To the Graduate Council:

I am submitting herewith a thesis written by Kevin D. Banker entitled "An Evaluation of Nonselective and Selective Pricing Strategies for Finished Hog Producers in Tennessee." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

Dan L. McLemore, Major Professor

We have read this thesis
and recommend its acceptance:

Charles Sappington

Emmit L. Rawls

Accepted for the Council:

Vice Provost
and Dean of The Graduate School

AN EVALUATION OF NONSELECTIVE AND SELECTIVE PRICING STRATEGIES FOR FINISHED HOG PRODUCERS IN TENNESSEE

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Kevin D. Banker

December 1987

AG-VET-MED.

Thesis
87
B354

ACKNOWLEDGEMENTS

The author is grateful to Dr. Dan L. McLemore (Chairman of his thesis committee) for his direct and detailed involvement, guidance and advice which made the completion of this study possible. The author is also grateful to Dr. Emmit L. Rawls and Dr. Charles B. Sappington for providing important information and suggestions about Tennessee hog producers, buying stations, packinghouses and live hog futures trading.

Appreciation is extended to the Chicago Mercantile Exchange for supporting this study through a grant to the department. Appreciation is also extended to Dr. Joe A. Martin and the Department of Agricultural Economics and Rural Sociology for providing financial aid to the author during graduate study. Finally, the author would like to express the deepest and most sincere gratitude to Gerald and Maxine Banker for their patience, love and support during this study.

ABSTRACT

Because of the difficulties a hog producer faces with fluctuating cash markets and demands placed on him by his creditors, the goals of increasing mean net returns and reducing price risks are assumed to be widespread among hog producers. This study evaluated the use of nonselective (routine) and selective pricing strategies to increase a finished hog producer's mean profits and reduce price risk. Computer simulation models were used to perform the evaluations. The types of strategies (both routine and selective) involved the use of cash markets, cash forward contracting, futures market hedging and the purchase of put options on live hog futures. The period of the study was from 1977 through 1984. Mean net returns and variance of net returns over the 92 production simulations were the main criteria for evaluating the performance of each strategy. Other values recorded for each strategy were minimum and maximum net returns and the number of noncash marketing simulations.

The results indicated that mean net returns and the variance of net returns were not improved for finish hog producers by using any routine strategy. However, selective strategies involving cash contracting and the use of futures markets increased mean net returns while providing more protection against adverse price movements than the traditional cash marketing approach. The purchase of at-the-money put options did provide some risk protection, but mean net returns were less

than a traditional cash marketing strategy. Purchase of in-the-money and out-of-the money put options (with the strike price being the nearest increment from the at-the-money strike price) also provided some risk protection, but with no significant improvements in net returns over those achieved with a traditional cash approach.

TABLE OF CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION	1
	Background	1
	Problem and Justification	2
	Marketing Tools Available to Producers	3
	Review of Literature	8
	Objectives of the Research	18
II.	PRICING STRATEGIES EVALUATED	20
	Introductory Comments	20
	Routine Benchmark Strategies	20
	Selective Futures Market Hedging Strategies	24
	Selective Cash Contracting Strategies	29
	Selective Put Option Strategies	31
III.	METHODOLOGY	35
	Live Hog Futures and Cash Market Prices	36
	Basis Estimation	39
	Break-Even Price Estimates	40
	Put Option Premium Estimates	42
	Criteria for Comparison of Strategies	48
IV.	RESULTS	50
	Introductory Comments	50
	Cash Contracting Strategies	51
	Futures Hedging Strategies	55
	Purchase of Put Options	66
V.	SUMMARY AND CONCLUSIONS	80
	Summary	80
	Conclusions	83
LITERATURE CITED		88
APPENDIX I		92
APPENDIX II		103
VITA		107

