AN ANALYSIS OF PRODUCERS' YEAR-TO-YEAR CHANGES IN SLAUGHTER HOG MARKETINGS*

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Much effort is devoted to explaining and forecasting changes in marketings of agricultural commodities. The usual procedure involves formulating hypotheses about behavior of individual producers, then testing them and quantifying relationships by using aggregate data. The purpose of this paper is to suggest and illustrate a procedure that may provide a foundation for improved explanation and prediction of period-to-period changes in marketings.

The procedure uses data obtained from individual producers to test hypotheses about period-to-period changes. Results obtained from an application of this procedure (to analysis of year-to-year changes in hog marketings) suggest that expected profitability alone is unlikely to provide either a very complete explanation or accurate predictions of year-to-year changes.

The procedure suggested in this paper involves the following steps. First, hypotheses are formulated about period-to-period changes in marketings by individual producers. These might include hypotheses about characteristics of producers who make and do not make period-to-period changes. Factors related to sizes and directions of period-to-period changes by producers who do make them might also be noted. Second, information about hypothesized characteristics distinguishing producers making period-to-period changes from those who do not, and information about actual changes and reasons then, is obtained from individual producers. Third, these data and appropriate quantitative techniques are used to test hypotheses and quantify relationships.

This procedure should complement and extend, rather than substitute for, analyses based on aggregate data. Results relating actual period-to-period changes by individual producers to their reasons for them may complement analyses based on aggregate data. This is done by identifying factors related to size and directions of changes, by determining which factors are particularly important in causing large and small changes, and by indicating whether and how relative importance of various factors changes over time.

Information about characteristics distinguishing producers who make frequent period-to-period changes from those who do not may be used to provide additional results. Specifically, trends in these characteristics may be used to forecast both incidence and magnitude of future production cycles.

An analysis of year-to-year changes in hog marketings illustrates the application of this procedure. Hypotheses about characteristics of producers making and not making changes, and about factors related to sizes of year-to-year changes by producers who do make changes, are developed. Discriminant and regression analysis are applied to data collected from a sample of Iowa hog producers to test these hypotheses.

Hypotheses are discussed next, followed by discussions of data and procedures, results and conclusions.

HYPOTHESES

Hypothesis I

The first hypothesis concerns characteristics distinguishing hog producers who frequently make

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substantial year-to-year changes in marketings from those who do not. It is hypothesized that the more likely to make changes in hog marketings are those producers who are younger and more educated than the average, have better management abilities, are owner-operators and have two or more livestock enterprises. Further, they would tend to operate more acres, have relatively capital intensive swine facilities and sell more hogs than the average producer. Conversely, it is hypothesized that producers not having these characteristics would be less likely to frequently make substantial year-to-year changes.

The reasoning underlying this hypothesis may be summarized as follows: Younger producers are less likely to have established specific levels of production they wish to maintain, and producers with more management ability are likely to be more confident of their abilities to correctly anticipate changes in profitability of hog production. Oehrtman's conclusions [7] that younger managers are less rigid, and that more educated and higher paid managers have higher self-esteem and confidence, support these propositions.

An owner-operator will likely make substantial changes more frequently than a tenant operator because he must convince only himself of their desirability. Producers who operate more acreage and livestock enterprises have greater opportunities to shift resources among livestock enterprises and (or) crop and livestock enterprises. Producers with less capital intensive facilities appear more inclined toward change because variable costs comprise a larger portion of total costs. For these producers, the price at which variable costs are no longer covered is higher than for those with more capital intensive facilities. Finally, as number of hogs sold increases, the incentive for a producer to formulate and adjust to expectations about profitability of hog production becomes greater.

Hypothesis II

The second hypothesis concerns an explanation of variation in amount of year-to-year change in hog marketings by producers who do make changes. It is hypothesized that, in a given change period, sizes of year-to-year increases and decreases in individual producers' marketings are related to their perceptions of importance of several factors. These are associated with expected profitability of hog production, luck and management (e.g., conception rates, disease, etc.), and availability of hog production inputs; and with producer, farm and enterprise characteristics.

This hypothesis is based in part on results of earlier studies of year-to-year changes in aggregate hog marketings. Some have concluded that changes are positively related to actual or expected hog prices, actual or expected fed cattle prices, and the hog-corn ratio [1, 3, 6]. Thus, it is expected that *ceteris paribus* producers who make year-to-year changes will indicate that these factors are important in causing changes, and that their assigned level of importance will be related to amounts of change. The relation between amount of change and importance of a given factor may be positive or negative and may differ between change periods and between directions of change.

