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SWINE PRODUCERS' PRICE EXPECTATIONS AND THE HOG CYCLE

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SWINE PRODUCERS' PRICE EXPECTATIONS AND THE HOG CYCLE

I. INTRODUCTION

Hog production and prices are subject to considerable annual variation. Part of this variation appears as short-term irregular fluctuations. A large part of the variability, however, has followed a more or less "cyclical" pattern--at least at the national level (Figure 1).

Although hog production in North Carolina has exhibited an upward trend since the late 1940's, most (but not all) major fluctuations at the national level also appear in the state data (Figure 2). Since hogs and pork are readily shipped among areas, prices in North Carolina closely follow the national pattern over time.

The phenomenon of a hog cycle raises several practical problems. It makes planning by producers, packers, and others in the hog-pork sector more difficult; the "cycle" is not so regular that its peaks and troughs can be forecast with accuracy. Errors and the risk of errors in planning, imply, of course, increased production costs and lower producer and perhaps consumer welfare. The variability created in producer income is widely considered a serious problem. In addition, marketing margins fluctuate over the cycle suggesting a cyclical effect on the distribution of income among participants in the various stages of the production-marketing process.

Because of these problems and the common occurrence of cyclical behavior among many industries, economists have long been interested in the causes of cycles. Several theories have been developed as a

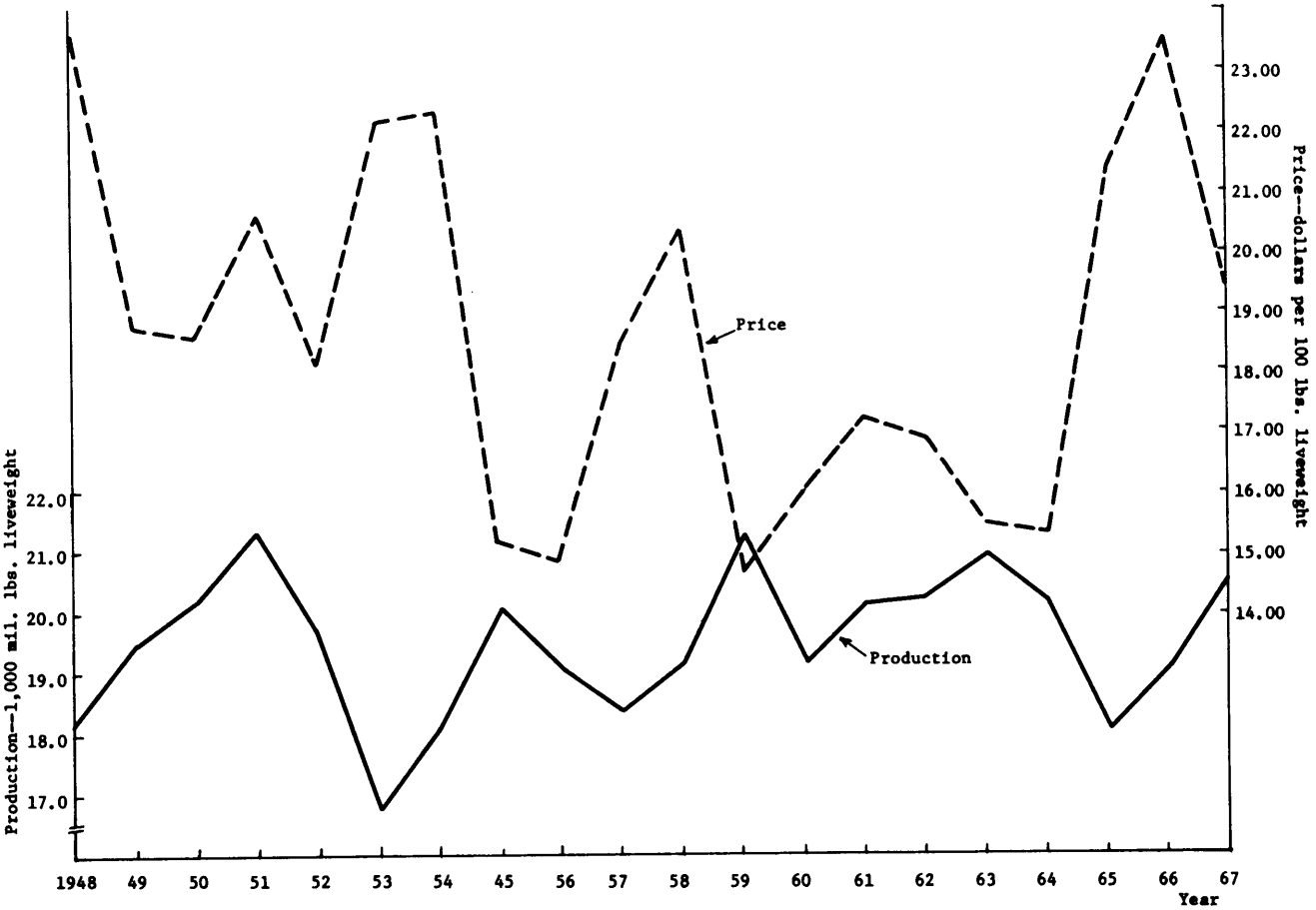

Figure 1. Hog Production, 48 States, and Price of Barrows and Gilts, 8 Markets Combined, 1948-1967

Source: United States Department of Agriculture (1963 and 1968).

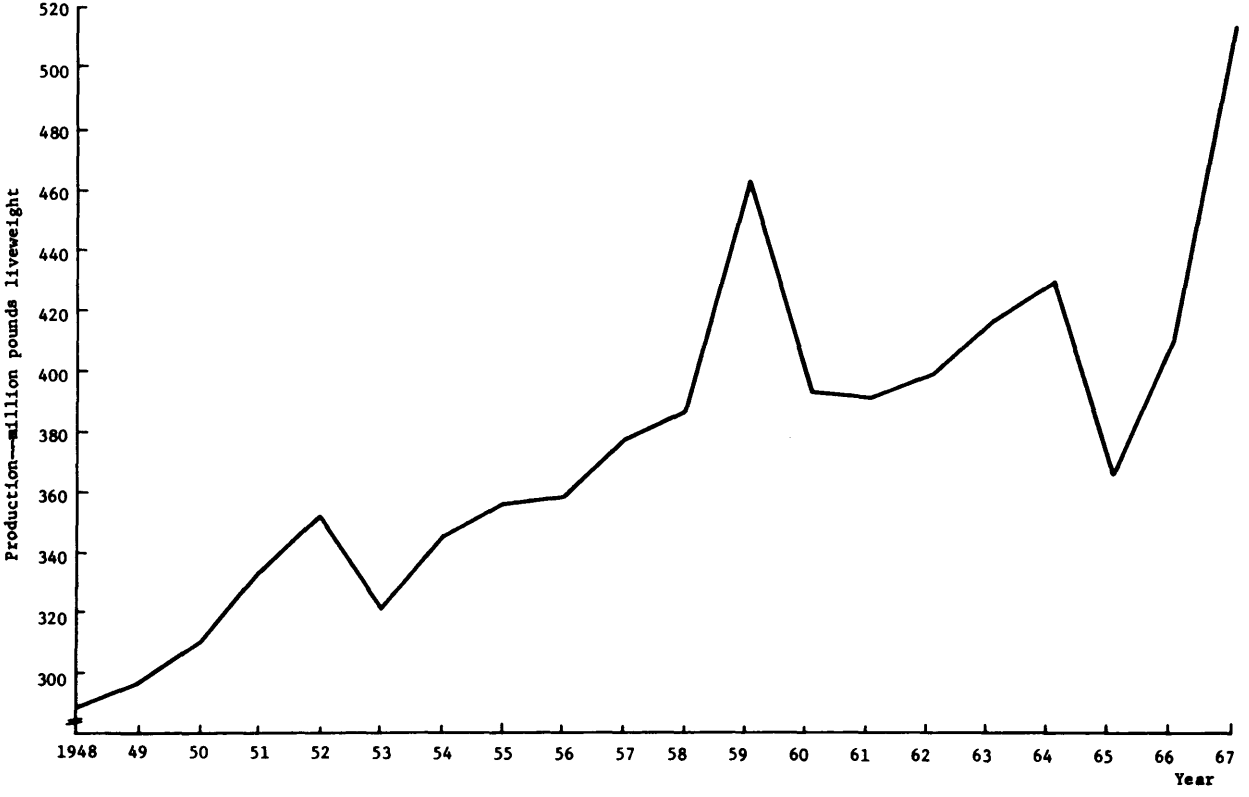

Figure 2. Hog Production in North Carolina, 1948-1967

Source: North Carolina Department of Agriculture.

basis for explaining and predicting cyclical behavior. These theories have been generally developed in terms of assumed decision making processes at the firm level and tested using industry level models and data. In addition, a number of studies have attempted to use firm level analyses of producer price expectations and production plans to gain insight into the decision making process. This study is of the latter type.

Objectives

The general objective was to examine, at the farm level, producer price knowledge and expectations as a factor contributing to the hog production cycle. The specific objectives were:

(1) To determine swine producer price knowledge and expectations.

(2) To explain differences in price expectations among producers.

(3) To determine the relationship between price expectations and production plans.

(4) To examine the contribution of the analysis to a better understanding of production cycles.

General Procedure

The procedure followed was to develop a set of hypotheses concerning the nature of price expectations and their role in producer output decision making. Data to test these hypotheses (and to suggest others) were obtained by a sample survey of farrow-finish swine producers in the summer of 1967. The producers were located in a relatively intensive hog producing area in northeastern North Carolina. The following sections of this report develop the framework for the analysis, describe the sampling procedure, and present the results and conclusions.

II. PRICE EXPECTATION AND PRODUCTION DECISION THEORIES

The purpose of this chapter is to briefly review some of the more important concepts and approaches used in the analysis of producer decision making and product supply, and to indicate their relationship to this study.

