Soybean meal Marketing

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Demand Elasticities for Soybean Meal in the European Community

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ABSTRACT

An econometric model provided estimates of the effects of E.C. agricultural policies on their demand for U.S. soybeans. Disaggregating world soybean demand into geographical regions improved elasticity estimates over previous studies with respect to substitutes, own price, and profitability index. E.C. mills powder surpluses had significant but negative small effects on U.S. soybean exports.

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Several different econometric models have been constructed to describe the demand for soybeans and soybean products (Houck et al., 1968, 1972, 1976; Matthews et al., 1973; Vandenborre, 1967, 1970; Jones et al., 1976). In most of these studies the demand for soybeans and soybean products in the European Community (E.C.) has been included as a proportional part of the aggregate world demand for U.S. soybean exports.

Such models provide only limited insight into the effect of policies in sub-sectors of the world and their predictive ability is restricted by the underlying assumption of similar demand and supply conditions in each geographical region. Recently, Brehdahl, Meyer and Collins (1979) have emphasized the need to disaggregate U.S. export demand into separate geographical markets in order to account for the influence of those countries whose internal prices are isolated from world markets.

Clearly, the Common Agricultural Policy (CAP) of the E.C. has resulted in demand and supply conditions that differ from those in many other importing countries. Disaggregation of the world demand to examine E.C. demand and supply relationships as a separate model is justified on the basis of market share (the E.C. is the largest importer of soybeans) as well as on the basis of the unique relationships generated by CAP.

The purpose of this study is to develop a model that incorporates E.C. policies into the demand relationships in the E.C.

Method of Analysis

In analyzing the soybean market, most observers follow the three market approach as outlined by Houck and Mann (1968) who distinguish markets for soybeans, soybean oil and soybean meal. Matthews et al. (1973) use essentially the same model to generate forecasts for the U.S. soybean economy. Vandenborre's model is also described by a system of equations. However, he departs from the three market approach, observing that "there is no final demand for beans" (Vandenborre, 1967). Thus, there are only two export markets, one for oil, and one for meal shipped as raw beans or product. Recognizing that the E.C. imports soybeans only to the extent they are needed to maintain the balance between oil and meal, this study follows Vandenborre's approach. However, by limiting the scope of the study, the econometric model is reduced to a single multiple regression equation to represent the E.C. soybean market.

The Economic Model

The following economic model of demand was developed to capture the effects of the Common Agricultural Policy (CAP) of the E.C. in conjunction with other components affecting the level of demand.

$$QDSM = f(PSM/PECC, ECPL, APFU, APS \text{ and } T)$$

where QDSM is the quantity of soybean meal demanded, PSM is the price of soybean meal, PECC is the E.C. price of cereals, ECPL is the E.C. profitability index for the livestock sector, APFU is the animal protein feed units, APS is the availability of protein substitutes and T is a time trend.

This model is characterized by the following features. (1) The price ratio of soybean meal to corn is used as a price variable to capture the effects of the CAP on the demand for soybean meal. The importance of this price ratio has been discussed in previous studies (Houck et al., 1972; Womack, 1976; Beyer, 1977). (2) The profitability index reflects the effect of the E.C. meat prices on the demand for soybean meal. This demand shifter was not included in the soybean meal demand equations in previous studies, presumably because of the difficulty of collecting the detailed data. (3) Animal protein feed units are used as the variable for livestock numbers. This method of measuring livestock numbers has the advantage that protein consumption can be derived directly from production units (milk, meat, and eggs) while still relating to producer behavior. Houck and Mann used the intake of protein concentrates per livestock sector as weights for their livestock number index. Vandenborre followed a similar method using Landman's figures for intake of protein concentrates per livestock unit in the dairy and swine sectors. The poultry sector was omitted. The approach of Houck-Mann and Vandenborre can be characterized as a behavioral approach since it is based on feed ratios used by farmers in the past. Houck-Ryan took a more empirical approach, entering the livestock numbers in the swine and poultry sectors as separate variables, while disregarding other livestock sectors (1976).

Both the behavioral and empirical approach have disadvantages which can be partially overcome by use of animal protein feed units as a measure of livestock demand. Livestock numbers are combined by weighting each sector by its protein requirements as formulated by nutrition experts.

(4) The availability of protein substitutes is confined to the protein concentrates available in the E.C. market, mainly the meal and cakes of other oilseeds, fishmeal, animal meal and skimmed milk powder. The inclusion of skimmed milk powder in this variable allows the tracing of the effect of the production surplus of skimmed milk powder on the demand for soybean meal. The conversion of protein substitutes into protein equivalents is done on the basis of the crude protein content of each meal or cake (Houck et al., 1972; Beyer, 1977; Hoffmeyer, 1977). (5) The time trend reflects the rapid increase in technical innovation in the livestock sectors during the period of observation.