For example, if expected slaughter-hog price were believed to be an important consideration to producers making relatively large year-to-year changes, a positive relationship would be anticipated. On the other hand, if that price were believed to be important in causing only smaller changes, a negative relationship would be anticipated. The importance of a factor and the amount of change would be unrelated (i.e., importance would not contribute to explanation of variation in amounts of change) if *ceteris paribus* producers who consider that factor unimportant make the same amounts of change as those who do. Tilley [9] used importance scored variables and producer characteristics to explain hog producers' choices of market outlets.

Results of an earlier USDA study [11] and a recent Missouri study [4] were also considered in developing this hypothesis. In the USDA study, survey information was used to draw conclusions about factors producers consider important in determining the number of spring pigs raised as well as what factors cause that number to change. It was concluded that price and cost factors were not considered very important in determining either number of pigs raised or changes in usual levels. Rather, availability of production inputs were most important in causing changes. In the Missouri study, it was found that disease and breeding problems and labor availability were among important reasons for year-to-year changes. These results suggest that producers who do make changes would indicate that luck, management and input availability are important in causing changes, and that amount of change is related to the importance attached to these factors.

Producer, farm and enterprise characteristics expected to be related to sizes of year-to-year changes include age and education of the producer, size of farm, tenure arrangement, number of livestock enterprises, relative importance of the hog enterprise, number of hogs sold in the previous period, availability of unused resources for hog production and the type of hog operation (i.e., farrow-finish only or other). The relation of the amount of change to these characteristics would depend on direction of change and change period.

DATA AND PROCEDURES

Data

Data used to test these hypotheses were obtained in a survey of Iowa hog producers conducted in February 1972. The population of Iowa producers who sold hogs in 1970 was stratified by number of hogs sold in 1970, and a random sample selected from each stratum. Four hundred eighty-nine interviews, all with producers who sold butcher hogs in 1971, were completed. Producers were asked to provide information about themselves, their farming operations and their hog enterprises.

Information obtained in this study differed from that obtained in earlier ones [4, 11]. Here, substantial changes were distinguished from small ones and, for each substantial change made, a producer not only identified factors that caused him to make the change but indicated their relative importance. To obtain this information, numbers of hogs sold were recorded for each producer for each of the years 1967-1971. Year-to-year increases and decreases were calculated for the four change periods. In each instance that a year-to-year change exceeded 10 percent of the previous year's marketings, the producer was asked to indicate the importance of each of several factors in causing that change by assigning a number from 1 (no importance) to 99 (maximum importance) to each factor. Thus, a set of importance scores was obtained for each of the four change periods in which each of 489 producers made a substantial change in hogs marketed.

Procedures

Discriminant analysis (a statistical technique that may be used to determine whether individuals in different groups may be distinguished on the basis of characteristics of the individuals) was applied to the survey data to test the first hypothesis. Hog producers were divided into two groups: those making one or more substantial year-to-year changes in hog marketings during 1967-71 (change group), and those making no substantial changes (no-change group). The first hypothesis identified characteristics thought to be important in distinguishing producers in the two groups. Variables used to quantify these characteristics are defined in Table 1. Note that Z_4—Z_8 are proxies for management ability.

A two-group discriminant function was estimated and tested. The two-group discriminant function is:

TABLE 1. DISCRIMINANT ANALYSIS: DEFINITIONS OF INDEPENDENT VARIABLES AND EXPECTED SIGNS OF COEFFICIENTS

Symbol	Definition	Expected Sign of Coefficient
Z_1	= 1 if owner-operator, 0 otherwise	+
Z_2	= Age of producer	-
Z_3	= Number of years of education	+
Z_4	= Number of market outlets used	+
Z_5	= Number of bids typically received per lot marketed	+
Z_6	= 1 if computer records, 0 otherwise	+
Z_7	= 1 if quality of swine records high, 0 otherwise	+
Z_8	= 1 if futures contracts used, 0 otherwise	+
Z_9	= Number of livestock enterprises, 1971	+
Z_{10}	= Number of acres operated, 1971	+
Z_{11}	= 1 if capital intensive swine facilities, 0 otherwise	-
Z_{12}	= Number of hogs sold in 1967	+

$$G_t = Z_t' \hat{D}_{12} \tag{1}$$

where

G_t = value of the discriminant function for the t^{th} observation

Z_t = a $k \times 1$ column vector of values of independent variables for the t^{th} observation and

$\hat{D}_{12}$ = a $k \times 1$ column vector of estimated coefficients.

