PART V

Interpretation of Supply Functions

Chapter 15

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Supply Response and the Feed-Livestock Economy

THIS PAPER will deal with some general relationships in the feed-livestock economy with the intent of showing that it is desirable to look at supply response from a farm management orientation as well as from the perspective of the analyst who deals with aggregative data of a time series nature. After all, we are looking toward a general kind of consistency in the results of analyses employing a variety of methods. If the estimates of relationships within the feed-livestock economy (or any other sector) are to be useful for policy formation, then the various pieces of evidence presented must have a reasonable degree of concordance.

FEED-LIVESTOCK RELATIONSHIPS 1922-41

The role of the feed-livestock sector in the agricultural economy of the nation is an important one in terms of the responsibility sometimes assigned to it to act as an equilibrator. The general nature of this process during the inter-war period (1922-41) can be shown by first tracing the direct or immediate effects of changes in certain key variables through the system (19).

1. During the period 1922-41, a 1 percent change in disposable consumer income was associated with an average change of 0.8 to 0.9 percent in retail prices of meat, dairy, and poultry products. Farm prices of livestock products generally changed about 1.5 percent for a 1 percent change in their retail prices, and the farm price of corn changed about 1 percent in response to a 1 percent change in farm prices of livestock products, if livestock production remained constant. Linking the steps together, during 1922-41, a 1 percent change in disposable income led, on the average, to about a 1.3 percent change in the farm price of corn.

2. In the absence of corn-price supports, a 1 percent change in corn production was directly associated with a 0.6 percent change in the supply of privately held feed concentrates — that is, feed supplies excluding CCC stocks. And a 1 percent change in the supply of feed concentrates (excluding CCC stocks) was associated with an opposite change of 2 percent in the market price of corn.

3. A 1 percent change in the supply of privately held feed concentrates was associated with a 0.9 percent change in total concentrates fed, while a 1 percent change in total concentrates fed was in turn associated with an average change of 0.34 percent in total volume of livestock production.

4. A 1 percent change in the volume of livestock production is associated with an opposite change of about 2 percent in livestock prices and a 1 percent change in the value of livestock products (farm basis). A 1 percent change in the farm value of livestock products is associated with a similar change in the farm price of corn.

The above average relationships are the estimated immediate ones. The longer term cumulative effect of a 1 percent increase in corn production would have been to depress the corn price about 1.2 percent. Over time, the lower corn price would cause an increase of about 0.2 percent in livestock production. The subsequent decrease in livestock prices leads to a corresponding decrease of 0.2 percent in the price of corn. Thus if time lags were disregarded, the total effect of a 1 percent change in corn production would, in the absence of storage or price support operations, have been an opposite change of about 1.4 percent in corn prices.

Thus two forces act in opposite direction on corn price — a change of 1.3 percent in corn price for each change of 1 percent in consumer incomes and a change of 1.4 percent in the opposite direction for each 1 percent change in corn production.

VARIATION IN FEED-GRAIN PRODUCTION

Let us now turn to supply response first for feed grains and then for the livestock. Most analyses of the feed-livestock economy have not explicitly considered feed-grain supply responses to price variables in their models. For example, Foote (9, p. 4) states:

> Acreage used for feed crops normally does not vary greatly from year to year, and changes in yields depend mainly upon weather and the general level of cultural practices. Within the usual framework of price relationships, year-to-year changes in supplies of feed are determined chiefly by nonprice factors.

In his treatment of determining optimal carryover levels of grains, Gustafson (12, p. 17) also treats the year-to-year variation in the production of feed grains as a random variable. However, he indicates that his analysis can accommodate supply functions for feed grains but that the present state of information concerning the economic determinants of acreage planted does not justify such inclusion at this time.