Basic Concepts

The analysis of producer decision making and product supply is clarified by distinguishing among conditions of certainty, risk, and uncertainty (Knight, 1957). A producer who knows current and future product prices (and costs) with certainty would be expected to select that output per unit of time which would maximize his profit, that is, the output for which marginal cost is equal to the known price. Since marginal costs would be expected to be positively related to output (in the short run), knowledge that the price would be higher next period would lead to plans to expand output, or if lower, to reduce output.

In practice, a producer will not have certain knowledge of the price in the next period. He may, however, know, or believe he knows, the probability of occurrence for each possible price. He would then be said to be facing a situation of "risk." If this were the case, he might select that output which would maximize his "expected" profit, that is, weight each possible price by its probability of occurring and use this weighted average price to select his level of output per unit of time. Alternatively, the loss of an extra dollar might have more significance or "utility" to the producer than a dollar increase in income, or vice versa. The variance of the distribution of possible prices would then influence his decision. In this case, he would choose the output level which would maximize his expected "utility." If this expected utility was less than the utility of the expected income, he would be said to have an aversion to risk. If it were greater, he would be said to have a preference for risk. Producers

with an aversion to risk would be expected to produce less given any distribution of anticipated prices than producers with a risk preference.

If the producer neither knows the price (or value of any other variable) for certain, nor has any notion of the probabilities to apply to possible prices, he is said to face a situation of "uncertainty." In this case, he is reduced to listing possible outcomes and then selecting the one which ranks highest on his "utility" function. For example, he might calculate the worst that could happen under alternative "strategies," and then select that strategy which performed the best under this extreme condition (i.e., use the minimax decision rule).

The details of alternative theories of choice are explained elsewhere (Luce and Raiffa, 1957; Ozga, 1965). The above outline is meant to summarize some of the key concepts and the general role played by price expectations in these theories. The following section indicates how these models have entered into supply estimation studies.

Expectations and Supply Analysis

The ultimate concern of this study is the explanation of variability in industry level production. Three classes of models which have been used in aggregate supply studies and their assumptions about producer behavior as identified by Nerlove (1961) are:

1. Extrapolative models: Producers are assumed to simply extrapolate current prices (e.g. cobweb model) or current changes in prices (e.g. harmonic motion model) into the next period. Although it can be shown that these models give rise to output cycles, and they have met with some success in applied studies (e.g. Harlow, 1962; Larson, 1964) a basic criticism has been their assumption that producers do not learn from past errors.

2. Adaptive expectations models: These models separate producer response to changed prices into two categories--a revised estimate of the "normal" price level and the production response to this change in expected price level. In each case the response is not instantaneous but distributed over several periods.

3. Rational expectations models: Expectations are assumed to be rational within the context of the whole behavioral model used. Nerlove

(1961) has illustrated this approach with the simple cobweb model. He shows that in this particular case the rational expectations hypothesis for price would be the adaptive expectations hypothesis. (The estimation procedure, however, would be different.)

The first two groups of models have been most commonly employed in studies of agricultural supply (e.g. Ezekiel, 1938; Harlow, 1962; Nerlove, 1958; Waugh, 1964). The fundamental hypothesis of all these models is that risk and uncertainty problems can be usefully reduced to certainty problems by postulating a "certainty equivalent" for the uncertain variable. The certainty equivalent may be the current price, the "expected" or "normal" price, etc. The objective is to reduce the problem to manageable proportions. Nerlove (1961, p. 45), however, points out two restrictive assumptions: "(1) Group behavior can be adequately explained by treating it as the behavior of a single representative and hypothetical decision maker; and (2) the representative decision maker behaves as if he maximizes the expected value of a function which is quadratic in the decision variables and the uncertain variables."

A recent study by Reutlinger (1964) used the representative firm concept, but attempted to include explicitly in the analysis the effect of price uncertainty. In this model, producers were assumed to try and minimize their maximum possible loss of profits. This model was compared to the maximization of expected profits motive assumed by the models outlined above. Reutlinger showed that if the marginal cost functions of firms are not linear, the variance of anticipated prices as well as their expected level is important in supply response. To the extent this result holds, the use of a "certainty equivalent" such as the expected price or most probable price could lead to erroneous predictions of output.

Estimation Problems

Efforts to employ these decision models at the aggregate level have often resulted in reasonably good predictions over the sample period, but with less success into future period (e.g. Harlow, 1962). In addition, efforts to apply the models have encountered a number of statistical problems (Nerlove, 1958; Griliches, 1967). Perhaps the

most important problem occurs when alternative decision hypotheses lead to the same statistical model (reduced form). Thus, even when the statistical model accounts for a statistically and economically significant portion of the variability in output, the implications for private or public decisions may still be obscure. In addition, one of Reutlinger's (1964, p. 2) conclusions was:

> In a positive sense, this study presents some evidence that supply predictions are essentially the same regardless of which uncertainty hypothesis is assumed in specifying the supply model. Conversely, it also seems evident that conventional regression analysis of time series is not likely to yield good tests of the structural hypotheses discussed in this study.

As indicated in the following chapter, the micro level analysis of producer decision behavior also encounters a number of serious estimation problems. A cross-sectional analysis, however, allows investigation of the role of a number of variables on producer output decisions not readily analyzed at the aggregate level. In general terms, these are variables characteristic of the producer, his production enterprise, and his production alternatives. If these characteristics influence producer behavior and are a function of time, then the industry supply function will be affected but the effect will not be readily measured using time series data.

For example, some persons believe the hog cycle is caused primarily by the entry and exit of small (and ill informed) producers acting in the manner suggested by the cobweb model, while larger producers find it profitable to produce at a level independent of expected prices. If this is true, the trend to larger size swine enterprises implies the demise of the cycle. An alternative hypothesis is that producers of all size groups make small adjustments (e.g. farrow one less sow) which in the aggregate become large. This alternative decision might be based on behavior as hypothesized by one of the decision models outlined above.

III. REVIEW OF PREVIOUS STUDIES

A number of studies have examined the nature of producer price expectations and the relationship between expectations and planned output by direct observation of individual producers. This review of survey results is limited to agriculture and primarily to studies of hog price expectations.[1]

In an Iowa State study in 1940, Schultz and Brownlee (1942) asked a group of farmers in March to predict the price of hogs in December. The price had declined from a level of $11.00 in 1937 to $4.90. Many persons expected war. The mean anticipated price observed was $5.09 with a standard error of $.58 (97 in sample). The distribution was skewed somewhat to the high side; it included 56 estimates of $5.00, 10 of $5.50, and 10 of $6.00. These results suggested a close link between current price and anticipated prices for hogs. No statistically significant relationships between anticipated price and location in the state, age, tenure, or education was found.

A second part of the study used analysis of variance to compare deviations between anticipated corn yields and corn yields that would have been anticipated under the hypothesis that equal weight had been placed on yields experienced 20 years and 3 years previous. This hypothesized value was almost identical to the average anticipated yield. Analysis indicated that yield expectations were a function of area of the state, education, tenure status, and yield experience as

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[1]Nerlove (1958) reviewed three studies of producer expectations in the industrial sector. He commented that these studies covered longer periods of time than those made in agriculture and hence provide better evidence for their conclusions (pp. 46-67). The general conclusions were that producers generally underestimate the magnitude of change in prices or sales and could generally do better with a naive projection of current values (changes?). One interpretation was that producers respond to long-term concepts of price and output and essentially ignore short-term variations. The present review concentrates on the agricultural studies because they would seem to be the most pertinent and collectively cover a substantial number of cases.

related to yield expectancy (i.e. relationship of 1938-39 yield to AAA base and expected yield to AAA base). Age of operator was not a significant factor. A conclusion of this study was that factors influencing yields are better "understood" and give rise to less uncertainty than highly fluctuating hog prices.

A study of farmers in the central cash-grain area of Iowa by Brownlee and Gainer (1949) did find less uncertainty with respect to corn yields than corn prices, but the study did not include hog prices. The authors noted that producers were apparently unfamiliar with the concept of probability. Technological factors rather than economic considerations were the more common reasons given for changing crop output levels.

In 1950, Williams (1951) examined the expectations of farmers in the cash grain area of Illinois. His study included corn, hog and beef cattle prices. In each case he found a reluctance to predict and a tendency for producers to extrapolate their own experiences, such as a relatively high loss of pigs, to other producers. Predicted prices were usually dependent on expected activities of the government and size of corn crop. Price expectations for corn, hogs, and beef had low (but statistically significant) correlations.

A study by Kaldor and Heady (1954) of producers in southern Iowa included 4 interviews over a period of 18 months. The study included hog and corn prices. They attempted to ascertain each producer's idea of the most probable price and the range in price. The range was defined in such a way that the chance that the price would fall outside the stated range was supposed to be .02.

This study found that the most probable price varied widely among producers. The implicit probability distributions were generally appreciably skewed. Producers appeared to be more certain of their forecasts of hog prices than corn prices. Degree of certainty was measured by the range in expectations relative to the most probable price; this ratio for corn was .83 and .76 and for hogs .50 and .58 for the respective years. This study found a significant correlation between forecasting errors among products for the same farmer in the same year. Forecasting errors for corn in 1949 were not correlated to errors made in 1948.

In both 1948 and 1949, comparison of June forecasts of hog prices with December forecasts indicated that revisions were in the same direction as actual price changes during the 6-month interval and resulted in more accurate forecasts. With the exception of two crops, revisions in estimated prices of crops also were in the same direction as actual changes but the revised estimates usually did not lead to greater accuracy.

Although averaging over producers suggested little change in plans compared to the previous year's operations, this small difference resulted from a cancelling out of very large differences on individual farms. Producers explained planned changes in crop production mostly in terms of crop rotations and changes in tenure arrangements.[2] Price-cost considerations were given more prominence for changes in livestock plans. The relationships among short-term expectations and adjustment and long-term expectations and plans was an area suggested in need of much additional research.

Tompkin and Sharples (1963) interviewed a group of Ohio farmers over a period of five years. They obtained anticipated prices for the month in which the producer expected to sell the product. Hog, corn, and soybean price expectations and crop yield and livestock birth rate expectations were obtained.

