tau},\ q_{\tau},\ r_{\tau},\ s_{\tau},\ X_{\tau},\ Y_{\tau},\ C_{\tau},\ (S_{\tau}^{(i)})_{1}^{m},\ (D_{\tau}^{(j)})_{1}^{n}\right\}$$

the consumption decision, or "demand" for consumption, for the i-th raw material,

$$(28)\quad X_{i,\tau+1} = X_{i,\tau+1}\left\{p_{\tau},\ q_{\tau},\ r_{\tau},\ s_{\tau},\ X_{\tau},\ Y_{\tau},\ C_{\tau},\ (S_{\tau}^{(i)})_{1}^{m},\ (D_{\tau}^{(j)})_{1}^{n}\right\}$$

and

$$(29)\quad Y_{j,\tau+1} = Y_{j,\tau+1}\left\{p_\tau,\ q_\tau,\ r_\tau,\ s_\tau,\ X_\tau,\ Y_\tau,\ C_\tau,\ (S_\tau^{(i)})_1^m,\ (D_\tau^{(j)})_1^n\right\}$$

the carryover decisions, or demands for carryover, for the i-th raw material and j-th product, respectively. If the firm is a monopolist in a product market or monopsonist in a raw material market, the corresponding $q_{j\tau}$ and $p_{i\tau}$ will not appear in (27)-(29), having been solved out in the decision-making process.

Assuming no price discriminations among firms, aggregation of (27) is direct: we aggregate only over the set of N firms who consume the i-th raw material, viz.:

$$(27')\quad \underline{x^*_{i\tau}} \equiv \sum_{\alpha=1}^{N} x^{*\alpha}_{i\tau}$$

$$\equiv \underline{x^*_{i\tau}}\left\{p_\tau,\ q_\tau,\ r_\tau,\ s_\tau,\ (X_\tau^\alpha)_1^N,\ (Y_\tau^\alpha)_1^N,\ (S_\tau^{(i)})_1^{m'},\ (D_\tau^{(j)})_1^{n'}\right\},$$

the aggregate demand for consumption of the i-th raw material,

where α designates a particular firm and where vectors appearing in (27') are of such dimension that we may include all relevant firms in the aggregation.

Writing $Z^\alpha_{g,\tau+1}$ as the carryover demanded by the α-th firm for the g-th commodity and aggregating over all firms who produce or consume it, we have the aggregate demand for carryover of the g-th commodity

$$(28')\quad \underline{Z_{g,\tau+1}} \equiv \sum_{\alpha=1}^{N'} Z^\alpha_{g,\tau+1}$$

$$\equiv \underline{Z_{g,\tau+1}}\left\{p_\tau,\ q_\tau,\ r_\tau,\ s_\tau,\ (X_\tau^\alpha)_1^{N'},\ (Y_\tau^\alpha)_1^{N'},\ (S_\tau^{(i)})_1^{m''},\ (D_\tau^{(j)})_1^{n''}\right\}.$$

(There is duplication of variables in the specification of (28') due to the fact that a particular commodity may be both a raw material for some of the firms over which we have aggregated and a final product of others.)

3.2 The following is an equation system proposed for the model:

3.2.1 Non-farm carry-over and consumption decisions

$$(30)\quad H_s(t, \tau+1) = f_1\{P_s(t,\tau), P_L(t,\tau), P_T(t,\tau), P_p(t,\tau), P_o(t,\tau), P_c(t,\tau), R_s(t,\tau), w(t,\tau), i(t,\tau), B(t,\tau), B_F(t,\tau), H_s(t,\tau), H_s^A(t,\tau), H_L(t,\tau), H_T(t,\tau), H_p(t,\tau), \delta_{\tau 2}A_s(t,1), \delta_{\tau 2}Z(t,1), \delta_{\tau 3}\left[A_s(t,1) - \bar{A}_s(t,2)\right], \delta_{\tau 3}Z(t,1), \delta_{\tau 3}Z(t,2), \delta_{\tau 4}S(t,3), \delta_{\tau 4}A_s^A(t,3), \delta_{\tau 1}S^A(t-1,4)\} + U_1(t,\tau)$$