The Error Components Model

Since data are available for each country of the E.C. and are collected on a weekly, monthly and/or yearly basis, the application of one of the econometric models in which cross-section and time series data are pooled seems most appropriate.

The key differences between many of the various time-series cross-sectional models lie in the assumptions that are made about the structure of the variance-covariance matrix of the error terms. Therefore, the possible factors that determine the size and the direction of the residuals should be examined. In the soybean meal demand model, the differences of the residuals in the different countries are possibly determined by a set of cultural and social factors which are characteristic for each country such as national government policy, market structure, and taste. For example, statistical data suggest that preferences for different kinds of meat differ by country regardless of price relations between each kind of meat (Eurostat "Supply Balance Sheet," 1961-76).

Differences between the different time periods are, among others, determined by the E.C. production of hay and forage, the quantity of which varies mainly because of variations in weather conditions. Weather, however, is not one of the explanatory variables in the economic model, since its influence is considered to be random over time. If this weather component is assumed to be dominant over the other non-observed disturbance factors that are effective over time, then two important sources of disturbances can be distinguished. One source of disturbances is typical for a specific country and unrelated to any time period. The other is specific for a given time period but unrelated to any country. The use of the Error Components Model is attractive under these conditions.

The Error Components Model is based on the assumption that the variation in disturbances over time depends on a set of unobserved autonomous factors whose influence remains constant over time. This implies that the degree of timewise correlation does not decline systematically over time (Kmenta, 1971). Analogously, it is postulated that the effect of unobserved factors that are particular to a specific sector remains more or less constant.

One of the crucial assumptions that underlies the Error Components Model is the treatment of these two kinds of unobserved factors as random variables with a zero mean and without intercorrelation (Balestra et al., 1966). Furthermore, a third error component is assumed to work in both directions and to be independent of each of the other two components.

Therefore, the classical linear econometric model is modified as follows:

$$Y = X\beta + U,$$

where

$$u_{ij} = e_{ij} + v_j + w_i$$

As is indicated in Figure 1, the dimensions of Y and u are (NT) x 1. X is a NT x k matrix where k is the number of explanatory variables that includes a constant term. The error components e, v and w are independent random variables and are characterized by the following behavior.

$$u_{it} = e_{it} + v_i + w_t \quad (i = 1, 2, \ldots, N;\ t = 1, 2, \ldots, T),$$

where

$$e_{it} \sim N(0, \sigma_e^2)$$

$$v_i \sim N(0, \sigma_v^2)$$

$$w_t \sim N(0, \sigma_w^2), \text{ and}$$

$$E(e_{it}, e_{is}) = E(e_{it}, e_{jt}) = E(e_{it}, e_{js}) = 0 \quad (i \neq j,\ t \neq s)$$

$$E(w_t, v_i) = E(w_t, e_{it}) = E(v_i, e_{it}) = 0$$

$$E(w_t, w_s) = 0 \quad (t \neq s)$$

$$E(v_i, v_j) = 0 \quad (i \neq j)$$

As Figure 1 shows, only three parameters, σ^2, ρ and δ, each being one or a combination of the variance of the error components, have to be estimated in order to determine the composition of the variance-covariance matrix (Resek, 1975). Asymptotically unbiased and consistent estimators of these parameters are obtained after the application of OLS regression on the pooled data whereby the residuals are used for the estimators (Wallace and Hussain, 1969).

Results

In estimating the economic model, Belgium and Luxembourg were counted as one economic unit. Ireland was deleted from the analysis because of incomplete data and its minor importance in soybean meal demand in the E.C. Since differences in total soybean meal consumption per country are very large, mainly due to country size, the consumption of soybean meal per animal feed unit (QDSM/APFU) was taken as the dependent variable in the econometric model, rather than the quantity of soybean meal consumed per country, to eliminate the effect of size of country in the model. The results of the estimation are shown in Table 1.

Estimated Price Elasticity

The estimated price elasticity of -.27 in Table 1 is considerably lower than estimates obtained from most previous studies. Although Vandenborre obtained an elasticity of -.28 in his first study, he arrived at -0.44 in the later one. Houck and Mann obtained an elasticity of -0.33. In reviewing estimates of different researchers Vandenborre (1970, p. 43) concludes that the price elasticity of demand for soybean meal in the U.S. "seems to converge to a value of around -0.40."