LIST OF TABLES

TABLE		PAGE
1.	Terminology for Call and Put Options When Comparing Futures Market Price and Strike Price.	8
2.	Determination of the Appropriate Live Hog Futures Contract for Hedging Simulations.	37
3.	Determination of the Appropriate Amount of Time Until Option Expiration for the Beginning and Ending of Each Production Period	45
4.	Mean and Variance of Net Return, Maximum and Minimum Net Return Levels and the Number of Noncash Marketings for Simulated Finish Hog Operations in Tennessee Using Cash Contracting Strategies, 1976-1984.	52
5.	Mean and Variance of Net Return, Maximum and Minimum Net Return Levels and the Number of Noncash Marketings for Simulated Finish Hog Operations in Tennessee Using Localized Futures Prices and Expected Net Returns from Futures Hedging Strategies, 1976-1984.	57
6.	Mean and Variance of Net Return, Maximum and Minimum Net Return Levels and the Number of Noncash Marketings for Simulated Finish Hog Operations in Tennessee Using Moving Average and Oscillator Futures Hedging Strategies, 1976-1984.	62
7.	Mean and Variance of Net Return, Maximum and Minimum Net Return Levels and the Number of Noncash Marketings for Simulated Finish Hog Operations in Tennessee Using at-the-Money Put Option Strategies, 1976-1984	69
8.	Mean and Variance of Net Return, Maximum and Minimum Net Return Levels and the Number of Noncash Marketings for Simulated Finish Hog Operations in Tennessee Using in-the-Money Put Option Strategies, 1976-1984	73
9.	Mean and Variance of Net Return, Maximum and Minimum Net Return Levels and the Number of Noncash Marketings for Simulated Finish Hog Operations in Tennessee Using Out-of-the-Money Put Option Strategies, 1976-1984	77
A1.	Basis Estimates on Live Hog Futures for the Fifth of Each Month, Tennessee, 1977-1984.	94

TABLE PAGE

A2. Monthly Break-Even Price Estimates for a Finished Hog Producer, Tennessee, 1976-1984 97

A3. Purchase and Salvage Put Premium Estimates for the Fifth of Each Month for at-the-Money, in-the-Money and Out-of-the Money Put Options on Live Hog Futures Contracts, 1977-1984 . 100

LIST OF FIGURES

FIGURE		PAGE
1.	A Graphic Illustration of a 5-Day and 10-Day Moving Average. .	14
2.	A Graphic Illustration of a Simple Oscillator.	16
3.	Mean and Variance of Net Returns for Cash Contracting Strategies with Routine Cash Strategy for Comparison, Tennessee, 1976-1984	53
4.	Mean and Variance of Net Returns for Localized Futures Hedging Strategies with Routine Cash Strategy for Comparison, Tennessee, 1976-1984	59
5.	Mean and Variance of Net Returns for Moving Average and Oscillator Hedging Strategies with Routine Cash Strategy for Comparison, Tennessee, 1976-1984	64
6.	Mean and Variance of Net Returns for Purchase of at-the-Money Put Options with Routine Cash Strategy for Comparison, Tennessee, 1976-1984	71
7.	Mean and Variance of Net Returns for Purchase of in-the-Money Put Options with Routine Cash Strategy for Comparison, Tennessee, 1976-1984	75
8.	Mean and Variance of Net Returns for Purchase of Out-of-the-Money Put Options with Routine Cash Strategy for Comparison, 1976-1984.	78
9.	Mean and Variance of Net Returns for Pricing Strategies Selected from Among All Strategies Tested, Tennessee, 1976-1984.	84
A1.	The Top 10 Hog Producing Counties in Tennessee	93
A2.	An Illustration of the Relationship Between Mean Net Returns and Variance of Net Returns as Greater Restrictions Are Placed on an Oscillator Strategy, Tennessee, 1976-1984 . . .	105

CHAPTER I

INTRODUCTION

1. Background

Pork production is a major industry in Tennessee. The state produced 1,048,001 finished hogs in 1982 which ranked it sixteenth in hog production nationwide (27, p. 23). In 1985, 820,000 finished hogs were marketed in Tennessee for a ranking of fourteenth nationwide (24). Tennessee accounted for only 1.4 percent of total United States production according to the 1982 Census of Agriculture. The total number of hogs and pigs sold in the state during 1982 was decreased by approximately 11 percent from 1978 Census of Agriculture statistics. Tennessee ranked thirteenth in feeder pig production in 1982. In that year 464,089 feeder pigs or 2.32 percent of the national total were sold in Tennessee (27, p. 24).