$$(31)\quad C_s(t,\tau) = f_2\{\text{same as in } f_1\} + U_2(t,\tau)$$

$$(32)\quad H_L(t,\tau+1) = f_3\{\text{same as in } f_1\} + U_3(t,\tau)$$

$$(33)\quad C_L(t,\tau) = f_4\{\text{same as in } f_1\} + U_4(t,\tau)$$

$$(34)\quad H_T(t,\tau+1) = f_5\{\text{same as in } f_1\} + U_5(t,\tau)$$

$$(35)\quad C_T(t,\tau) = f_6\{\text{same as in } f_1\} + U_6(t,\tau)$$

$$(36)\quad H_p(t,\tau+1) = f_7\{\text{same as in } f_1\} + U_7(t,\tau)$$

$$(37)\quad C_p(t,\tau) = f_8\{\text{same as in } f_1\} + U_8(t,\tau)$$

3.2.2 Production decisions in the farm-sector-

$$(38)\quad A_s(t,\tau) = \delta_{\tau 1} f_9\{P_s(t,\tau), P_w(t,\tau), P_1(t,\tau), P_e(t,\tau), Z(t,1), H_s^F(t,\tau), \ldots\} + \delta_{\tau 1} U_9(t,\tau)$$

$$(39)\quad \bar{A}_s(t,\tau) = \delta_{\tau 2} f_{10}\{P_s(t,\tau), P_w(t,\tau), P_1(t,\tau), P_e(t,\tau), Z(t,1), Z(t,2), H_s^F(t,\tau), \ldots\} + \delta_{\tau 2} U_{10}(t,\tau)$$

3.2.3. Domestic flaxseed carry over on farms-

(40) $H_s^F (t, \tau + 1) = f_{11} \{ P_s (t, \tau), P_w (t, \tau), S(t, \tau), H_s^F (t, \tau), \ldots \} + U_{11} (t, \tau).$

3.2.4. Production functions-

(41) $S (t, \tau) = \delta_{\tau 3} f_{12} \{ [A_s (t, 1) - \bar{A}_s (t, 2)], Z (t,1), Z (t, 2), Z (t, 3) \} + \delta_{\tau 3} U_{12} (t, \tau)$

(42) $L(t, \tau) = f_{13} \{ C_s (t, \tau) \} + U_{13} (t, \tau)$

3.2.5. Import supply equations-

(43) $I_s (t, \tau) = f_{14} \{ P_s (t, \tau), P_L (t, \tau), P_T (t, \tau), P_p (t, \tau) \ldots \} + U_{14} (t, \tau).$

(44) $I_L (t, \tau) = f_{15} \{ P_s (t, \tau), P_L (t, \tau), P_T (t, \tau), P_p (t, \tau), \ldots \} + U_{15} (t, \tau)$

(45) $I_T (t, \tau) = f_{16} \{ P_s (t, \tau), P_L (t, \tau), P_T (t, \tau), P_p (t, \tau), \ldots \} + U_{16} (t, \tau)$

(46) $I_p (t, \tau) = f_{17} \{ P_s (t, \tau), P_L (t, \tau), P_T (t, \tau), P_p (t, \tau), \ldots \} + U_{17} (t, \tau).$

3.2.6 Supply of and demand for drying oil products

(47) $O (t, \tau) = f_{18} \{ P_s (t, \tau), P_L (t, \tau), P_T (t, \tau), P_p)t, \tau), P_o (t, \tau), B (t, \tau), \ldots \} + U_{18} (t, \tau)$

(48) $O (t, \tau) = f_{19} \{ P_o (t, \tau), B (t, \tau), \ldots \} + U_{19} (t, \tau).$

3.2.7. Equilibrium Conditions-

(49) $H_s (t, \tau+1) + H_s^F (t, \tau+1) + C_s (t, \tau) - S(t, \tau) - I_s (t, \tau) - H_s (t, \tau) - H_s^F (t, \tau) = 0$