Houck, Ryan and Subotnik applied a series of models to the E.C.-6 covering the period from 1951 to 1967 and obtained price elasticities varying from -0.67 to -1.64. In the most recent study by Houck and Ryan, a U.S. export model using European livestock numbers as a variable provided an estimated price elasticity for the demand for U.S. soybean meal exports of -0.34 (calculated from their published data).

There are several explanations for the very low value of the price elasticity that is obtained in this study. First, the presence of a profit variable, not used in any of the above models, may have reduced the estimated effects of price changes somewhat. Secondly, it can be explained by the price and income stabilization policy of the E.C. Because of the CAP and the relative prices of feed grains and oil seeds, it is likely that West European compound feed manufacturers and livestock farmers are less sensitive to changes in soybean meal prices than their colleagues in other parts of the world. Thirdly, it can be explained by the expansion of the soybean meal market during the last decade (see Fig. 2). The continuing expansion shifts the demand curve to the right causing the demand to become more inelastic as data of more recent years are used for the estimation.

However, it should be added that the estimated elasticity for the E.C. should be lower than the elasticities for the U.S. market, since the U.S. market for soybean meal is larger in quantity and considerably lower in average price level (see Fig. 3).

Elasticity of Livestock Profitability

The elasticity of the demand for soybean meal with respect to the profitability of livestock production is also very low. The CAP causes profitability variations to remain within the limits of "fair" income and "fair" consumer prices, thus reducing the range of variability. The usefulness of the pooling of cross-section and time series data is illustrated by the estimation of this regression coefficient. Because the CAP limits the variation of profitability over time, little information about the profit elasticity is obtained from the variation in profit from one time period to another. However, since profit levels differ between countries because of harbor and transport facilities and national monetary policies, the variation in profit levels between the E.C. member countries (the cross-sections)provides additional information.

Elasticity of Protein Substitutes

During the period of observation (1961-76) soybean meal accounted for about 50% of the total crude protein in concentrates in the E.C. (Vachel, 1974). If soybean meal were a perfect substitute for other protein concentrates, a substitution elasticity of -1.0 might have been expected. The favorable amino-acid profile of soybean meal with respect to monogastic animal husbandry may explain the relative inelastic value for this variable (-0.55). The elasticity of the demand for soybean meal with respect to the availability of protein substitutes compares closely with earlier findings.

The Effects of the CAP on the Demand for Soybean Meal

The effects of a number of changes in the E.C. agricultural policy can be explored with the help of the estimated model. The estimated changes in E.C. soybean meal demand are shown in Table 2.

The effects of changes in cereal prices and meat prices are derived directly from the estimated demand elasticities. The derivation of the effect of the surplus of skimmed milk powder on the demand for soybean meal warrants a further explanation. The average amount of protein substitutes yearly available in the E.C. is 2739.16 x 1000 MT protein equivalents. The average annual quantity of skimmed milk powder produced during the period under study was 399,820 MT--14.6% of the total substitutes. Consequently, an increase of 10% in the production of skimmed milk powder augments the total amount of substitutes by only 1.46% implying a (1.46 x -.55 =) 0.8% decrease in soybean meal consumption. In other words, the production of skimmed milk powder could increase 12.5% (+50,000 MT in protein equivalents) before the E.C. soybean meal production would decrease by 1% (-26,200 MT protein equivalents). The differences between 50,000 and 26,200 MT protein equivalents demonstrates the loss of efficiency in terms of protein utilization. The so-called surplus production of skimmed milk powder (i.e., the amount that is actually dumped on the market) is only a small part of the total skimmed milk powder production. For that reason, the production of milk powder in the E.C. could increase by a very high percentage before the negative consequences on demand for soybean meal would be felt. Although it is often argued that the E.C. skimmed milk powder production has a large negative effect on the demand for soybean meal, this negative effect seems rather small and possibly negligible given the estimated substitution elasticity and the increased use of soybean meal required for the production of the surplus milk.

Conclusion

The major conclusions of this study are: (1) The Common Agricultural Policy has a significant effect on the demand for soybean meal. Increases in E.C. grain prices which depend on the CAP result in an increase in soybean meal demand. Also, meat prices and skimmed milk powder surpluses affect the E.C. demand for soybean meal. However, the negative effect of the skimmed milk powder surplus is rather small. (2) The price elasticity of the demand for soybean meal is more inelastic than the price elasticity of the U.S. soybean meal market. This might be caused by the price and income stabilizing policy of the E.C. The effect of price and income stabilizing policies on demand elasticities for farmers' inputs deserves further research. (3) Estimates of demand for U.S. soybean exports can be improved through disaggregation of aggregate world demand models into geographical regions with similar agricultural policies affecting prices and quantities of related products.