Total cash receipts (preliminary results) from hogs sold in Tennessee for 1985 was $158,461,000 (24). These cash receipts from hogs accounted for 38.8 percent of total cash receipts from meat animals (cattle, hogs and sheep) in 1982. This percentage was up from 33.7 percent of total cash receipts from meat animals in 1980 (30, p. 392).

Approximately 14.3 percent of the 90,565 farms in Tennessee had hogs in 1982 (28, p. 16, and 30, p. 380). The number of farms in the state with hogs dropped from 19,535 in 1978 to 12,963 in 1980. Eighty-six percent of the farms with hogs had less than 200 hogs per farm, 13 percent had 200 to 999 and only 1 percent of the farms in Tennessee had

more than 1,000 hogs during 1982. It is interesting to note that the 11,142 farms which had less than 200 hogs each (the 86 percent above) had only 23.8 percent of the total hog and pig inventory, while the 128 farms with more than 1,000 head each (the 1 percent above) had 26.6 of the total hog and pig inventory in 1982. The number of farms with more than 1,000 head each increased from 96 in 1978 to 128 in 1982 (28, p. 16).

The largest areas of swine production in Tennessee are in the western to middle portions of the state. West Tennessee probably produces more hogs due to the predominance of row cropland compared to the eastern portion of the state. Figure A1 in the Appendix I provides a visual representation of the 10 counties in Tennessee producing the most hogs according to the United States Bureau of Census and Tennessee Agricultural Statistics (24, p. 54, and 30, p. 129).

2. Problem and Justification

Farmers currently face very difficult economic conditions. In light of many bankruptcy sales and foreclosures, many hog producers cannot afford the risk associated with an unpredictable cash market. An adverse price fluctuation during the production period could be catastrophic. Many producers operate with a heavy debt load which makes assuring the sale price very desirable to both hog producers and their creditors (18).

Prices in the cash markets can fluctuate widely over relatively short periods of time. For example, during the four-month period from

March 5, 1979, to July 5, 1979, prices in the Tennessee cash market fell from $50.52 per hundredweight to $40.32 per hundredweight. Again, in 1979-1980 prices fell by $10.17 per hundredweight from December 5, 1979, to April 7, 1980. Conversely, prices rose from $41.00 per hundredweight to $56.13 per hundredweight between January 5, 1982, and May 5, 1982 (9). With price fluctuations such as these it is difficult for a farmer to predict a cash market price at the end of a production period. Accurate anticipation of fluctuating cash market prices is one of the major problems facing Tennessee hog producers.

Previous studies have shown that the traditional cash marketing approach is not always optimal (16,17,18,21,22,23). If the hog producer's goals include only simplicity, a traditional cash marketing approach would be preferred. If a hog producer has other goals such as higher profits on the average along with less variable profits, then a traditional cash marketing approach is probably not the optimal solution to the marketing/pricing problem. This study assumes that higher average profits and more nearly stable profits over the long run are the desired goals of all hog producers. Furthermore, the study assumes that if higher average profits with lower variability can be achieved through means other than the traditional cash marketing approach, then hog producers would choose the alternative.

3. Marketing Tools Available to Producers

Marketing tools are available to hog producers and producers of other products which may reduce the risk associated with adverse price

movements. Cash contracting with buyers, hedging methods using the futures market and the use of options on futures and have been suggested by many writers (6,7,10,15,16,17,18,20,21,22,23).

Discussion of Basis

Most of the nontraditional marketing/pricing methods involve "basis" in one way or another. The basis is the relationship between a given futures contract price and the price at a local cash market at a given time. The basis is calculated by subtracting the local cash price from the nearby futures contract price at the same point in time. The importance of basis is well documented. Hieronymus (12) states, a farmer "must know what a given futures price means in terms of the price of the cash commodity at their usual, generally local, markets." Others have said prices in local markets must be related to those in futures markets to effectively place a hedge (25). A wide variety of factors affect the basis, and it is often difficult to predict. The difficulty in predicting the basis is often referred to as "basis risk." However, some literature has suggested that the risk associated with predicting the basis is not as great as that associated with predicting cash price (23).