Correlation analysis of expected hog price and (1) actual price received, (2) University outlook price, (3) price previous fall, (4) current price, and (5) hog supply previous fall found few significant relationships and none that were consistent over time. More success was obtained in an analogous study of corn and soybean prices. Simple correlations did indicate that operators' expectations for the current year were influenced by the direction in which the previous year's expectation was in error for crop yields and livestock birth rates. In particular, significant correlations were obtained for litter size estimates and litter size previous fall for both 160-acre and 320-acre producers and with litter size the previous spring for the 160-acre group. The larger farmers' hog price expectations were slightly more

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[2] A change in crop rotation rather than a change in production due to a given rotation would seem to be the relevant consideration.

closely correlated with outlook prices compared to the smaller farmers. This was the only study in which expectations were examined by size of farm. No study attempted to find differences by size of swine enterprise.

Analysis of paired comparisons was used to test the accuracy of predicted values. Over 40 percent of the mean price differences for livestock were significantly different from zero. No consistency over time in the ability of individual operators to predict prices was found, nor could good and poor predictors be characterized by age, education, years of farming experience, quality of land, or operator's labor income. Intervals consisting of a dollar above and below producers' expected price were found to contain the actual price on approximately one-third of the days in the relevant month. No discussion of the distribution of expected prices, given the month of expected sale, was presented. The producer average expected monthly prices were generally at least as accurate as the University outlook price. A graphic comparison of actual price, outlook price and average expected price reported by the 160-acre producers indicates that both producers and outlook people underestimated actual changes in prices.

When questioned about what changes would be made in response to specified price levels, hog production was found to be the most responsive of the enterprises examined. Each $1 increase in price over the range $10-$30 was associated with an increase of about .5 litters per farm (spring and fall) for each size group.[3] The simple correlation coefficients between expected number of spring litters and expected fall hog prices, however, were not statistically significant. Linear programming results suggested that the effect of small price changes on producer returns was not appreciable.

Asked about "nonprice" factors associated with production decisions, 80 percent of the 160-acre producers indicated "lack of sufficient knowledge of probable returns" from alternatives, while 53 percent of the 360-acre operators indicated this factor was important.

Several of the above studies included an analysis of the attitude of producers toward price uncertainty and the effect of uncertainty

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[3]Derived from Figure 3, p. 20, and assuming sample sizes of 35 (p. 4) (Tompkin and Sharples, 1963).

on output decisions. The usual approach was to ask each producer the minimum price at which he would contract for production and how much he would produce at that price. These answers were then compared to his anticipated prices and planned production.

Most researchers expected that producers would prefer to avoid risks, and thus be willing to accept a contract price lower than their expected price. The opposite results, however, were attained. Even after carefully reducing his sample to only the most pessimistic (mainly hog and dairy) producers, Boan (1955), for example, found producers either desired a higher guaranteed price or refused to accept a guaranteed price at all. P. R. Johnson (1962) has summarized these results[4] and rationalized them in utility maximization terms. Drayton (1955) has emphasized the difficulties that producers face in sorting out their expectations and values, especially when faced with hypothetical situations. In addition, an assumption made in these studies was that the most probable price can be treated as the "expected" price. As indicated above, the distribution of anticipated prices sometimes may be appreciably skewed.

In summary, these studies of producer hog price expectations indicate a large degree of price uncertainty among producers at any point in time. Although producers have little notion of probability distributions _per se_, the implicit distributions often are skewed. The degree of uncertainty and the degree of skewness in the distributions vary from period to period. There has been some analysis aimed at explaining the variability in expectations among producers and over time. The influence of size of swine enterprise on price knowledge and expectations, however, has not been examined. This relationship, if it exists, would appear to be important in predicting changes in hog production variability as size of enterprise continues to grow.

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[4]Studies included in his paper from the above set were Brownlee and Gainer (1949), Williams (1951), Kaldor and Heady (1954), and Boan (1955). The following two studies also were included: Morrison _et al._ (1955) and G. A. Bramlett and P. R. Johnson, "Reducing Market Risks in Selling Selected Farm Products," unpublished, 1959.

Several studies have attempted to relate expected changes in prices to planned changes in production. Efforts to quantify the relationship for hogs have been limited to the Tompkin-Sharples study.

All studies have suggested that most farmers prefer at least some degree of price risk. There has been little effort, however, to explain variation in risk preference in terms of producer or enterprise characteristics. Such an analysis would be useful in this period of rapidly changing size of enterprise and increased interest in contracting and other forms of vertical coordination in swine production.

All studies related to swine expectations have been conducted in the Corn Belt states, the major hog producing region. To the extent that interregional comparisons can be made, they would provide a further test of hypotheses which seek to explain price and production variability.

Finally, it is widely recognized that the interview method introduces a number of severe problems and limitations. These include translating the concepts of theory into practical terms (e.g. few persons, if asked the probabilities of alternative prices, would provide a set summing to one; a producer might act as if responding to a "normal" price level but not be able to say what that level is or how it relates to current prices); a producer may carefully project prices at the time decisions are made but have relatively little information at the time of the interview (i.e. it is difficult to both avoid essentially hypothetical questions and obtain data comparable among producers); all the well-known problems of interviewer biases; recall problems where records are not kept; the widely diverse situations facing individual producers; and the high cost of each schedule. In addition, if data are obtained over a period of time from each producer, which would be desirable in this type of study, individual behavior might be expected to be influenced by the interview process leading to a nonrepresentative sample.

In this study, an effort was made to avoid hypothetical questions by having the questions deal with hogs on hand or with planned future farrowings. An effort to reduce producer variability was made by limiting the study to farrow-finish producers.

IV. HYPOTHESES AND DATA

The purpose of this chapter is to indicate the major hypotheses tested in this study and the source of data used to test them. The specific models employed are discussed in the following chapters.

Hypotheses

1. Price expectations hypotheses:

(a) Producers believe the most probable price next period is the price of the current period, i.e. $P^*_{t+1} = P_t$.

(b) Producers believe the most likely change in price between the current period and the next period is the change between the current period and the previous period, i.e. $(P_{t+1} - P_t)^* = P_t - P_{t-1}$.

(c) Predicted price is a function of size of swine enterprise and experience in producing swine for market.

2. Production response hypotheses:

(a) Planned change in the level of swine production is a function of the anticipated change in price.

(b) Producer response to a given change in price is influenced by current size of swine enterprise, degree of specialization in swine cost and financial factors, and risk preference.

Data

The data used in this study were obtained from a sample of swine producers in a seven-county area of northeastern North Carolina.[5] The seven counties were Halifax, Chowan, Perquimans, Hertford, Northampton, Gates, and Bertie. This area is part of the major hog producing region of the state, but even here swine is a relatively minor part of the

[5]Data also were obtained in a second seven-county area in the east central part of the state. Difficulties in locating sample producers and obtaining their cooperation in the study, however, resulted in too few complete schedules, especially with respect to price data, to provide reliable tests of the hypotheses.

agricultural sector. Major crops in the area are peanuts, soybeans, and cotton.[6]

A stratified random sample of the larger hog producers in the area was drawn from a listing of such producers. The list of producers was obtained from a mail survey of county extension chairmen. Each chairman was asked to list all producers in his county who farrowed 30 or more litters per year.[7] In addition to the name and address of each producer, information on the type and size of swine enterprise was obtained. The number of such producers in each county was thought to be small enough to make such a request feasible but too small for any other sampling method.

The sample drawn was stratified into 3 size groups: 30-49, 50-79, and 80 or more farrowings per year. Since the sample was desired for analytical rather than descriptive purposes, an effort was made to obtain equal numbers of producers in each size group, namely 20.[8]

In addition, a random sample of 20 producers in the size range of 10-29 litters was desired. Since it was expected that these producers would be relatively more numerous, an area sampling procedure was employed. In fact, however, this procedure had to be abandoned because of the difficulty of locating such producers in the areas selected. Additional producers in this size group were obtained from leads provided by other producers.

Only producers who both raised their own pigs and fed them to market weights--called farrow-finish producers--were included in the study. For purposes of sampling the producer lists, a farrow-finish producer was one for whom (a) fewer than 20 percent of pigs born were

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[6]North Carolina Agricultural Statistics (North Carolina Department of Agriculture, 1965). This issue contains dot-type maps clearly indicating the major producing areas for various crop and livestock enterprises.

[7]Such a list was obtained for all counties by Cline et al. (1964) for 1962 and updated by this writer for 1965 and 1966.

[8]The goal of 20 producers per size group was not attained because of time and cost considerations. The sample was balanced geographically within each area. The sample was drawn with the assistance of Professor C. H. Proctor, Department of Experimental Statistics, N. C. State University. Professor Proctor also assisted in drawing the area sample discussed below.

sold as feeder pigs, and (b) the major enterprise was commercial hog production, not the development and sale of purebred breeding stock.[9]

Sixty schedules were obtained during the three-month period, June-August, 1967.[10] The number of usable records obtained by size group is presented in Table 1. How the schedules were classified on the producer (sampling) list is indicated as a rough measure of the accuracy of the list.

Table 1. Number of Producers by Size Group, Listing Classification, and Source

Source and Size[a] Classification	Actual Size[a] Group, 1966				
	10-29	30-49	50-79	80+	Total
	(number of producers)				
Producer List					
30-49	6	7	5	1	19
50-79	2	5	6	3	16
80+	0	0	2	17	19
Non-list[b]	5	1	0	0	6
Total	13	13	13	21	60

[a]Number of litters farrowed per year.

[b]From the area sample and other sources.

Adequacy of the Data

At best, the data obtained indicate producer price expectations and production plans at a given point in time, in particular at a point on the downward side of the hog price cycle. A more complete analysis obviously would test the various hypotheses presented at different points

[9]In editing the schedules obtained, this definition of a farrow-finish producer was relaxed by raising the cut-off levels to 25 percent and applying this percentage to the usual practice of the producer. The "usual practice" was determined from purchases and sales reported for 1964 through 1966 and planned for 1967 and 1968.