The estimates $\hat{D}_{12}$ were chosen so that the ratio of between-group variance of the Z's to within-group variance of the Z's would be maximized. The estimator satisfying this criterion used in this study is

$$\hat{D}_{12} = K^{-1} d_{12} \tag{2}$$

where d_{12} is the vector of differences between mean values of the Z's for groups 1 and 2, and the rs^{th} element of the matrix K is

$$k_{rs} = \frac{1}{(N-2)} \sum_{i=1}^{2} \sum_{t=1}^{n_i} (x_{its} - \bar{x}_{ir})(x_{its} - \bar{x}_{is}) \tag{3}$$

where n_i is the number of observations in group i and N is the total number of observations.[1]

[1] Ladd [5] shows that any estimator proportional to the estimator in equation (2) also maximizes the ratio of between-group to within-group variance of the Z's.

By using the procedure suggested by Hallberg [2], coefficient estimates were standardized so that coefficient values could be used to rank independent variables according to discriminatory importance. Expected signs of the standardized coefficients are shown in Table 1. A positive (negative) sign implies that the larger the value of the independent variable, the more (less) likely the observation is in the change group. The null hypothesis that individual coefficients and sets of coefficients are zero were tested by using procedures presented by Ladd [5] and Hallberg [2]. The final discriminant function was obtained by defeting explanatory variables whose coefficients were not significant at the 10 percent level.

Multiple regression analysis was used to test the second hypothesis. The survey information was divided into 16 data sets, four for each of the four change periods. The four data sets for each change period were for: farrow-finish operators who increased production, farrow-finish operators who decreased production, combination operators (i.e., those who were not strictly farrow-finish operators, e.g., ones that purchased or sold feeder pigs) who increased production, and combination operators who decreased production. Models were estimated for each data set and for some combinations of data sets, and tests were performed to determine whether and how sets could be combined.

First a multiple regression model was estimated for each of the 16 individual data sets. The dependent variable was year-to-year change in hog marketings. Independent variables were those listed in Table 2. To correct for over-reaction by producers assigning scores near the middle of the 1-99 scale and under-reaction by producers assigning scores near either end of the scale, the importance scores (X_1—X_{12}) were converted to standard normal deviates. The expected signs of the coefficients are shown in the right column of Table 2.

Independent variables in models for operators who decreased marketings were multiplied by −1 so expected signs of coefficients would be the same as in models for operators who increased marketings. Except for importance of expected fed cattle price (X_3), importance of factors related to expected relative profitability of hog production (X_1—X_5) was hypothesized to be positively related to amount of change. Importance scores for input availability (X_6—X_8) were also expected to be positively related to amount of change. Except for importance of operator health (X_{12}), importance scores for luck and management (X_9—X_{12}) were expected to be negatively related to amount of change. All producer, farm and enterprise characteristics except age were expected to be positively related to amount of change.

TABLE 2. MULTIPLE REGRESSION ANALYSIS: DEFINITIONS OF INDEPENDENT VARIABLES AND EXPECTED SIGNS OF COEFFICIENTS

Symbol	Definition	Expected Sign of Coefficient
X_1	= Importance of price of feeder pigs.	+
X_2	= Importance of expected price of slaughter hogs	+
X_3	= Importance of expected price of fed cattle	-
X_4	= Importance of corn price	+
X_5	= Importance of ratio between hog price and corn price	+
X_6	= Importance of labor supply	+
X_7	= Importance of feed supply	+
X_8	= Importance of capital supply	+
X_9	= Importance of average conception rate	-
X_{10}	= Importance of average litter size	-
X_{11}	= Importance of disease problems	-
X_{12}	= Importance of health of operator	+
X_{13}	= Age of producer	-
X_{14}	= Number of years of education	+
X_{15}	= 1 if owner-operator, 0 otherwise	+
X_{16}	= Number of acres owned, 1971	+
X_{17}	= Number of livestock enterprises, 1971	+
X_{18}	= Number of acres operated, 1971	+
X_{19}	= 1 if excess capacity in 1971, 0 otherwise	+
X_{20}	= Percentage of gross farm sales from hog enterprise, 1971	+
X_{21}	= Number of hogs sold in previous year	+

Tests were performed to determine if data sets for different types of operations (farrow-finish and combination) could be combined. F-tests were used to determine sequentially whether intercepts and slope coefficients were different for the different data sets. If null hypotheses (that intercepts and slope coefficients were equal for the two data sets) were not rejected, sets were combined. Tests were performed to determine if data sets for operators who increased marketings could be combined with those for operators who decreased marketings, and to determine if those for different change periods could be combined. Results should be interpreted recognizing that final models were obtained by deleting variables whose coefficients were not significant at the 10 percent level.