Cash Contracting

Cash contracting involves an agreement between a buyer and a hog producer which separates the time of pricing from the time of delivery. Usually the contract is made at the beginning of or during the production period. Typically, the buyer quotes a basis for each month of the

year based on past experience with the actual basis and other considerations. The basis is then deducted from the appropriate underlying futures price to determine the buyer's quoted price for the hogs when they are ready for slaughter. The buyer agrees to accept the hogs at that price at a given time in the future and the producer agrees to deliver at that price and time. This marketing tool provides the producer with a method of accurately determining, in advance, the price to be received at slaughter. The producer is not directly involved with the futures market. However, the price that he is quoted is based on the futures market price. Typically, the buyer simultaneously hedges his cash contract commitment by selling futures.

Futures Hedging

Futures hedging involves a hog producer, a brokerage agent and a commodities exchange where live hog contracts are traded. The initiation of the hedge consists of the selling a live hog contract(s) at the beginning of or during the production period. The sale is neutralized (hedge lifted) by buying a live hog contract(s) at the end of the production period, while simultaneously selling the physical commodity in the cash market. A hedger hopes that as the time for selling the commodity and lifting the hedge draws near, cash and futures prices will differ by no more than the expected basis. Futures hedging allows the hedger to "lock-in" a final selling price (less brokerage commissions) if the basis is accurately anticipated (21). However, basis is rarely accurately anticipated. In the absence of a fully predictable basis, a hedger escapes "price risk" associated with cash markets and assumes

"basis risk" associated with the difference between cash and futures prices.

Commodity Options

Finally, the newest pricing tool is the use of options on live hog futures contracts. It should be noted that commodity options were traded in the United States more than 50 years ago. However, an attempt to manipulate the wheat market with options resulted in a scandal which eventually led to a ban on the trading of options in 1936. The 1982 Futures Trading Act lifted the ban (14, p. 2).

Two types of options exist: calls and puts. A call option allows the holder the right, but not the obligation, to buy one futures contract at a fixed price from the option seller or writer within a time limit. A put option allows the holder the right, but not the obligation, to sell a futures contract at a fixed price within a time limit. The fixed price is referred to as the "exercise" price or "strike" price. The exercise or strike price for a call option writer is the price at which the writer must sell a futures contract--on the demand of the call option holder--anytime between the time of purchase and the expiration date of the option. The exercise or strike price for a put option writer is the price at which the writer must buy a futures contract. The put option holder may sell anytime after the purchase of the put option and prior to the expiration of the put option.

Option strike prices are based on the level of futures price and are established in increments that are considered appropriate for the particular commodity. For example, if the increment was 25 cents for

soybeans, some of the possible strike prices could be $5.50, $5.75, $6.00 and $6.25 per bushel. If the increment was $2.00 for hogs, some of the possible strike prices could be $44.00, $46.00, $48.00 and $50.00 per hundredweight. Option strike prices are established by the market place. The only option strike prices available to a hog producer are those traded (bracketed or posted) on the exchanges during that day.

Options are also referred to as being either at-the-money, in-the-money or out-of-the-money. An at-the-money option is an option whose strike price is equal (or approximately equal) to the current market price of the futures contract (sometimes called the underlying futures contract). An in-the-money option for a call is when the futures market price exceeds the strike price. When the futures market price exceeds the strike price for a put, it is an out-of-the-money option. Conversely, when the strike price exceeds the futures market price a put is considered in-the-money and a call is considered out-of-the-money. In addition, some refer to the degree by which an option can be in or out-of-the-money. If the market price for a live hogs futures contract was $50.45, a $62.00 put would be "deep" in-the-money and a $62.00 call would be "deep" out-of-the-money. If the strike price was $40.00, a put would be "deep" out-of-the-money and a call would be "deep" in-the-money. Table 1 summarizes the foregoing discussion.

The option can be purchased for a premium, much like an insurance premium on a house or automobile. The only risk associated with purchasing an option is the possible loss of the premium. Potential return to an option holder is unlimited. While options on hogs have been

trading about three years on the major exchanges and volume is not very large, many think that due to flexibility of use, options provide a feasible pricing tool (6,7,10,14,15). For this reason, hog producers need information on the use of options as a marketing alternative.