[10]A single interviewer was employed. A preferable procedure may have been to use several interviewers and test for any interviewer biases using statistical methods.

on the cycle. Initially it was hoped that additional data could be obtained over time, but this did not prove to be feasible.[11]

[11]A mail survey of sample producers was made in the spring of 1968. Questions pertained to prices received and production in 1967 and anticipated prices and production for 1968. Too few replies were received to produce reliable tests of the models used in this study. The few regressions attempted produced nonsignificant and/or illogical results, such as a negative relationship between price and production.

V. PRODUCER PRICE KNOWLEDGE AND EXPECTATIONS

As indicated earlier, the problem of explaining variation in output can be broken into two parts; the nature of producer price expectations and the response of producers to a given set of expectations (or change in expectations). This chapter examines price knowledge and expectations. Because price expectations were expected to be a function of current and past prices, producer knowledge of several aspects of current and past hog prices is examined first.

Producer Price Knowledge

Current Prices

Assuming prices influence the number of sows producers intend to farrow, they would be expected to know the price of hogs at farrowing time and have devoted some effort to predicting prices for the anticipated marketing date. If prices also influence feeding rates or other short-term decisions, producers also would be expected to know the price of hogs at any point in time. Since the returns associated with the latter set of adjustments probably are relatively unimportant on most farms, producers generally would not be expected to know the current price with certainty. This latter price, however, is the only "current" price the survey method allows us to relate to anticipated prices. Information can possibly be obtained on current price knowledge and expectations; it would be much too unreliable to try to have producers recall the price knowledge and expectations they had at breeding time.

The hypothesis tested in this section is that the average producer estimate of the current price of hogs did not differ from the actual current price. Producer estimates of the current market price are presented by month of interview (1967) in Table 2. Market price estimates of the Statistical Reporting Service (SRS) as published by the North

Table 2. Current Hog Prices Reported by Sample Swine Producers and Statistical Reporting Service, by Interview Date

Month	No. Producers Reporting	Estimated Current Price, 1967		Actual Price[a]	
		Average	Standard Deviation	1967	1966
		(dollars per 100 pounds)			
June	17	22.24	.50	21.00	23.20
July	24	22.51	.37	21.20	23.20
August	13	21.75	.84	20.30	23.80
Totals	54	22.24	.55	20.93[b]	23.34[b]

[a]Source: North Carolina Department of Agriculture.

[b]Average monthly prices weighted by number of producers reporting most probable price.

Carolina Department of Agriculture for the comparable months of 1966 and 1967 are presented for comparison.

At least superficially, these data suggest that producers believed market prices were higher than they actually were. The difference between producer estimates of the current price and the Crop Reporting Service's estimates averaged $1.31.[12] Four possible explanations are: (1) SRS estimates were in error, (2) the producer estimates include grade or weight premiums, (3) the producer data reflect a locational differential, or (4) producers were in error.

Since there is no reason to expect that the SRS estimates would be consistently in error, reason (1) is assumed not true. With respect to reason (2), the question emphasized market price. This does not mean that premiums were not included. But a separate question specifically concerned premiums. The average premium reported was $.23 per 100 pounds which indicates that errors in reporting premiums would not change the conclusion. Although some price variation among areas of the state has been observed, it has been minor compared to the observed differences in Table 2 (Purcell et al., 1965, pp. 17 and 33-34). The

[12]This difference is highly statistically significantly different from zero.

conclusion is that producers, in the summer of 1967, were overestimating the current price of hogs by an average of about 6-7 percent.

One possible explanation for this result would be that producers in the summer of 1967 had in mind the relatively high prices of 1966 (Table 2). The weighted average price reported by SRS for the comparable period in 1966 was $23.34. The SRS data thus indicate a drop during the year of $2.41 while the producers' replies indicated a decline of only $1.10. In other words, producers apparently were aware that prices had fallen since the previous summer but were not aware of how far they had fallen.

The hypothesis that the estimated current price was a function of the past price level was further tested using multiple regression analysis. In this analysis, the past price was represented by the average price received in 1966.[13] Additional independent variables included were size of swine enterprise, years producing hogs for market, and month of interview. Larger and more experienced producers were expected to be more aware of current prices; the data of Table 2 clearly suggested that the estimated price was a function of the interview date.

The regression results indicated that the price received in 1966 had no effect on producers' estimates of the current price level.[14] No other reason was found for the general overestimation of current prices. The current price estimate was not related to size of producer

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[13]The reported prices for 1966 varied widely among producers. Variation in marketing dates and memory errors would be two possible reasons in addition to differences in market outlets, quantity and quality differences, etc. The average price for 1966 reported by those producers who supplied both a 1966 and a current price estimate was $22.88.

[14]The estimated function was (with t values in parentheses):

$$P_c = \underset{}{23.05} - \underset{(-.53)}{.03P_{66}} - \underset{(-.27)}{.07L_1} - \underset{(-.42)}{.11L_2} - \underset{(-.35)}{.08L_3} - \underset{(-.55)}{.004E} + \underset{(.97)}{.20I_1} - \underset{(-2.25)}{.52I_2}$$

$$R^2 = .27 \qquad d.f. = 41$$

where P_{66} = average price received, 1966. The L's and I's are sets of dummy variables for size of swine enterprise and interview date, respectively, and E is years producing swine for market. These non-price variables are defined more precisely on page 30. Only the coefficient of I_2 was statistically significant (at the 95 percent level).

nor was it related to years of experience. The effect of interview date was as expected given the data of Table 2.

Seasonal Price Variation

The question of the degree to which producers are aware of seasonal variation in hog prices has direct relevance in evaluating answers to anticipated price changes. For example, does an anticipated lower price for December mean that the producer thinks the price level is going to be lower cyclically or does it only mean that he is aware of the fact December is a relatively low-price month? This question has received too little attention in previous studies of this type. The regression analysis described above indicated that the month of interview had a highly significant influence on the current price reported.[15]

Producers were asked to identify the month which usually had the lowest hog price and which one the highest. Many producers indicated more than one month for each answer. There was overwhelming agreement that June, July and August were the highest price months. A majority of replies mentioned February, March, or April as the lowest price month with November, December, and January not far behind. The average difference in price between the high and low price months reported by 58 producers was $4.67 per 100 pounds with a standard error of $1.32.

For purpose of comparison, the average seasonal price pattern during the period 1957-1966 in North Carolina is presented in Table 3. These data were computed using a 12-month moving average. The number for each month is interpreted as the average proportion over the period that that month's price was of the annual price, after eliminating the effects of trend, cyclical, and irregular fluctuations in prices.

Producers were generally accurate in identifying the high and low price months but overestimated the price difference. The average annual price in North Carolina over the period 1961-1966[16] was $17.98. Applying the seasonal price index to this average price suggests an average maximum difference of $1.91, less than half the average difference

[15]The average price reported for August was significantly lower than the prices for June and July (also see Table 2).

[16]The period 1961-1966 represents the latest complete price "cycle" prior to 1967.

Table 3. Prices Received by Farmers in North Carolina as a Percent of the 12-Month Moving Average, 1957-1966

Month	Percent	Month	Percent
January	98.12	July	105.39
February	97.71	August	106.15
March	95.64	September	103.93
April	95.56	October	100.32
May	97.57	November	97.96
June	102.67	December	99.00

reported by producers.[17] If this error carried over into replies concerning anticipated prices, it would lead to an upward bias in the high price months and a downward bias in the low price months. This apparent error in belief about the degree of seasonal variation in prices is surprising but might have contributed to the overestimation of current prices indicated above.

Cyclical Price Variation

In addition to knowledge of current prices and seasonal price patterns, information was obtained on producer knowledge of the hog cycle. The data are presented in Table 4.

Producers in the smallest size group appeared to be least aware of the concept of the hog cycle. Research results suggest a cycle of about 4 years (Harlow, 1962). This is a somewhat longer period than indicated by most of the producers replying to the questions, especially those in the smallest size group.

Producer Price Expectations

In order to make the question as meaningful as possible, producers were asked to predict the price of hogs only for those times at which

[17] The overestimate of the degree of seasonal variation was not due to confusion of seasonal, cyclical and trend variation. The simple average differences between April and August prices over the 1957-1966 and 1961-1966 periods, respectively, were $2.04 and $2.49 per 100 pounds. It is possible, however, that producers were thinking in terms of high and low daily average prices.

Table 4. Producer Knowledge of the Hog Cycle, by Size Group

Size Group	Familiar with Cycle		Estimated Length of Cycle		
(litters per year)	(number)	(percent)	(no. obs.)	(average length in yrs.)	(standard deviation)
10-29	4	30.8	3	2.0	1.00
30-49	6	46.2	2	3.0	1.41
50-79	6	46.2	5	3.8	.76
80+	13	65.0	11	3.1	1.36
Total	29	49.2	21	3.1	1.21

they would have hogs for sale. Information was requested on the expected marketing date, most probable market price, and range in anticipated price. This set of questions was posed for current pigs on hand (unless they were virtually ready for market) and the next farrowing. For convenience, these cases are referred to, respectively, as farrowings No. 1 and No. 2. Some general characteristics of the price distributions are presented first, followed by an analysis of differences in predictions among producers.

General Results

The results of the above set of questions for farrowing No. 1 are presented in Table 5. The actual price for each month, as published by the Statistical Reporting Service, also is provided for comparison.

The average most probable price anticipated by producers was $19.94 per hundred pounds (Table 5). Considerable variability in expectations, however, is evident. Part of this variability can be attributed to differences in expected marketing date, but the column of standard deviations clearly indicates wide variation in anticipated prices within months.[18] In general, the within month variation is apparently greater than the variation in estimating the current prices of Table 2.

[18] Analysis of variance indicated no statistical relationship between marketing month and most probable price for farrowing No. 1. The effect was significant at the 95 percent level, however, for farrowing No. 2.

