U.S. DEMAND FOR FISH MEAL*

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Abstract

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by

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Fish meal quantity demanded is inelastic with respect to its own price and that of soybean meal but elastic with respect to chick and lagged broiler prices. Quantity demanded adjusts fairly rapidly to economic stimuli and in the long-run is elastic except with respect to the price of corn.

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Introduction

Fish meal is a high protein feed used in mixed feeds as a source of some of the fundamental amino acids, particularly lysine and methionine. Fish meal is primarily used by the broiler industry, because of its high protein content and its unidentified growth factor which causes poultry to grow at a faster rate than other high protein feeds (4). Fish meal can be used between 2 and 10 percent of the feed mix ratio for poultry feeding. If the poultry feeding ratio is less than 2 percent of fish meal it may not enhance the nutrition and growth; on the other hand, if the ratio is more than 10 percent, it may imbue the meat and egg with fishy flavor(1).

As a protein ingredient in livestock and poultry feeds, and particularly poultry, fish meal competes with soybean meal and with synthetic amino acids. Soybean meal is rich in lysine but poor in methionine. However, several of the fundamental amino acids such as lysine and methionine are produced commercially and in the future fish meal will be competing with synthetic protein (single cell protein) which has properties similar to fish meal. Synthetic proteins are produced as by-products of petroleum, sugar, and paper (3).

The U.S. is one of the world's major users of fish meal. Until recently it has been a key importer of fish meal. The U.S. is not considered a large producer of fish meal although in 1974 it accounted for about 6 percent of the approximately 4.3 million metric tons produced in the world (10). The major producers of fish meal are Peru, Norway, South Africa, Chile, Denmark and Iceland. Substantial export earnings of these countries are derived from fish meal and they are vitally interested in the demand for fish meal in the U.S.

Historically the demands for all major agricultural commodities and foods have been analyzed. Less attention has been devoted to analyzing the demand for inputs although King's study (2) on protein feeds is quite comprehensive. When it comes to fish meal little is known about the nature of the demand and how sensitive quantity demanded is to changes in its own price and the prices of close substitute protein feeds.

This paper focuses on identifying and measuring the affects of key factors influencing the U.S. demand for fish meal. Attention is also devoted to measuring both short and long-run relative responses to price changes in substitutes and complementary inputs used in broiler production.

The Model

Since fish meal is an important feed ingredient in broiler production, the demand relation for fish meal is formulated as a demand for an input in broiler production. Because of uncertainty, complete adjustment to changes in prices and other economic variables is assumed not to be instantaneous in any one year but to take several years (5). The annual demand for fish meal is assumed to be a curvilinear relation which can be approximated by the following hypothesized logarithmic equation:

$$\log q_{fm} = \log \beta_0 + \beta_1 \log P_{fm} + \beta_2 \log P_{sm} + \beta_3 \log P_{ch} + \beta_4 \log P_{cr}$$

$$+ \beta_5 \log P_{bro(t-1)} + \beta_6 \log q_{fm(t-1)} + \beta_7 \log T + U$$

where:

q^d_{fm} = fish meal disappearance for feed, in thousands of short tons per year

P_{fm} = average annual price of fish meal, 60 percent protein, Los Angeles, dollars per short ton

P_{sm} = average annual price of soybean meal, 44 percent protein, decatur, dollar per short ton

P_{ch} = average annual price of baby chicks, paid to hatcheries for straight-run broiler type, dollars per hundred chicks

P_{cr} = U.S. annual average price of corn received by farmers, dollars per bushel

$P_{bro(t-1)}$ = U.S. annual average price of broilers (live-weight), cents per pound, lagged one year

T = time variable, one to twenty-five

$q_{fm(t-1)}$ = fish meal disappearance for feed, in thousands of short tons per year, lagged one year

β_0, $\beta_1 \ldots \beta_7$ = are unknown parameters

U = is a stockastic disturbance term

It is hypothesized that the slope of the demand curve for fish meal with respect to its price will be negative. Soybean meal is a substitute for fish meal, and the price of soybean meal is hypothesized to have a positive effect on the quantity demanded of fish meal. Broilers are the output and the lagged price of broilers is expected to have a positive effect on the quantity demanded of fish meal. The coefficient of the lagged quantity of fish meal disappearance will be between zero and one. It is hypothesized that corn is a complement with fish meal, therefore, the price of corn is going to be negatively related to the quantity of fish meal demand. It is also hypothesized that baby chicks and fish meal are complements, therefore, the price of baby chicks will be negatively related to quantity of fish meal demanded. There is no basis for hypothesizing the sign of the coefficient of the time variable.

Empirical Results

All the data used in this estimation come from the U.S. Department of Agriculture, primarily from Agriculture Statistics (6), and other monthly bulletins (7, 8, 9). The data used are annual averages based on an October to September year.

Ordinary least squares methods were used to estimate the annual U.S. demand for fish meal 1949-73. The demand equation was estimated in linear-log form using undeflated prices.[1/] The estimated coefficients of the structural demand equation, the t-values, the coefficient of determination (R^2), and F-statistics are presented in Table 1.

The estimated equation has a R^2 of .90, indicating that 90 percent of the variation in the quantity demanded of fish meal is accounted for by the price of broilers, the price of fish meal, the price of baby chicks, the price of corn, the quantity lagged of fish meal disappearance and the time variable. The F test was significant at the .005 level and signs of all coefficients were as hypothesized.