Table 1. Terminology for Call and Put Options When Comparing Futures Market Price and Strike Price

Price Condition			Calls	Puts
Market price	>	Strike price	In-the-money	Out-of-the-money
Market price	=	Strike price	At-the-money	At-the-money
Market price	<	Strike price	Out-of-the-money	In-the-money

Source: Chicago Board of Trade. Options on Soybean Futures: Fundamentals, Pricing and Applications, Our Next New Dimension. Chicago, Illinois, June, 1984.

4. Review of Literature

A large amount of literature has been published concerning the use of futures markets. This literature has appeared in the form of magazine articles, journal articles, brochures, pamphlets and books. Only that part of the literature which has direct applicability for this study will be discussed.

Comprehensive Books

Several books have been written concerning futures markets. Probably one of the more popular books which describes the entire spectrum of futures trading activities in a general sense was written by Hieronymus (12). Hieronymus gives a description of commodity exchanges providing a historical perspective. The book also treats the economics of futures markets, the use of futures markets and market operation. Another popular book which provides similar information was written by Gold (11). Both books describe methods used by speculators and hedgers and have been used as textbooks by various institutions.

Cash Contracting Literature

Cash contracting strategies for live hogs have been examined by several researchers. While cash contracting does not directly involve futures contracts, the cash contract prices are established using futures prices and an estimate of the basis. In a study by McLemore, Adams, Sappington and Rawls (16), cash contracting was computer simulated for both farrow-to-finish and finishing operations for the period 1970 to 1979. Monthly break-even prices were established which included the sum of the variable costs of production per hundredweight. Cash contract prices were calculated by subtracting $2.00 from the appropriate futures market price quotes for the contract which is maturing nearest to, but after the date the hogs were to be sold. If the cash contract price exceeded the break-even price by a given amount per hundredweight, then a cash contract between the buyer and producer was executed. If the cash contract price exceeded break-even by $8.00,

$9.00 or $10.00 per hundredweight, the results indicated that by cash contracting a hog finishing operation could obtain higher average profits and lower variability of profits as compared to a traditional cash marketing strategy.

Futures Hedging Literature

A study by Sappington (22) estimated net returns for Tennessee producers who fed out purchased feeder pigs with and without using the futures market. The period of the study was from 1964 through 1972. The futures market was used to estimate expected net returns. Two production-marketing strategies were developed using estimated expected net returns. The first strategy was to "buy feeder pigs only if estimated expected returns are at least $1.00 per head without placing a hedge." The second strategy was to feed out the feeder pigs only if the expected returns were $4.00 (or more) per head by executing a futures hedge when the feeder pigs were purchased. From the results the following conclusions were made:

1) Using the futures market to calculate expected revenues in the budgeting process would have increased net returns and reduced the labor input. On the average, low expected returns before purchase of feeder pigs indicated low actual returns from feeding. The futures market, however, seldom predicted price accurately 5 (or 6) months into the future.

2) The use of the futures market to hedge net returns of at least $4 per head would not have worked satisfactorily.

McLemore and Miyat analyzed the use of futures market hedging strategies in backgrounding feeder cattle (17). A "localized futures" price was calculated for each production period from 1972 thru 1978. The localized futures price was derived by subtracting a basis estimate

for the end of a production period from the appropriate futures contract price for the beginning of the production period. This localized futures price was then compared with break-even and cash prices. If the localized futures price exceeded the break-even or cash price by a given dollar increment, then a hedge was executed. Various methods of deciding when to lift the hedge were tested. In the same study, several variations of moving average and point and figure charting strategies were tested.

"Selective hedging" strategies for live hogs have been tested by McLemore, Adams, Sappington and Rawls (16) as part of the study mentioned above. Selective hedging means that the hog producer follows a set of rules to determine when to place and/or lift a hedge. If a specific condition was met, the hog producer would place a hedge. Then, if a hedge was placed during a production period, the hog producer would follow a set of rules for lifting the hedge. Hedging strategies using the localized futures concept were applied in simulation procedures for live hogs. Farrow-to-finish and hog finishing operations were simulated for 1970 through 1979 using localized futures versus break-even and cash, moving averages, occurrence of delivery months and the occurrence of seasonal low prices as criteria to determine when hedges were placed. The futures hedging strategy that was considered optimal for hog finishing operations was to hedge if localized futures exceeded break-even plus $9.00 or $10.00. The futures hedging strategies considered optimal for farrow-to-finish operations were to hedge if localized futures

exceeded cash by $4.00 or $5.00 or if localized futures exceeded break-even by $21.00.