(50) $H_L (t, \tau+1) + C_L (t, \tau) - L (t, \tau) - I_L (t, \tau) - H_L (t, \tau) = 0$

(51) $H_T (t, \tau + 1) + C_T (t, \tau) - I_T (t, \tau) - H_T (t, \tau) = 0$

(52) $H_p (t, \tau + 1) + C_p (t, \tau) - I_p (t, \tau) - H_p (t, \tau) = 0$

where:[1]

(a) endogenous variables

H_s = non-farm flaxseed stocks

C_s = flaxseed consumption

H_L = linseed oil stocks

C_L = linseed oil consumption

H_T = tung oil stocks

C_T = tung oil consumption

H_p = perilla oil stocks

C_p = perilla oil consumption

A_s = acreage planted in flaxseed

$\overline{A}_s$ = flaxseed acreage abandoned

H_s^F = flaxseed stocks on farms

S = flaxseed production

L = linseed oil production

I_s = flaxseed imported

I_L = linseed oil imported

I_T = tung oil imported

I_p = perilla oil imported

O = factory sales of linseed oil products

P_s = price of flaxseed

P_L = price of linseed oil

P_T = price of tung oil

P_p = price of perilla oil

P_o = weighted average of prices of drying oil products. The weights being the producing industry's average share in total drying oils consumption.

(b) Predetermined variables

P_c = price of linseed cake

---

1. All prices, quantities, etc., are for U.S. except where indicated.

R_s = flaxseed storage fee

P_w = price of wheat

w = wage rate (non-farm labor)

i = short term interest rate

B = index of U.S. building activity

B_F = index of foreign building activity

H_s^A = Argentine flaxseed stocks

A_s^A = flaxseed acreage in Argentina

S^A = Argentine flaxseed production

Z = weather in domestic flaxseed producing area (perhaps two variables, e.g. average rainfall and average temperature)

P_1 = wage rate of form labor

P_e = cost of farm equipment services

3.3. Equations (30)-(37) were based on the considerations leading to (27') and (28') of section 3.1. Since the observations on the variables in the model will be quarterly time series data, we shall have to assume that the "planning" periods for the firms we are dealing with correspond to the quarters of the year, i.e. τ = 1, 2, 3, 4. The stock variables appearing as determining variables in equations (30)-(37) are on the one hand the aggregate variables which each firm may use as predictors in forecasting market prices and are on the other aggregates of stocks of individual firms, which are restricted in their decision-making by such requirements as (26). Needless to say difficult problems of aggregation as well as of functional stability over time are abstracted from in all the equations.

Equations (38)-(40) were not derived with the aid of a formal decision-making model. However, with an assumption of fixed proportions of inputs, the farmer makes only one type of "production" decision of interest here, namely, the distribution of farm land among alternative uses. In the case of the flaxseed farmer, about the end of the first quarter he must choose among planting acres in flaxseed, planting other field crops, particularly spring wheat, and leaving land idle or in pasture. It is assumed that toward the end of the second quarter, he may abandon some of the acreage planted on the basis of revised anticipations of crop prices and yields at harvest time (the third quarter) due, for example, to current weather developments, etc. He is also to decide when to market his harvest. Although most domestic flaxseed leaves the hands of farmers by the end of the calendar year, there is considerable variation in the marketings between the third and fourth quarters, while some domestic flaxseed is still coming to elevators in June, the end of the crop year.

The lack of observations on appropriate variables precludes the use of more general production functions than (41) and (42).

The equations (43)-(46) and (49)-(52) are patterned after those of the simplified system in 3.1.

The present proposal is to estimate equations (30) and (32) by incomplete system methods for linear stochastic equations. This requires that at least five predetermined variables not appearing in (30) and (32) should appear elsewhere in the system (30)-(52). Thus subject to revisions in the general scheme of the model, the problem at hand is the more nearly complete specification of determining variables in the system. It might be noted that the use of quarterly data likely involves serially correlated disturbances, a case to which the limited information method of estimation has not yet been extended.