The general recognition that yield variation swamps acreage variation in its influence on feed-grain production,[1] should not discourage

[1] According to the method suggested by Sackrin (20) for measurement, yield variations account for about 90 percent of total corn production variation in the U.S. 1900-1958, with acreage variations accounting for the remaining 10 percent.

economists from attempting to explain acreage changes and at least a part of yield variations in a framework of economic analysis (18), rather than becoming meteorologists. Among other indications of the apparently growing recognition of the influence of weather, we may cite Marion Clawson's suggestion (4, p. 248):

> ...random annual variations in gross farm output, due primarily to weather conditions, have blurred the picture of a comparatively continuous and regular increases.... It seems to me that the first step in any careful analysis of output, whether of total or by farms or commodities, is to estimate first the effect of weather conditions in the year and time period under study.

We cannot help being reminded of Cochrane's review (5) of "The Economic Organization of Agriculture" in which he commented on preoccupation with weather phenomena as an explanation of instability in agriculture. Stallings (21) has recently attacked the problem of adjusting yield data for weather.

VARIATIONS IN LIVESTOCK PRODUCTION

Although livestock production is much less affected directly by such uncontrollable factors as the weather, the explanation of changes in production is not exactly straightforward (see, e.g., 2, 17). Needless to say, an explanation of fluctuations in livestock production is a necessary condition for estimating the demand for feed grains, an important key in determining any storage policy.[2] The beginning inventory of livestock on farms in a given year plays the dominant role in determining livestock production in that year (9, p. 16-18). But an important effect of changes in feed supply in a given year is the indirect effect on later livestock production via the build-up or depletion of breeding livestock inventories. The estimates of Hildreth and Jarrett (14) are consistent with the Foote analysis in terms of the relative importance of changes in feed supply on current marketing and later production.[3]

[2] If the storage problem is viewed in terms of "the inventory problem" [see, e.g., Gustafson (12) and Gislason (11)], then account needs to be taken of not only the fluctuations in feed-grain production (which may be sufficiently close to being random to consider as random), but also fluctuations in demand for feed grains which are certainly not of a random character, being influenced as they are by livestock cycles, general business cycles, wars, defense spending, etc. Historically, the year-to-year changes in domestic demand for feed grains have been smaller than the year-to-year changes in feed grain production. For a discussion of the nature of yield variations see Foote and Bean (10).

[3] In contrast to the work of Foote and Hildreth and Jarrett, Cromarty (6) has (within a model for U.S. agriculture) disaggregated the feed-livestock economy into a category for feed grains and five livestock product categories. It is interesting to note that his supply elasticities appear more plausible than his price elasticities for demand. For example, he reports an estimate of demand price elasticity for hogs of approximately -2.37. Work is also underway by Hassler at the University of Nebraska on a feed-livestock model for determining, among other things, the effects of various allocations of feed grains among the different species of livestock.

CHANGES IN THE FUNCTIONING OF THE FEED-LIVESTOCK ECONOMY

There is now some feeling that the traditional role of the feed-livestock economy to act as an equilibrator to absorb the shocks of fluctuations in feed grain production is changing (3). Immediately following the war the relatively high price and income elasticity for livestock products acted as an important factor in maintaining farm income and preventing an even more rapid accumulation of crop surpluses. The experience of 1955-56 made it clear to many observers that the absorptive capacity of the livestock economy for feed has some limits that need recognition. Cavin (3) suggests that the price structure to producers is endangered whenever the supply of meat for consumption is much in excess of 160 pounds per capita. He reported that the 1955 Household Food Consumption Survey indicated that when incomes rise a shift in purchases occurs to higher priced meats rather than higher quantities. There is other evidence that the demand conditions are changing. Dean and Heady (7) report that both price and income elasticity for hogs have decreased when the 1924-1937 period is compared with the 1938-1956 period.

In this connection Kiehl (15) has also pointed out, "... it would be unfortunate if hogs were given the assignment to 'eat up' our feed-grain surplus."

IMPLICATIONS OF STRUCTURAL CHANGE IN SUPPLY ANALYSES

Changes occurring in the demand for livestock products (and hence the derived demand for feed grains) have been detected by analyses of time series data with a relatively high degree of aggregation <u>and</u> by cross-sectional data on consumer expenditures. Similarly, it seems natural that we check results of time series supply analyses against cross-sectional data from individual farms. The more rapidly the structural changes in production occur, the more important it is to do such cross checking.[4] An earlier paper at this workshop by Cochrane and Learn has dealt with the interpretation of regression analyses when structural changes occur.