Shafer, Griffin and Johnston (23) studied the use of integrating several different types of hedges for cattle feeder operations. Long hedges for corn and feeder cattle futures contracts were executed (the main inputs of production). At the same time a short hedge was placed for live cattle (the output from production) over a two-month planning period. Forty-seven pens of cattle where analyzed using mean-variance analysis during a 52-month period from 1972 through 1976. The corn and feeder cattle hedges were lifted with the purchase of the actual physical commodity while the short live cattle hedges could be held throughout the production period. The most profitable strategy was a moving average based hedging strategy ($31.45 per head). However, this strategy had the second highest variance of returns. One hundred percent of the pens were hedged using the moving average strategy. The extended lock-in strategy was the second most profitable ($21.90) per head while at the same time had the second most desirable variance. Thirty-nine of the 47 pens were hedged with the extended lock-in strategy. The smallest net return and highest net return variance were from the cash market strategy (no hedging, full exposure to cash price risks).

Technical Futures Trading Literature

Technical analysis includes the use of charts, moving averages, measures of volume of trading, oscillators, open interest data and other quantitative factors to guide the trader's actions. These tactics exclude consideration of the basic economic forces which fundamentalists

believe play an important role in determining prices. Technical methods of trading have proved profitable in short- and long-runs (16,17,18,21,23,25).

Moving averages. Moving average strategies are trend-following methods used to identify buy or sell signals in price trending markets. A crossing action between a relatively short length moving average (i.e., three-day) with a longer length moving average (i.e., 15-day) generates a buy or sell signal. They are referred to as "moving" averages because they are updated daily with the oldest price in the average being replaced by the latest price.

The underlying theory of moving average strategies is that shorter length moving averages are more responsive to price movements than longer length moving averages. If the price is initially trending downward but begins a sharp upward trend, the shorter length average will rise faster than the longer average. In this case, a graphical plot of the two moving averages would show the shorter length average crossing the longer average from below, indicating a buy signal. If price is initially trending upward but begins a sharp downward trend, the shorter average will fall faster than the longer average indicating a sell signal. In this case, a graphical plot of the two moving averages would show the shorter length average crossing the longer average from above, indicating a sell signal. False signals can be generated when the market is moving "sideways" or has no definitive trend. Variations of the moving average strategy include: a) using a third intermediate length average to confirm or deny a signal, b) placing the

most weight on the most recent prices in the series and the least weight to the oldest day's price and c) requiring the shorter length moving average to cross the longer average by a prescribed "penetration" amount (17, pp. 9-11). Figure 1 graphically represents a 5-day and 10-day moving average of a commodity price.