Table 5. Anticipated and Actual Prices, Farrowing No. 1, by Expected Marketing Date

Expected Marketing Date		Most Probable Price			"Range" in Price[a]			
Month	Year	Number Producers Reporting	Average	Standard Deviation	Number Producers Reporting	Avg. Minimum Price	Avg. Maximum Price	Actual Price[b]
		(dollars per 100 lbs.)			(dollars per 100 lbs.)			
August	67	4	23.00	.82	1	21.00	25.00	20.30
September		3	20.33	.58	1	18.00	22.00	18.90
October		5	20.40	2.30	1	19.00	23.00	18.30
November		2	20.00	0.00	2	20.50	21.50	17.60
December		14	19.71	1.34	4	17.50	19.25	17.60
January	68	12	19.46	2.92	5	20.00	21.40	17.70
February		4	18.25	2.75	2	20.50	21.50	17.80
Totals and averages		44	19.94	2.10	16	19.38	21.25	18.02[c]

[a]Not all producers volunteered both a most probable price and a range in prices. Due to a misunderstanding, producers who provided a most probable price generally were not asked also for a range in prices.

[b]Source: North Carolina Department of Agriculture.

[c]Average monthly prices weighted by number of producers reporting most probable price.

It was expected that variability in predictions would be an increasing function of the length of prediction period. Although these results give some support to this hypothesis, the low variance for December does not support it.

The small number of producers reporting a minimum and maximum price they thought had any chance (1 in 100) of occurring was too small in most cases to be meaningful.[19] The average range in these prices for the group brackets the average most probable price, but this was not true for every month.

The correspondence between the average most probable prices and actual prices is clearly small. The average producer predicted price exceeds the weighted average actual price by $1.92 or 11 percent. This difference is highly statistically significantly greater than zero, and suggests a possible relationship to the overestimation of the current price reported previously.[20]

Producer price expectations for farrowing No. 2 (Table 6) exhibited the same general characteristics as for farrowing No. 1. The overall average most probable price was slightly lower but still 11 percent above the actual prices. The standard deviation of the most probable price was somewhat lower at 1.85. The range between the average minimum and average maximum prices included the average most probable price.

Finally, a large number of producers volunteered that they paid little attention to hog prices. One question specifically asked was "Do you usually try to predict year to year variation in hog prices?" Only 25 percent of the producers gave an affirmative answer--but this writer places little confidence in the replies to such questions.

Explanation of Variation in Expectations among Producers

The particular price expectation held by an individual producer at a point in time is no doubt a function of numerous factors. Some of

[19] Due to a misunderstanding, producers who provided a most probable price generally were not also asked for a range in prices.

[20] It is noteworthy that a comparison of producer expected prices, university outlook prices, and prices actually received, over a five-year period in Ohio also suggests a tendency to underestimate price changes (Tompkin and Sharples, 1963, p. 8).

Table 6. Anticipated and Actual Prices, Farrowing No. 2 by Expected Marketing Date

Expected Marketing Date		Most Probable Price			"Range" in Price[a]			
Month	Year	Number Producers Reporting	Average	Standard Deviation	Number Producers Reporting	Avg. Minimum Price	Avg. Maximum Price	Actual Price[b]
		(dollars per 100 lbs.)			(dollars per 100 lbs.)			
December	67	4	22.50	2.38	2	19.00	21.50	17.60
January	68	9	19.67	1.20	5	17.40	19.00	17.60
February		14	18.64	1.01	4	17.75	19.25	17.70
March		7	20.00	3.12	7	19.00	20.57	17.80
April		3	19.33	2.08	1	20.00	21.00	17.70
May		2	19.50	2.12	1	22.00	23.00	18.00
Totals and averages		39	19.62	1.85	20	18.55	20.15	17.70[c]

[a]Not all producers volunteered both a most probable price and a range in prices. Due to a misunderstanding, producers who provided a most probable price generally were not asked for a range in prices.

[b]Source: North Carolina Department of Agriculture.

[c]Average of monthly prices weighted by number of producers reporting most probable price.

these probably are highly subjective and transitory and might simply reflect his current degree of optimism about the future in general as well as the hog business in particular. A basic assumption of this study was that to an important degree expectations also are a function of a reasoned effort to predict future prices and to act on these predictions. The logic behind this assumption was that at least some effort at such predictions would necessarily be one part of good management practices. Therefore, it was hypothesized that a producer's ability to predict price would be a function of his general managerial or entrepreneurial skill. This skill was assumed to be a function of such observable variables as size of swine enterprise, degree of specialization in swine, and experience in producing hogs for market. Also, size of enterprise would reflect the value of making accurate predictions. To the extent that the hog cycle can be related to erroneous price predictions, and such errors can be related to observable variables, changes in the cycle would be more predictable.

In addition, the wide variation in producer estimates of the current price level, indicated in the previous section, unexpectedly allowed testing of the hypotheses that (1) producer price expectations are primarily an extrapolation of producer beliefs about the current price, and (2) they are primarily a function of producer beliefs about recent changes in prices.[21]

Multiple regression analysis was the primary tool used to explain the observed variation in price expectations among producers. The specific model employed was:

$$P_i = f(P_c, L_1 - L_3, E, I_1, I_2, M_{ij}, e_i)$$

where:

P_i = most probable price, farrowing No. i, i = 1, 2.

P_c = producer estimate of current price.

$L_1 - L_3$ = 1 for size group 30-49, 50-79, 80 and more litters farrowed, 1966, respectively; 0 otherwise.[22]

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[21] It was anticipated that data spanning a period of years would be necessary for these tests. Indeed, such data would be useful for a more thorough analysis but would be very expensive to obtain.

[22] The effects of size group 10-29 litters, interview date in June, and marketing date in August (for farrowing No. 1) or November (for farrowing No. 2) are included in the constant term; the coefficients of the dummy variables are relative to these bases.

E = number of years producing swine for markets.

I_1, I_2 = 1 for interview date in July or August, respectively, 0 otherwise.[22]

$M_{11} - M_{16}$ = 1 if expected marketing date for farrowing No. 1 was September, 1967 - February, 1968, respectively; 0 otherwise.[22]

$M_{21} - M_{25}$ = 1 if expected marketing date for farrowing No. 2 was January, 1968 - May, 1968, respectively; 0 otherwise.[22]

e_i = random error term for equation i.

It was assumed that variation in the stated most probable price, given the expected marketing date, would reflect variation in expectations about changes in the general level of future hog prices. Variation among producers in predicted price for a given marketing month, however, could be due to different beliefs about the degree of seasonal, cyclical, or trend factors in hog prices. These three potential sources of variation could not be separated given the cross-sectional nature of the data.[23]

Variable P_c, estimated current price, was included, as indicated above, to test the widely held hypothesis that producers tend to "predict" prices by simply extrapolating the current price of hogs. Dummy variables for interview date (I_1 and I_2) were included in order to hold constant (a) the general economic conditions under which the price predictions were made, and (b) the length of prediction period. In other words, the analysis relates differences among producers in beliefs about the current price of hogs, at a given point in time, to their predictions of the price at a given future point in time.

Size of swine producer, measured in number of litters farrowed in 1966, was used as a measure of the absolute size of the swine enterprise. Producers generally seemed to have more confidence in their ability to recall the number of litters farrowed than the number of hogs sold. It was expected that larger producers would find it more profitable to

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[22] See page 30.

[23] Note that producers varied appreciably in their estimates of the magnitude of seasonal price changes, but there was general agreement on the high and low price months. There was little or no trend in hog prices. Also, note that only cyclical price differences would be expected to influence production. The results of the following chapter, therefore, give some support to the assumption that the major source of differences in price expectations were cyclical.

invest in price information and hence have more accurate price predictions. Since the general tendency was to overestimate prices, this reasoning led to the expectation of negative coefficients for the dummy variables representing the size groups (L_1 - L_3).[24] An alternative line of reasoning, however, was that larger producers would tend toward a policy of producing regardless of (especially short-term) price changes. This policy might be based on relatively low per unit costs and/or the idea they were in the hog business to stay. In this case, a positive coefficient would be expected since it would be the larger producers who would be expected to be the more unaware of recent price changes. A two-tailed test of significance, therefore, was used for the coefficients of these variables.

Variable E was included in the belief that more experienced producers would be better price predictors. Given the general overestimation of prices, a negative correlation was expected between P_1 and E.

The regressions for farrowing No. 1 produced no statistically significant relationships between predicted prices and the variables of interest; only some of the marketing month variables had statistically significant coefficients.[25] In the case of farrowing No. 2, however, predicted price was related to current price. The estimated function for farrowing No. 2 was (with t values in parentheses):

$$P_2 = \underset{}{-20.82} + \underset{(2.46)^c}{1.92P^{**}} + \underset{(.27)^1}{.28L_1} - \underset{(.34)^2}{.35L_2} + \underset{(.55)^3}{.51L_3} + \underset{(1.03)}{.03E} - \underset{(-.22)^1}{.18I_1} + \underset{(.90)^2}{.80I_2}$$

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[24] It also was expected that the more specialized swine producers, given the size of swine enterprise, would be better managers of it, including better price predictors. The largest size producers tended to be relatively highly specialized so that a separate measure of the specialization effect was not possible.

[25] The estimated function was (with t values in parentheses):

$$P_1 = \underset{}{21.52} + \underset{(.07)^c}{.06P} + \underset{(.21)^1}{.24L_1} - \underset{(-.54)^2}{.70L_2} - \underset{(-.47)^3}{.51L_3} + \underset{(.40)}{.02E} - \underset{(-.49)^1}{.56I_1} + \underset{(.42)^2}{.56I_2}$$

$$- \underset{(-1.47)^{11}}{2.58M_{11}} - \underset{(-1.34)^{12}}{2.40M_{12}} - \underset{(-1.28)^{13}}{2.62M_{13}} - \underset{(-1.92)^{14}}{2.97M^{*}_{14}} - \underset{(1.88)^{15}}{3.27M^{*}_{15}} - \underset{(-2.25)^{16}}{4.85M^{**}_{16}}$$

$$R^2 = .31 \qquad d.f. = 30$$

$$- 3.12M^{**}_{21} - 4.26M^{***}_{22} - 2.36M^{*}_{23} - 3.69M^{**}_{24} - .41M_{25}$$
$$(-2.58) \quad (-3.73) \quad (-1.96) \quad (-2.25) \quad (-.17)$$

$$R^2 = .51 \qquad d.f. = 25$$

The coefficient of current price (1.92) is an estimate of the effect of a one-dollar difference in producers' beliefs about the current price on the price predicted, other things equal. Although significantly greater than zero, it was not significantly different from unity. In other words, the result for farrowing No. 2 supported the hypothesis that swine producers simply extrapolate the current price of hogs when predicting future prices, whereas the result for farrowing No. 1 rejected the hypothesis.