An example of some insights that might be obtained by analysis of individual farm data is suggested by a preliminary analysis of data on some hog farms in four Illinois counties: Bureau, Henry, Knox, and Stark. The general problem being investigated is the effect on stability of production of concentration of the production of hogs in the hands of fewer producers. This particular problem is of interest in connection

[4] It is important to establish some logical relationship between the types of analyses. Kuh (16) cautions: "In general, we cannot estimate dynamic coefficients from cross-sections with any degree of confidence unless there is supporting time series information..."

with the apparent increase in the importance of a cyclical pattern in affecting variation in hog production.[5]

In the four counties mentioned above the census reports indicate that (in addition to a drop in the number of farms) the percent of farms reporting hogs dropped from 83.6 percent to 78.4 percent from 1950 to 1954. With total numbers of hogs on farms increasing, it is reasonable to infer that average size of operation of hog producers is increasing.

A suggestion that production may become more stable, as a result of fewer but larger producers, is given by relating the stability of the production (in terms of annual variation in numbers of litters produced) to the size of operation. Coefficients of variation on the variable, litters produced, were computed for each of 82 hog producers for the period 1946-58. This measure of variation, in turn, was related to the average number of litters per producer during the period. The resulting regression[6] indicates greater stability of production on the part of the larger producers. Thus it appears that a force tending toward stability would be the concentration of production in larger scale operations. This year-to-year variation is, of course, due to many causes; the analysis must obviously proceed to seek to explain the variation.[7]

Analysis of individual farm data is mentioned only to suggest that supply analyses with aggregative time series data may, especially in times of rapid structural change in production, need support from collateral analyses of a cross-sectional type with more detailed individual farm data.

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5. Cochrane, Willard, "Professor Schultz discovers the weather," Jour. Farm Econ., 35:280-83, 1953.

[5] Dean and Heady (7) report an increase in supply elasticity (to hog-corn price rate) when the period 1924-1937 is compared with 1938-1956 (Table 1, p. 854). This, coupled with a decrease in demand elasticity would tend to accentuate instability. See also Breimyer (1). It should be noted that the greater the influence of endogenous variables in explaining production, the more useful become models which test the time path of certain of the variables to analyze the nature of the system, i.e., whether it is explosive, stable, etc. Among other studies employing this type of analysis related to livestock production, see Foote (8) and Haavelmo (13).

[6] $y = 65.5 - 0.49x^{**}$ where y = coefficient of variation and x = average number of litters produced (1946-1958). For details see Swanson and Meline (22) pp. 10-12.

[7] The suggested increase in stability does not necessarily mean that supply elasticity with respect to the hog-corn ratio is not more elastic than it has been previously. See Dean and Heady (7, p. 854). Other factors than the hog-corn price ratio account for year-to-year changes: e.g., cross-elasticity with respect to beef, etc.

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Discussion

SWANSON'S STATED PURPOSE was to show that it is desirable to look at supply response from a farm management as well as a time series perspective. I believe he has made a real contribution in this regard. His classification and discussion of the various phases of analysis of the feed-livestock area suggest several important areas of research at the level of the firm.

My review will be largely from the standpoint of the use of the general relationships he has developed in making aggregate production response estimates and the research needed for such estimates. Frequently at the national level, economists in the Agricultural Marketing Service and the Agricultural Research Service are called upon to make projections of production at some future date under assumed program price and economic conditions. It seemed to me that a few comments from this standpoint might be helpful. These comments center largely on estimates of feed grain production.