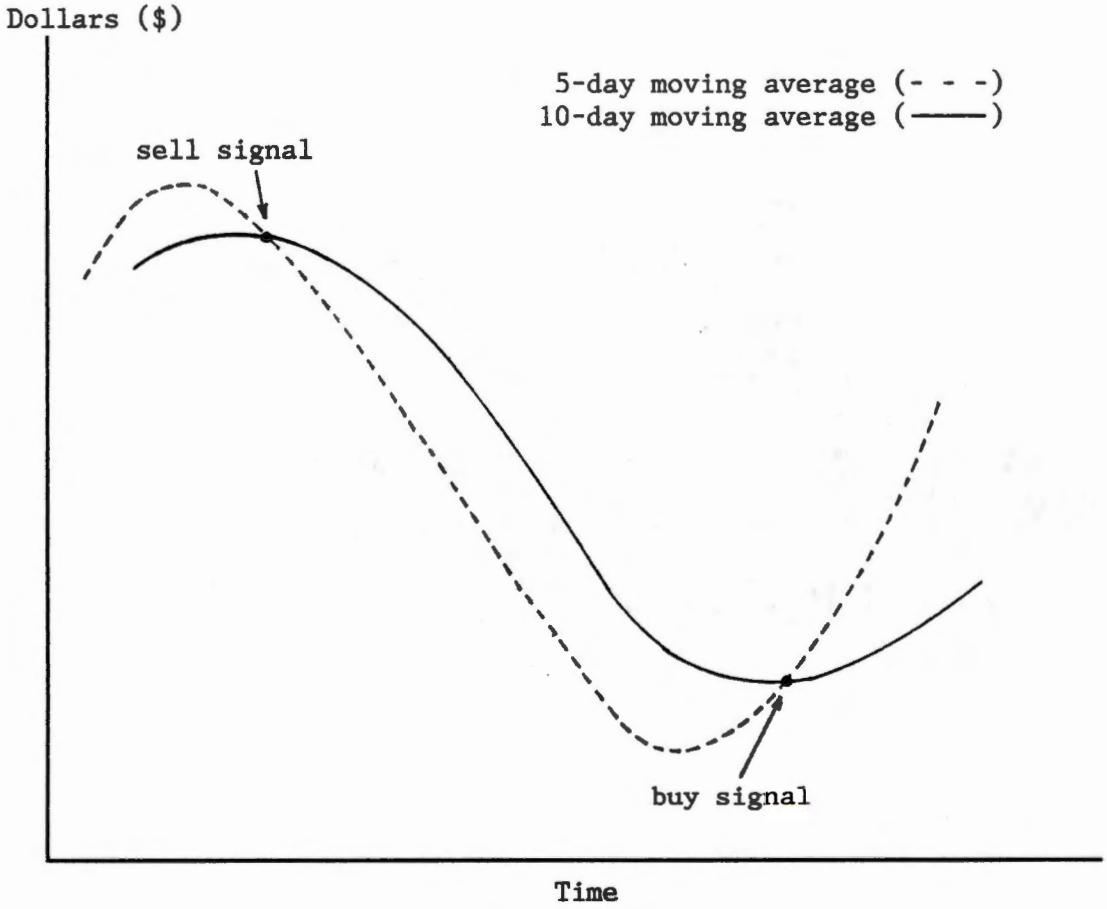

Figure 1. A Graphic Illustration of a 5-Day and 10-Day Moving Average

Purcell and Riffe (18) tested the use of technical trading systems for hedging with moving averages while at the same time examining the cash flow positions during the production periods for large cattle feeders. Considering cash flow was an attempt to deal with the criticism that cash flow was not examined in other studies. Impacts of hedging strategies on cash flow might be an important factor when judging the usefulness of selective hedging strategies. Simulated cash flows where examined every 30 days over the 1966 to 1976 period. Purcell and Riffe concluded that the analysis of cash flow positions along with use of moving average hedging strategies protected "the financial position of the cattle feeder within the production or analysis period. Furthermore, point and figure or moving average hedging strategies provided price risk reduction for cattle feeders" (18, p. 91).

Oscillators. Oscillators are another technical analysis tool used by speculators and hedgers. Oscillators can be constructed with price differences, moving averages or any objective method of measuring a commodity's price movements. Typical oscillators have a base line, an upper limit and a lower limit. As the oscillator moves through time, buy signals are indicated when the oscillator crosses the lower limit. Conversely, sell signals are indicated at the point in time when the oscillator crosses the upper limit. The exact point in time to buy or sell a futures contract is determined by the decision criteria of the individual user. Figure 2 graphically represents a simple oscillator consisting of a five-day moving average of a commodity price. The base