RESULTS

Discriminant Analysis

Results of the discriminant analysis are presented in Table 3. Four of the twelve independent variables listed in Table 1 were found to be significant at at

TABLE 3. DISCRIMINANT RESULTS: COEFFICIENT ESTIMATES AND r-RATIOS

Independent Variable	Definition	Standardized Coefficient Estimate	Approximate t-Ratio
Z_3	Number of years of education	0.452	3.80[a]
Z_4	Number of market outlets used	0.218	1.91[a]
Z_{11}	Capital intensity of facilities	-0.160	-1.42[a]
Z_{12}	Number of hogs sold in 1967	-0.335	-2.90[a]

[a] $P < 0.10$.

least the 10 percent level. These are identified in the left column of Table 3. Standardized coefficients and approximate t-values (computed by using estimates of assymptotic variances) are shown in the middle and right columns. Magnitudes of standardized coefficients indicate relative discriminatory power of independent variables, thus the ordering is Z_3, Z_{12}, Z_4 and Z_{11}. The discriminant function was significant at the 10 percent level.

These discriminant results are mildly supportive of the first hypothesis. They are based upon 473 observations (responses of 16 of the 489 producers interviewed were not usable). Three hundred sixty-three of these producers made at least one substantial year-to-year change in hogs marketed during 1967-71, and 110 made no substantial year-to-year changes during this period. Results suggest that producers who made year-to-year changes were more likely to be those who had more education, sold fewer hogs at the beginning of the period 1967-71, used more market outlets (perhaps indicating they were more active managers), and had less capital intensive swine facilities. Except for the sign of Z_{12}, the signs are those hypothesized.

Regression Analysis

Results of F-tests indicated that the 16 data sets could be combined to estimate four separate regression models: one for all producers (i.e., farrow-finish or combination producers who increased or decreased marketings) for the 1970-71 change period, one for all producers in both the 1968-69 and 1969-70 change periods, one for those who increased marketings during 1967-68, and one for those who decreased production during 1967-68. These F-test results suggest that impacts of the explanatory variables in Table 2 on sizes of year-to-year changes neither differed between types of hog operations, nor between producers who increased and those who decreased marketings except in one change period, but were different in all except two of the change periods. Regression results for the three most recent change periods are presented in Tables 4 and 5. Regression results for the 1967-68 change period can be found in Trampel [10].

Regression results for the 1970-71 change period in Table 4 show that price of feeder pigs, expected price of fed cattle and operator health were important in causing large year-to-year changes in hog marketings. Expected price of slaughter hogs and labor supply were important in causing small year-to-year changes. Signs of importance of price of feeder pigs and health of operator were those hypothesized; but signs of the other three importance-scored variables are plausible, but opposite those hypothesized. Results also show that larger changes were made by producers with more education, more livestock enterprises, and more hogs marketed the previous year. Signs of these nonimportance-scored variables are those hypothesized. This model was estimated by using observations for 86 producers (representing about one-fourth of Iowa producers) who substantially increased marketings, and observations for 126 producers (representing about one-third of Iowa producers) who substantially reduced marketings.

Importance of expected price of slaughter hogs was not related to size of year-to-year change in hog marketings during 1968-69 or 1969-70. Regression results in Table 5 show that importance of feeder pig price, capital supply and average litter size had the hypothesized relationships with size of change. The sign of importance of feed supply is opposite that hypothesized. Number of years of education and hogs marketed the previous year were again significantly related to size of change, along with three other

TABLE 4. REGRESSION RESULTS FOR 1970-71: COEFFICIENT ESTIMATES AND t-RATIOS

Independent Variable	Definition	Coefficient Estimate	t-Ratio
Intercept		1.246	0.134
X_1	Importance of price of feeder pigs	21.363	2.651[a]
X_2	Importance of expected price of slaughter hogs	-12.781	-1.725[a]
X_3	Importance of expected price of slaughter cattle	15.092	1.613[a]
X_6	Importance of labor supply	-12.023	-1.806[a]
X_{12}	Importance of health of operator	20.079	2.603[a]
X_{14}	Number of years of education	5.068	2.174[a]
X_{17}	Number of livestock enterprises	24.767	3.067[a]
X_{21}	Number of hogs sold in 1970	0.244	13.664[a]

NOTE: $R^2 = 0.74$.