Table 1. Estimated Coefficients and Elasticites for the Error Components Model

	Estimated Regression Coefficient	t-values	Derived Elasticity Around the Means
PSM/PECC (price)	-0.1226	2.94	-0.27
ECPL (profit)	0.0146	1.65	0.10
APS (substitutes)	-1.0118×10^{-4}	1.51	-0.55
T (trend)	0.0313	7.18	0.70

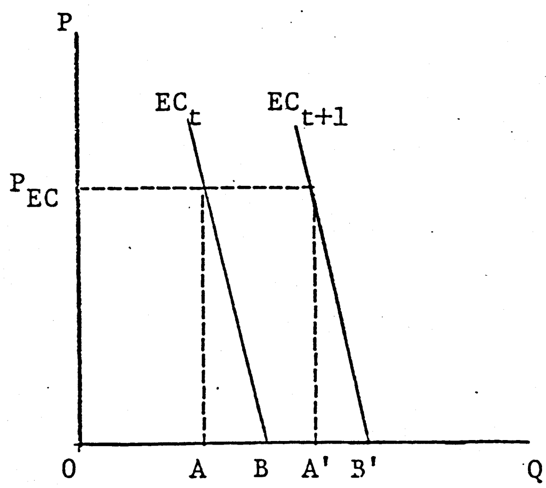
Table 2. Effects of Changes in the CAP on the Yearly Demand for Soybean Meal (1961-1976).

CAP Changes	Soybean Meal Demand Changes	
	Relative Change (%)	Absolute Change (1000 MT)
-10% cereal prices	-2.7	-162
+10% meat prices	+1.05	+63
+10% skimmed milk powder production	-0.8	-48

$$V = \sigma^2 \begin{bmatrix} A & B & \cdots & B \\ B & A & \cdots & B \\ \vdots & \vdots & \ddots & \vdots \\ B & B & \cdots & A \end{bmatrix}_{NT \times NT}, \text{ where}$$

$$A = \begin{bmatrix} 1 & \rho & \cdots & \rho \\ \rho & 1 & \cdots & \rho \\ \vdots & \vdots & \ddots & \vdots \\ \rho & \rho & \cdots & 1 \end{bmatrix}_{T \times T} \text{ and } B = \begin{bmatrix} \delta & 0 & \cdots & 0 \\ 0 & \delta & & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \delta \end{bmatrix}_{T \times T}$$

Figure 1.

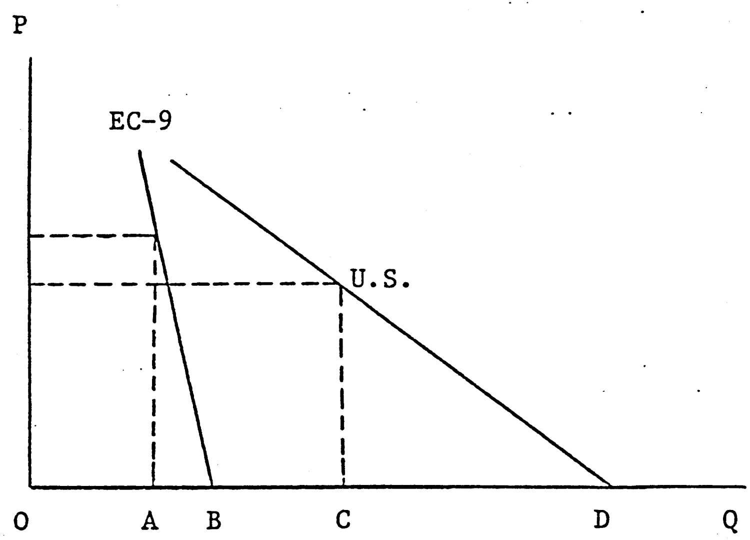


$$e_{EC_t} = \frac{AB}{0A}$$

$$e_{EC_{t+1}} = \frac{A'B'}{0A'}$$

If $AB \simeq A'B'$, then $e_{EC_{t+1}} < e_{EC_t}$

Figure 2.



$$e_{EC-9} = \frac{AB}{OA}$$

$$e_{US} = \frac{CD}{OC}$$

$OC > OA$ $\qquad$ $CD >> AB$

$$e_{US} > e_{EC-9}$$

Figure 3.

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