In general, one would expect that the shorter the time period the more reliance would be placed on the current price as an estimate of a future price. For very short periods, however, (in this case within 6 months), producers may have felt more capable of predicting the change in price, while for the somewhat longer period which extended into the new year, relatively more weight was given to the current price.[26] In neither case, however, did size of swine enterprise nor years of experience producing swine for market influence the predicted price level.

Other regressions indicated that predicted change in price was not related to beliefs about the recent change in price, where the latter was measured by the difference between estimated current price and price received in 1966.

Summary

Producers appeared to be well aware of seasonal variation in prices; if anything they tended to overestimate the degree of seasonal variability. They were less aware of cyclical variation and its characteristics. Especially the smaller producers either were unaware of the cycle or underestimated its length.

Producer estimates of the current price of hogs varied widely but averaged higher than the actual current price. It was hypothesized that

[26] Note that the current price was well below the six-year average price for the period. For relatively long periods producers would have been expected to use such a longer term average as a price predictor.

the overestimation of current prices represented a lag in awareness of recent price changes and that producer knowledge of current prices would be a function of size of enterprise and experience. Regression analysis, however, indicated no such effects.

Predicted prices also varied widely among producers. Some evidence was found in favor of the hypothesis that producers simply extrapolate the current price of hogs when predicting future prices, but this did not appear to be the case for prices in the immediate future. Neither size of swine enterprise nor experience appeared to influence the accuracy of price predictions.

VI. PRICE EXPECTATIONS AND PRODUCTION PLANS

Price expectations, as discussed earlier, were expected to influence planned output. Despite the general anticipation of lower prices, however, most producers planned to increase output (Table 7). Apparently factors other than price had a strong influence on production plans. It was hypothesized that these factors would include size of swine enterprise, cost structure, financial position, and personal characteristics of producers. In addition, producer attitudes toward risk were expected to affect planned changes in production. Efforts to explain the large degree of variation in these attitudes and to relate degree of risk aversion to production plans, however, were largely unsuccessful. The data on risk preference and a discussion of the analyses made are presented in the Appendix.

Table 7. Mean Number of Litters Farrowed, 1965-1968, and Annual Percentage Changes, by Size of Swine Enterprise, 1966

Size Group	1965	1966	1967	1968
No. litters, 1966		(number of litters)[a]		
10-29	18	19	26	32
30-49	30	37	34	43
50-79	52	60	65	93
80+	100	117	125	139
All	57	66	71	85
		(percent change from previous year)		
10-29	-	106	137	123
30-49	-	123	92	126
50-79	-	115	108	143
80+	-	117	107	111
All	-	116	108	120

[a]The number of observations varied slightly. The total numbers of producers were 56, 60, 60, and 58 for the respective years 1965-68. Data for 1965 and 1966 represent actual farrowings, and data for 1967 and 1968 represent planned farrowings.

Multiple regression was used to examine the effects of the above factors on production plans. The specific model employed was:

$$Q' = f(P_1', L_1 - L_3, E, C, D_1 - D_3, F_1 - F_3, M_{11} - M_{16}, e)$$

where

Q' = planned number of litters farrowed, 1967, as a percent of number of litters farrowed, 1966.

P_1' = most probable price No. 1 as a percent of reported average price, 1966.

$L_1 - L_3$ = 1 for size group 30-49, 50-79, 80 or more, litters per year, 1966, respectively; 0 otherwise.[27]

E = number of years producing swine for market.

C = percentage of total feed grain used in 1966 which was purchased.

$D_1 - D_3$ = 1 if total debts were \$5,000-\$9,999, \$10,000-\$19,999, \$20,000 or more, respectively; 0 otherwise.[27]

$F_1 - F_3$ = 1 if gross farm receipts were \$20,000-\$29,999, \$30,000-\$49,999, \$50,000 or more, respectively; 0 otherwise.[27]

I_1, I_2 = 1 for interview date in July or August, respectively; 0 otherwise.[27]

$M_{11} - M_{16}$ = 1 if expected marketing month for farrowing No. 1 was September, 1967 - February, 1968, respectively; 0 otherwise.[27]

e = random error term.

Independent variable Q' was measured in terms of litters farrowed because the number of litters would be the key decision variable in the sense that it is more directly under control than the number of hogs to be produced. In addition, or perhaps for this reason, number of litters appeared to be more easily discussed with producers than number of market hogs. Although variation among producers in number of litters could reflect differences in pigs saved per litter, this would not likely affect the ratio Q'.[28]

As a measure of the anticipated change in prices between 1966 and 1967, the variable P_1' has several apparent limitations. In particular,

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[27] The effects of size group 10-29 litters, debt level less than \$5,000, income level less than \$20,000, interview date in June, and expected marketing month in August are included in the constant term; the coefficients of the respective dummy variables are relative to these bases.

[28] Note the survey was conducted in the summer of 1967. Producer estimates of total litters to be farrowed in 1967 should thus be quite accurate. To the extent that price expectations may have changed during the year, however, the relationship between Q' and P_1' would be obscured.

the anticipated price refers to only one litter whereas the price for 1966 is an average for the whole year. Also, the dependent variable refers to all litters in each year. This problem was ameliorated, however, by including variables $M_{11} - M_{16}$, the expected marketing dates, to hold constant seasonal variation in anticipated prices. The assumption is that given the expected marketing date, differences in P_1' among producers reflect differences in annual price expectations.

Several reasons might be advanced for expecting size of swine enterprise and/or degree of specialization in swine[29] to influence planned changes in production. Whether the net effect would produce a positive or negative relationship between L and Q', however, was not clear. The smaller less specialized producers might be more "flexible" (have a higher ratio of variable to fixed costs) with respect to the general expectation of a decline in prices. The "income effect" of the price drop, however, would be relatively greater the larger the number of hogs sold. In addition, producers generally planned to increase production, a reflection, perhaps of the longer term trend to fewer but larger producers. A two-tailed test of statistical significance, therefore, was used. Dummy variables for size group were employed to capture any non-linear effects.

Variable E, number of years producing swine for market, was included in an effort to hold constant some of the personal characteristics of producers which might influence their response to a given set of price expectations. There was no a priori expectation of the net direction of these effects. More experienced producers might have more confidence in their predictions of prices (and costs) and hence respond more strongly to an expected price decrease. On the other hand, more experienced producers would tend to be older and perhaps less interested in adjusting production levels, especially on a short-term basis. Statistical significance was measured using a two-tailed test.

Corn and hog production traditionally have been closely related. The reasons include important complementarities in production and the

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[29]The regression holds constant size of farm (as measured by total farm receipts). Variables $L_1 - L_3$, therefore, reflect both size of swine enterprise and degree of specialization in swine.

fact that corn is the major ingredient in hog rations. In any case, corn represents one of the major expenses in producing swine. The greater the proportion of corn used that is purchased, the larger the ratio of variable to fixed costs in hog production; also the greater the risk of an out-of-pocket loss as a result of adverse hog prices. It was hypothesized, therefore, that given an anticipated short-term change in price, the larger the proportion of feed purchased the larger would be the change in planned hog production. In other words, a positive coefficient for variable C was expected.

It was also desired to include explicitly some factors thought to be directly related to producer response to uncertainty. One of these was financial status. The greater the level of debt, other things equal, the greater the risk of bankruptcy and the less the chance of securing additional funds for expansion. A thorough analysis of this factor would distinguish between short- and long-term debt and various measures of credit worthiness. In this analysis only very rough measures of these factors were obtained. Producers were asked to indicate the level of their total debts in terms of several dollar categories. Another question asked for their total gross farm income, again in terms of specified dollar levels. By using dummy (0, 1) variables for the debt and income categories, the effects of price and size of swine enterprise were obtained holding these approximate measures of debt and debt capacity constant.

To the extent the relationship between debt level and willingness to adjust production suggested above holds, negative coefficients would be expected for variables $D_1 - D_3$. On the other hand, a relatively large debt may have been incurred in building additional swine facilities, facilities to which the production level was still being adjusted. In this case, a positive coefficient would be expected. A two-tailed test thus was used to test the significance of variables $D_1 - D_3$.

The relationship between total farm income (variables $F_1 - F_3$) and changes in hog production likewise appeared to be largely an empirical question. Given the level of hog production, a larger total income suggests the possibility of less interest in the relatively minor swine enterprise but greater ability to make a change should it be desired. Again, a two-tailed test was used.

Interview date was included in the regression to reflect changes over the interview period in planned production. These changes could have been due to factors such as changed crop (corn) yield expectations and additional knowledge of actual farrowings up to the interview date.

In addition to this regression, which hypothesizes a proportional relationship between anticipated change in price and planned production, a second regression was run using the planned level of production (Q_{67} = planned number of litters farrowed, 1967) as the dependent variable. This second regression thus tested the hypothesis that planned production bore a linear relationship to the anticipated change in price, other things equal. The expected effects of the independent variables were the same as discussed above except for the change in the form of the relationships. An exception to this is that the size of enterprise in 1967 was expected to be positively related to size in 1966.

The two estimated functions are presented in Table 8. The high statistical significance of the price coefficient in equation (2) is evidence for a linear relationship between planned production and anticipated change in price. The form of the equation indicates that a 1 percent difference in expected price was positively associated with a 1.56 litter difference in level of planned production, regardless of size of producer. This result implies that the "supply elasticity" was a function of size of producer.[30] If accepted, this result would support the idea that over-reaction of smaller size producers to anticipated price changes is a major factor in the hog cycle.