[a] $P < 0.10$.

TABLE 5. REGRESSION RESULTS FOR 1968-69 AND 1969-70: COEFFICIENT ESTIMATES AND t-RATIOS

Independent Variable	Definition	Coefficient Estimate	t-Ratio
Intercept		18.580	1.892[a]
X_1	Importance of price of feeder pigs	12.164	1.824[a]
X_7	Importance of feed supply	-23.885	-3.503[a]
X_8	Importance of capital supply	22.260	2.855[a]
X_{10}	Importance of average litter size	-11.831	-1.998[a]
X_{13}	Age of producer	-1.831	-3.094[a]
X_{14}	Number of years of education	5.619	2.112[a]
X_{18}	Number of acres operated	0.128	2.982[a]
X_{19}	Excess capacity	33.587	2.051[a]
X_{20}	Percentage of gross farm sales from hogs	1.608	4.106[a]
X_{21}	Number of hogs sold in previous period	0.124	5.533[a]

NOTE: $R^2 = 0.67$

[a] $P < 0.10$

nonimportance-scored variables. All nonimportance-scored variables have the hypothesized signs.

Results for all four change periods may be briefly summarized: Of the importance-scored variables, those related to relative profitability of hog production were most often significantly related to amount of change. Those related to input availability were next in significance, and those related to luck and management were significant least often. None of the importance-scored or nonimportance-scored variables, however, was significant in all four models. Also, none of the importance-scored variables was considered extremely important by a large proportion of producers making substantial changes. For example, for 1970-71, every importance-scored factor was of no importance to 40 percent or more of producers making substantial changes, and only two factors (disease problems and operator health) were of extreme importance to more than 10 percent of these producers [8].

That importance of expected price of slaughter hogs had a significant positive coefficient in only one of the four models is surprising and deserves comment. There are several possible explanations. One is simply that producers do not consider expected price when making decisions about year-to-year changes, perhaps because they are not confident in price predictability. A second possible explanation is that producers respond to expectations about price but often have sharply different expectations. If some producers plan large changes in marketings because they expect a large change in price, while a similar number of others because they expect small price changes, then no significant relationship between importance of expected price and change in marketings may emerge. Still other explanations are that the interviews did not permit producers to accurately state attitudes about importance of economic factors in causing year-to-year changes, or that expected price is important in the formulation of longer or shorter term plans.

SUMMARY AND CONCLUSIONS

In most studies of period-to-period changes in marketings of agricultural commodities, hypotheses about individual producer behavior are formulated and then aggregate data are used to test them and quantify relationships. An analysis of period-to-period changes based on data obtained from individual producers may complement and extend studies based on aggregate data by identifying characteristics that distinguish producers who make frequent period-to-period changes in marketings from those who do not, and by identifying factors that those making changes define as important in causing those changes. Data obtained from individual Iowa hog producers were used in an analysis of year-to-year changes in hog marketings.

Some limitations and possible extensions of this study deserve mention. The estimated discriminant function was not overwhelmingly significant. More confidence could be placed in these results if they were confirmed in later studies. Later studies could be improved by better measures of producer characteristics and by efforts to distinguish more groups of producers. For example, continuing producers who make frequent year-to-year changes might be distinguished from those who enter and exit.

Regression results also leave questions unanswered. It is not clear which of the possible explanations (for lack of a stronger relationship between importance of expected hog price and amount of change) is most nearly correct. Also, it is clear that impacts of explanatory factors on amount of change vary over time, but the pattern of, or reasons for, changes are not clear.

The results of this analysis, however, do provide some insights about year-to-year changes in hog marketings. They suggest that a sizable fraction of hog producers do not make substantial changes. Those who do are more likely to be more educated, to sell fewer hogs, to be better managers and to have less capital intensive facilities. Results also suggest that, in any one change period, some producers make substantial increases while others make substantial

decreases, that several factors are important in causing changes, and that the list of factors changes over time. Factors related to expected relative profitability of hog production are not unimportant in causing year-to-year changes, but many other factors also have influence.

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