A one-tailed t test was used to test hypotheses about all individual coefficients except the coefficient of the time variable. A two-tailed t test was used for it. The estimated coefficients of the price of broilers and the price of soybean meal variables were significantly greater than zero at the 0.005 level while the coefficients of the price of fish meal and the price of baby chicks were significantly less than zero at the 0.005 level. The coefficient of the price of corn variable was significantly less than zero at the 0.10 level and the coefficient of the lagged quantity of fish meal disappearance variable was significantly greater than zero at the 0.025 level. The coefficient of the time variable was significantly different

Table 1. Estimated Coefficients, t-values,[1] Coefficients of Determination, and F-Statistics, U.S. Demand for Fish Meal (Nominal Prices in Log Form) 1949-73

Variables	Coefficients
Intercept	4.530
T	0.210** (2.261)
$q_{fm(t-1)}$	0.365** (2.481)
$P_{bro(t-1)}$	1.501* (2.957)
P_{fm}	-0.889* (4.076)
P_{sm}	0.663* (3.485)
P_{ch}	-1.525* (3.550)
P_{cr}	-0.492*** (1.474)
R^2	0.90
F-Statistics	21.05

[1] t-values are in parenthesis.

Significance levels denoted by the asterisks are:
*   = 0.005
** = 0.025
*** = 0.100

from zero at the 0.05 level.

Short-run and long-run elasticities are presented in Table 2. In the short-run the quantity of fish meal demanded is inelastic with respect to its own price and the price of soybean meal, -0.89 and 0.66 respectively. The quantity of fish meal demanded is quite elastic with respect to the price of baby chicks, -1.53, and the lagged broiler price, 1.50. The cross-price elasticity with respect to the price of corn is -0.49. Thus, in the short-run the quantity of fish meal demanded is more sensitive to changes in the price of baby chicks and the lagged broiler price than to changes in its own price.

The elasticity of adjustment is 0.64 and indicates that about 64 percent adjustment toward long-run equilibrium is made in one year given a once-and-for change in variables. This elasticity of adjustment is the linkage between the short-run and long-run in the type of Nerlovian framework (5) used here. As indicated in Table 2 in the long-run the quantity of fish meal demanded is elastic with respect to all prices except the price of corn. Of course as in the short-run it is most sensitive to the chick and lagged broiler prices.

Conclusions and Implications

From a statistical viewpoint the most highly significant variables affecting the quantity of fish meal demanded are the price of fish meal, the price of soybean meal, the lagged price of broilers, and the price of chicks. The quantity of fish meal demanded is more sensitive, in terms of magnitude of response and elasticities, to the price of chicks and lagged broiler price than to the price of fish meal and the price of soybean meal. The effects of the price of chicks and the lagged broiler price are about the

Table 2. Short-run and Long-run Elasticities for the U. S. Demand for Fish Meal (Nominal Prices in Log Form)

Variable	Elasticities	
	Short-Run	Long-Run
$q_{fm(t-1)}$	0.365	0.576
$P_{bro(t-1)}$	1.501	2.365
P_{fm}	-0.889	-1.400
P_{sm}	0.663	1.045
P_{ch}	-1.525	-2.404
P_{cr}	-0.492	-0.775

same magnitude but of opposite sign and thus a given percent change in each of these two prices would result in off-setting effects.

More important possibly is the fact that the quantity of fish meal is inelastic with respect to the price of fish meal and the price of soybean meal in the short-run but not in the long-run. In the long-run the demand for fish meal is direct and cross-price elastic. Since soybean meal with additional methionine is used as a substitute for fish meal the continued growth in soybean production in the U.S. and in other parts of the world is likely to dramatically decrease the quantity of fish meal demanded. This of course is assuming that the increases in quantity of soybeans supplied will exceed the increases in the quantity of soybeans demanded. This appears plausible given the trends in the U.S. soybean production and trends in other large soybean producing countries such as Brazil. Currently Brazil accounts for about 15 percent of the world production but by 1980 Brazil is expected to double its 1974 production which will be about 10 times its 1970 production (8).

Additional competition will be forthcoming from high proteins of vegetable origin besides soybeans, synthetic amino acids, and synthetic protein. Particularly the production of synthetic amino acids and synthetic proteins are increasing (3). The high price of fish meal experienced in the last few years is likely to even further encourage the production of the synthetic single cell proteins.

Furthermore, the estimated elasticity of adjustment suggests that the broiler industry is able to adjust quite rapidly to economic changes influencing the demand for fish meal. Given an economic stimulus the elasticity of adjustment of 0.64 means the broiler industry makes about a

99 percent adjustment toward long-run equilibrium by the fifth year assuming no other stimuli. Hence the rapid growth in soybean production and the production of synthetic proteins could have some rather rapid and profound depressing affects on the quantity of fish meal demanded.

The outlook for the demand for fish meal in the U.S. does not look overly encouraging from the viewpoint of the large fish meal producing countries. All evidence suggests that the quantity of fish meal demanded in the U.S. is likely to decline. Major fish meal producing countries need to (1) consider new methods of fishing and fish meal production that will reduce costs, (2) explore new uses of fish meal, e.g., as a fertilizer or for human consumption[2/], (3) look for new world markets in Eastern Europe and Latin America and, (4) observe the trends in the broiler industry and with the information about the demand for fish meal determine the size of its future market.

The only encouraging thing for the fish meal industry is that thus far fish meal contains an unknown growth factor which makes poultry grow at a faster rate than do any other high protein feeds. This desirable quality may at least temporarily lessen the negative effect of a higher price of fish meal on the quantity of fish meal demanded.

FOOTNOTES

1/ The demand equation was estimated in linear and logarithmic functional form and the price variables were estimated with deflated prices and undeflated prices. The $P_{bro(t-1)}$ was deflated by prices received by farmers and P_{fm}, P_{sm}, P_{cr}, and P_{ch} were deflated by prices paid by farmers. The undeflated linear-log functional yielded the highest R^2. The signs of a coefficient were the same for all the estimated equations.

2/ Norway has already started producing and selling fish meal for human consumption (3).

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