The price coefficient in equation (1) was statistically significant only at the 95 percent level. As indicated below, however, when these analyses employed the predicted prices for farrowing No. 2 and farrowing quantities relevant to planned production in 1968, the results (with respect to price) for equation (1) were quite similar to those for farrowing No. 1 whereas in the case of equation (2) price was not a significant variable. The conclusion drawn was that formulation (1)

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[30]The implied "elasticities" of supply [i.e. percentage change (difference) in planned production resulting from a 1 percent change (difference) in anticipated price] were 6.0, 4.6, 2.4, and 1.2 for size groups 10-29, 30-49, 50-79 and 80 plus, respectively. The average "elasticity" was 2.2.

Table 8. Regression Analyses of Planned Production

Independent Variable	Regression Coefficient[a]	
	Equation 1 Dependent Variable Q'	Equation 2 Dependent Variable Q_{67}
P_1': exp. price change	1.16**	1.56***
	(1.86)	(2.88)
L_1: 30-49 litters	-48.37**	16.44
	(-2.11)	(.82)
L_2: 50-79 litters	-34.16	58.44**
	(-1.26)	(2.47)
L_3: 80 and over litters	-47.21*	104.28***
	(-1.93)	(4.89)
E: experience	-1.80**	-2.07***
	(-2.21)	(-2.91)
C: percent feed purchased	.24	.12
	(.91)	(.53)
D_1: $5,000-$9,999 debts	-14.84	9.37
	(-.68)	(.49)
D_2: $10,000-$19,999 debts	-.05	31.65
	(-.002)	(1.42)
D_3: $20,000 and over debts	-72.58***	-34.54*
	(-3.40)	(-1.86)
F_1: $20,000-$29,999 farm receipts	41.30*	37.72*
	(1.76)	(1.84)
F_2: $30,000-$49,999 farm receipts	68.83**	62.60**
	(2.59)	(2.71)
F_3: $50,000 and over farm receipts	104.91***	82.15***
	(3.44)	(3.09)
I_1: July interview date	-17.90	-33.17
	(-.56)	(-1.20)

I_2: August interview date	-66.06**	-58.70**
	(-2.13)	(-2.17)
M_{11}: September market date	44.21	97.43**
	(1.16)	(2.93)
M_{12}: October market date	59.06	21.56
	(1.67)	(.70)
M_{13}: November market date	73.35*	77.85**
	(1.94)	(2.37)
M_{14}: December market date	74.00**	72.41**
	(2.25)	(2.53)
M_{15}: January market date	69.79*	71.18**
	(1.85)	(2.16)
M_{16}: February market date	95.84**	120.36***
	(2.41)	(3.47)
Constant term	11.99	-161.36
R^2	.70	.87
Degrees freedom	18	18

[a]Statistical significance is indicated as follows: * = .90; ** = .95; *** = .99.

was more reliable. It implies a supply "elasticity" of approximately unity for all size groups.[31]

As expected, the larger the size group in 1966, the larger the absolute level of production planned for 1967--at least for producers farrowing 50 litters or more in 1966 (equation 2). Producers farrowing 10-29 litters per year planned the largest percentage increase in production;[32] otherwise the percentage increase was independent of size ceteris paribus (equation 1).

Debt levels below $20,000 in 1966 were not related to planned production, other things equal. Debts above $20,000 were associated with a smaller than average planned percentage change in production (equation 1) and a smaller than average level of planned production (equation 2).

The coefficients of the gross farm income variables (F_1 - F_3) indicate that the larger farmers planned appreciably larger percentage increases in swine production than smaller producers and also higher levels of production. Years of experience in producing swine had a negative effect on planned production while percentage of feed purchased apparently had no effect.

As a further test of these production relationships, the functions were estimated in terms of planned production for 1968 and predicted prices for farrowing No. 2. Although not strictly comparable,[33] the estimate of a price "elasticity" of about unity was supported at the 95 percent probability level while no support was obtained for a linear relationship between expected change in price and the absolute level of planned production. Producers in the $20,000 and over debt level

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[31]Note that Tompkin and Sharples (1963) found little or no relationship between production and anticipated prices for producers in Ohio.

[32]The sampling procedure, however, omitted from the analysis any producers who might have gone out of production between 1966 and 1967.

[33]The equivalent of equation (1) used planned number of litters, 1968, as a percent of planned litters, 1967, farrowing price No. 2 as a percent of current price, size group (planned) in 1967, percent feed purchased (planned) 1967, and marketing dates for farrowing No. 2. The other variables were the same as in equation (2) due to lack of data. The price coefficient was .96 with a "t" value of 1.44.

(1966) again planned a significantly smaller percentage increase in production than the other producers, but size group and total farm size had no effect on plans.

In summary, the strongest evidence appears to favor a supply "elasticity" estimate of about unity. Despite the expectation of lower prices, producers planned to increase production. Those in the 10-29 litters per year size group planned the largest percentage increase, other things equal. The larger the farmer, the larger the planned increase in hog production, but farmers with large debts, other things equal, planned appreciably smaller production increases than those with smaller debt levels. Experience (age) was negatively related to planned production.[34]

[34]Other regression analyses indicated no statistically significant relationship between planned level of production and most probable price level. Also, alternative farm enterprises appeared to have no effect on planned swine production.

VII. SUMMARY AND CONCLUSIONS

Several theories of the hog production cycle have emphasized producer price expectations as a causal factor. These include extrapolative, adaptive expectations, and rational expectations models and models more explicitly including the uncertainty of future prices. The objective of this study was to test several hypotheses about producer price expectations and output plans at the farm level. Data were obtained from a random sample of farrow-finish hog producers, stratified by size group, located in a relatively intensive swine producing area in North Carolina. The survey was made in the summer of 1967. In order to make the questions on expectations as relevant as possible, they were framed in terms of current and planned farrowings. The expectations and production plans thus were for short-term periods.

The following results were obtained:

1. Producers tended to overestimate the current price of hogs. Given a recent period of high prices, this result suggested a lag in awareness of price changes. Regression analysis, however, indicated no relationship between estimated current price and average price received the previous year.

2. Producers were aware of the seasonal pattern of hog prices but tended to overestimate the degree of seasonal variation.

3. Many producers, especially the smaller ones, apparently were unaware of the concept of a hog cycle. There was some tendency, greatest among the smaller producers, to underestimate the length of the cycle.

4. The predicted most probable price varied widely among producers. On the average, however, producers overestimated actual future prices by about 11 percent.

5. Multiple regression analyses of predicted prices provided some evidence for the hypothesis that producers simply extrapolate the current price of hogs when predicting the future price over intermediate periods

of time, but no relationship between predicted and estimated current prices was obtained for the more immediate future.

6. The most probable price expected was not related to size of swine enterprise, nor years of experience in marketing hogs. Predicted prices were strongly influenced by expected marketing month, reflecting producer awareness of seasonal variation in prices.

7. Multiple regression analysis indicated a positive relationship between planned change in production and expected most probable change in price. The strongest evidence suggested an "elasticity" of unity, other things equal.

8. Some evidence was obtained which indicated that the smaller producers and larger farmers planned the greatest increases in production. Producers in the largest debt category planned the smallest percentage increases in production, other things equal. Planned percentage changes in output were negatively related to years of experience.

9. There was wide variation in the willingness of producers to accept risk--as measured by the ratio of the estimated most probable price to the lowest acceptable guaranteed price--but, on the average, there was no apparent preference or aversion to risk (i.e. the above ratio averaged unity). Efforts to explain differences among producers in degree of risk aversion and to relate them to differences in planned production were not successful.

Although not conclusive, the above results provide some evidence that producers simply extrapolate the current price of hogs when predicting future prices. Also, production plans were found to be a function of predicted prices. These results, therefore, tend to support the cobweb theory of the hog cycle. In addition, size of swine enterprise did not appear to appreciably influence either predicted prices or the response (in percentage terms) to those prices. This suggests that the trend toward larger more specialized swine producers will have little effect on the amplitude of the hog cycle.

Despite the average expectation of a decrease in hog prices, producers on average planned to increase production. This could reflect the influence of the longer term trend to larger size, a trend probably due to factors such as economies of size associated with new technologies of production. Expansion, however, requires investment funds. The

findings that smaller producers and larger farmers planned the greatest percentage increase in production, while those producers with large debt levels planned the smallest, other things equal, suggest the importance of the financial factor.

This study suggests that the analysis of producer price expectations and production plans using cross-sectional data can be useful in understanding some aspects of production cycles. The most obvious need is to repeat the analysis for alternative points on the cycle. There would appear to be no way to do this short of repeated personal interviews over time--an expensive approach which can also lead to biased results due to the learning process of producers.

Alternative models need to be developed in order to explain more of the variation in price expectations, risk preference, and production plans. In the latter case, improvement of the crude measure of financial status of producers would appear to be promising. The additional investment funds provided by a period of relatively high prices may be an important factor in the ability as well as willingness of producers to expand production and hence a factor helping to generate production and price cycles.

REFERENCES

Boan, J. A. 1955. A study of farmers' reactions to uncertain price expectations. Journal of Farm Economics 37:90-95.

Brownlee, O. H. and Walter Gainer. 1949. Farmers' price anticipations and the role of uncertainty in farm planning. Journal of Farm Economics 31:266-275.

Cline, Donald, L. A. Ihnen, and W. D. Toussaint. 1964. Hog production in North Carolina - 1962. Misc. Publication No. 12, Department of Agricultural Economics, North Carolina State University, Raleigh, N. C.

Drayton, L. E. 1955. Reactions to uncertain price expectations. Journal of Farm Economics 37:559-560.

Ezekiel, Mordecai. 1938. The cobweb theorem. Quarterly Journal of Economics 52:255-280.