Swanson points out that formal aggregative models of feed-livestock economy usually have not explicitly included feed grain supply response. A few time series studies have been made of supply response for corn and other individual crops, but I am not aware of any studies of feed grains as an aggregate. In preparing national estimates, the production from different feed grains are close substitutes over considerable ranges. Consequently, total feed grain production becomes the most important variable. I wonder whether some analysis of aggregate feed grain output, yield, and acreage changes wouldn't be helpful. As one approach, perhaps some variant of the time series approach now used by Griliches[1] in analyzing aggregate output might be used for feed grain output. In this connection, it would seem desirable to take a closer look at the effects of acreage controls of other crops on feed grain acreages.

Swanson warns economists against becoming meteorologists. Although I would agree with this, I was not clear as to how he would suggest that economists handle the effects of weather. I believe there is also the danger that economists will overlook the contributions of meteorology, agronomy, and other physical sciences to supply analysis. In making aggregate estimates of supply, it is important that economists bring to bear enough meteorology and physical science to estimate the effects of both weather and crop practices, such as fertilizer, on yields. In recent publications by economists from the USDA and the University of Illinois,[2] the "normal" yield for corn for 1960 is projected at 49 and 44 bushels, respectively.

A gap like this really overshadows the price-supply relations. Assuming a supply elasticity of, say, 0.2, for example, it would take a price decline of 50 percent to be equivalent to this difference in yield.

In analyzing aggregate production changes in feed grains, it is usually not possible to distinguish between the implications to production of "structural changes" and the movement from one equilibrium point to another as a result of changes in price-cost relations.

This is particularly true in the case of crop yield. Use of fertilizer, for example, is a major factor affecting corn yields. This is related partly to adoption of new technology or use of fertilizer on additional farms. It is related partly to the use by able operators of proper amounts of fertilizer, whose usage will shift because of price relations. In between, of course, is a group of farmers who are "experimenting" with small quantities and who, at least in the aggregate, will find it profitable to use more under the range of prices assumed.

It is not possible to distinguish at the aggregate level among these

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[1] Griliches, Zvi, "Estimates of Aggregate U. S. Farm Supply Function," University of Chicago and National Bureau of Economic Research, 1959 (mimeo).

[2] Hieronymus, T. A., "We aren't growing too much feed!" Farm Journal, 83:45, Oct. 1959. Christensen, R. P., Johnson, S. E., and Baumann, R. V., "Production prospects for wheat, feed and livestock, 1960-65," USDA, ARS 43-115, 1959.

situations. Further, I am not convinced that it is of a first order of importance in aggregate production analysis. A decrease in prices, for example, is likely to be in the direction of decreasing the "rate of adoption" by the farmers in the first and third situations and of less usage by farmers now in an equilibrium situation. A rise in prices would have reverse effects.

Such a distinction, however, does have increasing importance as the relative importance of these situations change materially. For this reason, an approximate indication of the stage of the industry is needed. I believe this to be an area in which analysis at the level of the firm can make a real contribution.

An associated area for farm management analysis that would be of assistance in aggregate analysis would seem to be analysis of the relation of income and prices to the rate of adoption of technological developments.

Available evidence indicates that on many farms increased applications of yield-increasing inputs would be profitable even with considerably lower prices. The explanation for this would seem to lie partly with such things as the learning process and risk and uncertainty on investment aspects. How are these factors affected by changes in income and price? The device of the producer panel discussed earlier in the conference would seem to offer some promise for gaining insight into this area.

Finally, the question raised by Swanson as to whether structural changes are increasing or decreasing the elasticity of supply is an important one in constructing aggregate production projections. Analysis of representative farming systems in different stages of technological development from the standpoint of shifts in the optimum combination of production factors in response to price with special emphasis on the importance and flexibility of so-called "fixed" factors might yield valuable insight into this problem.

Some economists reason that because labor has become less important in the process of agricultural production and "cash costs" more important, changes in supply will be more readily affected by price changes. On the other hand, it has been pointed out that in some enterprises and cases, the "cash costs" are composed to a considerable extent of specialized capital goods, such as a corn picker-sheller. If aggregate returns for the enterprise are reduced, the "salvage value" of such machines may be reduced proportionately. Further, as Glenn Johnson emphasizes, the salvage values are often considerably lower than the value in use.