Friedman, Milton and L. J. Savage. 1948. The utility analysis of choices involving risk. Journal of Political Economy 56:279-304. (Reprinted in A. E. A., Readings in Price Theory, Vol. VI.)

Griliches, Zvi. 1967. Distributed lags: A survey. Econometrica 35: 16-49.

Harlow, Arthur A. 1962. Factors affecting the price and supply of hogs. Tech. Bul. 1274, United States Department of Agriculture, Economic and Statistical Analysis Division, U. S. Government Printing Office, Washington, D. C.

Johnson, Paul R. 1962. Do farmers hold a preference for risk? Journal of Farm Economics 44:200-207.

Kaldor, Donald R. and Earl O. Heady. 1954. An exploratory study of expectations, uncertainty and farm plans in southern Iowa agriculture. Res. Bul. 408, Iowa Agricultural Experiment Station, Iowa State University, Ames, Iowa.

Knight, Frank H. 1957. Risk, Uncertainty, and Profit. Kelley and Millman, Inc., New York.

Larson, Arnold B. 1964. The hog cycle as harmonic motion. Journal of Farm Economics 46:375-386.

Luce, R. D. and H. Raiffa. 1957. Games and Decision. John Wiley and Sons, Inc., New York.

Markowitz, H. 1952. The utility of wealth. Journal of Political Economy 60:151-158.

Morrison, T. C., G. G. Judge, and E. H. Thompkins. 1955. Impact of price expectations and uncertainties on decision making by poultry firms. Bul. 320, Storrs Agricultural Experiment Station, Storrs, Connecticut.

Nerlove, Marc. 1958. The Dynamics of Supply: Estimation of Farmers' Response to Price. The Johns Hopkins Press, Baltimore.

Nerlove, Marc. 1961. Time analysis of the supply of agricultural products. In E. O. Heady, C. B. Baker, H. G. Diesslin, E. Kehrberg, and S. Staniforth (eds.), Agricultural Supply Functions. Iowa State University Press, Ames, Iowa.

North Carolina Department of Agriculture. North Carolina farm report. Raleigh, N. C., selected issues.

North Carolina Department of Agriculture. 1965. North Carolina agricultural statistics. No. 114, Federal-State Crop Reporting Service, Raleigh, N. C.

Ozga, S. A. 1965. Expectations in Economic Theory. Aldine Publishing Company, Chicago.

Purcell, J. C., D. D. Rohdy, and W. L. Fishel. 1965. Analysis of price of hogs in the Southeast. Southern Cooperative Series Bul. No. 103.

Reutlinger, Shlomo. 1964. Evaluation of some uncertainty hypotheses for predicting supply. Tech. Bul. No. 160, North Carolina Agricultural Experiment Station and U. S. Department of Agriculture, North Carolina State University, Raleigh.

Schultz, T. W. and Brownlee, O. H. 1942. Two trials to determine expectation models applicable to agriculture. Quarterly Journal of Economics 56:487-496.

Tompkin, J. Robert and Jerry A. Sharples. 1963. The role of operators' expectations in farm adjustment. Res. Bul. 936, Ohio Agricultural Experiment Station, Ohio State University, Wooster, Ohio.

United States Department of Agriculture. 1963 and 1968. Livestock and meat statistics, 1962. Statistical Bulletin No. 333 and Supplement for 1967. U. S. Government Printing Office, Washington, D. C.

Waugh, Frederick W. 1964. Cobweb models. Journal of Farm Economics 46:732-750.

Williams, D. B. 1951. Price expectations and reactions to uncertainty by farmers in Illinois. Journal of Farm Economics 33:20-39.

APPENDIX
RISK AVERSION AND PRODUCTION PLANS

As discussed earlier, producers were expected to vary in the degree to which they were willing to accept risks. Presumably this willingness would be a function of psychological factors and special circumstances such as level of financial debt relative to total assets. This study has indicated some relationship between planned production and debt level, other things equal. In order to further explore producer attitudes toward risk and the relationship between risk aversion and production plans, the ratio of the most probable price expected to the lowest acceptable guaranteed price was used to measure the degree of risk aversion.[35] Although this measure or its equivalent was estimated in previous studies, no effort has been made to relate it to differences in planned production. The objective here was to determine if risk preference could be related to observable producer characteristics and, in turn, if it influenced planned changes in production.

Degree of Risk Aversion

With respect to the degree of risk aversion among producers, the mean value of the most probable price for farrowing No. 1 as a percentage of the lowest acceptable guaranteed price was 100, with a standard deviation of 14 (44 observations). In other words, on the average, producers were "neutral" with respect to risk; they were indifferent between a price which was merely most probable and the same price with

[35] This measure has a number of weaknesses. It assumes the most probable price and the expected (mean) price anticipated are the same. Given the difficulties of communicating with producers, it may be that some replies include consideration of undesirable aspects of guaranteed prices such as government controls, and contract specifications (also, see Johnson, 1962).

certainty.[36] There was wide variation among producers, however. Of the 44 producers reporting, 11 had a ratio of 100, 19 less than 100 and 14 more than 100.

Analysis of Variation in Risk Aversion

Theories of choice under conditions of risk (Friedman and Savage, 1948; Markowitz, 1952) suggest that the reactions of persons to risk would depend on level of income (wealth), the probabilities and magnitudes of the possible gains and losses, and other factors. Although these theories appear to rationalize much observed behavior, such as the simultaneous preference of persons for some kinds of gambles and insurance, they fail to explain other phenomena such as lotteries with prizes of various sizes (Markowitz, 1952; Ozga, 1965).

This study employed multiple regression analysis to test several relatively simple hypotheses concerning differences among producers in their degree of risk aversion.

The most probable change in price was included as one independent variable. Markowitz's version of the theory of choice under risk is that the utility function immediately below (approximately) the customary level of wealth is convex (from above) and immediately above this level is concave. In addition, a concave segment is added to the lower portion and a convex segment to the higher portion to cover cases of more extreme changes in wealth. Given relatively small changes in anticipated prices (and hence wealth or income levels), one might expect a negative relationship between anticipated price change and degree of risk aversion, other things equal.[37]

Since the effect on income of any given change in the price of hogs would depend directly on the number of hogs produced, the above reasoning suggests a negative relationship between size of enterprise and the risk

[36] The proportion (42 percent) of producers indicating an aversion to risk was higher than in most previous studies of this type (Johnson, 1962).

[37] For "small" price increases, the minimum guaranteed price demanded would be greater than the most probable price expected and for anticipated "small" price decreases the guaranteed price would be less than the most probable price. The theory suggests that for "large" changes in prices the relationship would be positive within each of these two segments (also, see footnote 38).

aversion variable--again assuming the expected income changes would be quite small relative to current income for all producers. The higher the current level of income, other things equal, the more willing a producer was expected to be to assume the risks of erroneous price predictions. The higher the debt level, however, the greater would be his aversion to risk. The more experienced (usually older) producers were expected to have a greater aversion to risk than the younger producers. Producers purchasing a high proportion of feed could more easily adjust to unexpected price changes and hence be more willing to accept price risks. Interview date and anticipated marketing date were included to hold constant any variance in the implicit price distributions due to length of prediction period, as well as differences in prices due to seasonal variation.

The estimated function was (where $Y = P_1$ as a percent of the minimum acceptable guaranteed price and t values are in parentheses):

$$Y = \underset{}{84.19} + \underset{(2.37)}{.38P_1'}{}^{**} + \underset{(.10)}{.59L_1} - \underset{(-1.13)}{7.90L_2} - \underset{(-.78)}{4.89L_3} - \underset{(-1.68)}{.35E} + \underset{(.84)}{.06C}$$

$$+ \underset{(1.70)}{9.56D_1}{}^{*} - \underset{(.92)}{6.06D_2} + \underset{(.37)}{2.04D_3} + \underset{(.83)}{5.01F_1} + \underset{(.20)}{1.39F_2} + \underset{(1.00)}{7.86F_3} - \underset{(-2.13)}{17.44I_1}{}^{**}$$

$$- \underset{(-.26)}{2.06I_2} - \underset{(-1.68)}{16.75M_{11}} + \underset{(.11)}{.96M_{12}} - \underset{(-.88)}{8.60M_{13}} - \underset{(-.79)}{6.66M_{14}} - \underset{(-.44)}{4.27M_{15}} - \underset{(-2.44)}{24.97M_{16}}{}^{**}$$

$$R^2 = .81 \qquad \text{d.f.} = 18$$

The estimated positive relationship between expected change in price and risk aversion, although statistically significant, appears to make no sense in terms of the above theories of choice.[38] In addition, none

[38] A positive coefficient could have been consistent with Markowitz's theory if all producers had expected a decrease in price or an increase in price. A negative coefficient was expected because of the expected shift from risk aversion to risk preference with a change from expected price decrease to expected price increase. A scatter diagram, however, confirmed the strong positive relationship throughout the range in the data available. (A regression using the guaranteed price as the dependent variable and the most probable price as the independent variable (all other variables the same) produced results consistent with those presented above). Elimination of all producers expecting an increase in price or no change would have left too few complete observations to give reliable multiple regression results especially when so many had the common value of 100 for the independent variable.

of the other variables influenced the degree of risk aversion in the way expected.

Efforts to relate degree of risk aversion to planned production were unsuccessful. It was anticipated that the higher the degree of risk aversion, the smaller the planned change in output. The high correlation between the measure of risk aversion and anticipated change in price, however, precluded reliable estimation of their separate effects.[39]

The results of this section suggest that producers probably do vary widely in their attitude toward risk. Success in explaining this variability and relating it to differences in production plans probably will require more adequate theories of decision making in risky situations. One of the major difficulties, however, would appear to be the problem of obtaining the quantity and quality of data needed to adequately test the hypotheses developed.

[39]The simple correlation coefficient was .68. When added to equation (1) above, the risk aversion variable was positive rather than negative and the P_1' coefficient was cut in half and not significant. When added as dummy variables reflecting values less than or greater than 100, the coefficient of P_1' was not affected, but the dummy variables were far from significant.

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