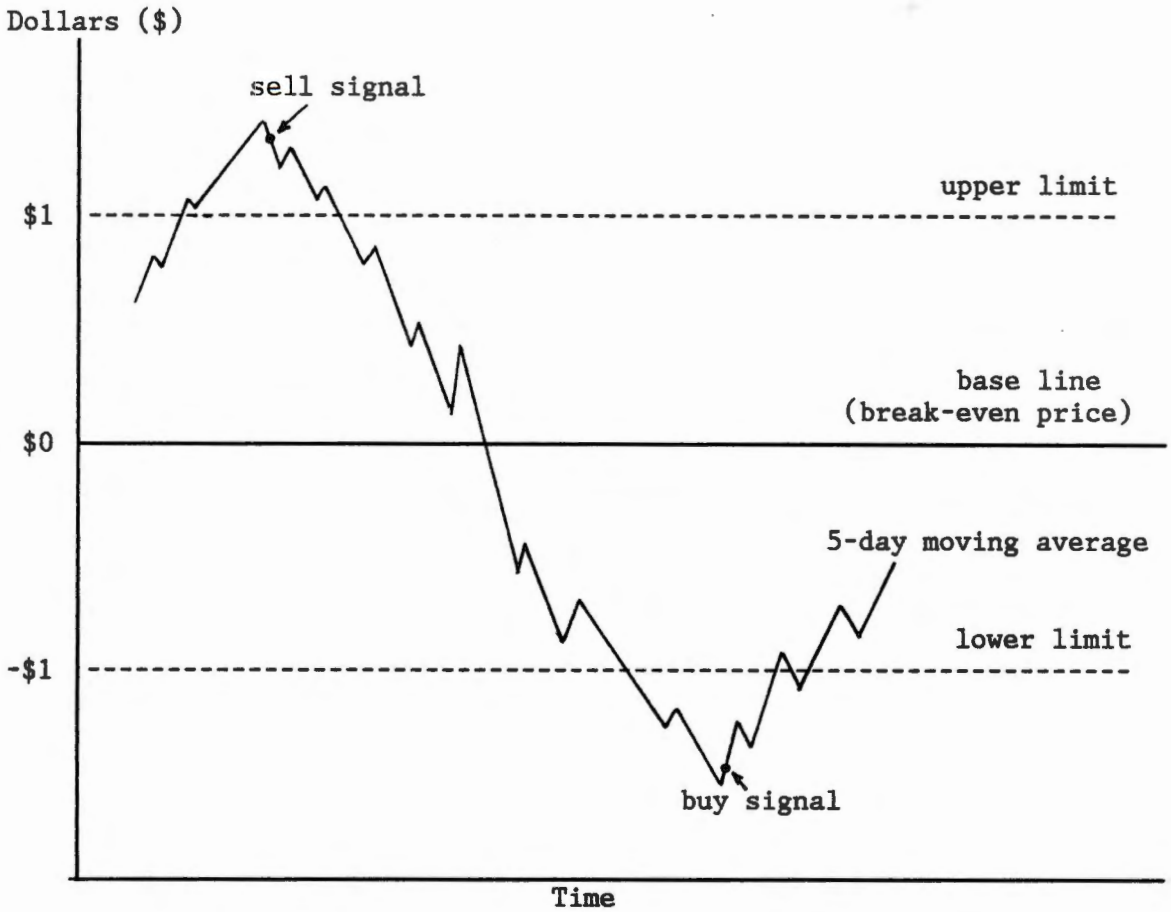

Figure 2. A Graphic Illustration of a Simple Oscillator

line represents the break-even price as calculated by the user at the beginning of the month. Upper and lower limits are $1.00 and -$1.00, respectively. The base line and limit lines can be averages, fixed dollar amounts, standard deviations or any other value the user wishes to devise. Therefore, a wide variety of oscillators and decision rules can be formulated (23, p. 84).

Russell and Franzmann (21) studied the use of oscillators as a guide to selectively hedging feeder cattle. Three models were constructed and tested for feeder cattle contracts for the years 1972

through 1977. The three oscillator strategies were compared to a cash strategy and a routine hedge for each production period. They concluded all three of the oscillator strategies used as a guide, could "increase the decision maker's profits and usually decreases the variance of returns." The oscillator technique is "both objective and relatively easy to compute" (21, p. 88).

Literature on Commodity Options

There has been a large amount of literature on options that provides the basic introductory information in the form of brochures, pamphlets and booklets. A booklet by the Chicago Board of Trade on soybean options provides very good information concerning the introduction of options (6). Commodity options offer a farmer a form of price protection that has not been previously available.

While there are abundant sources of introductory information regarding commodity options, there has been very little empirical research conducted regarding agricultural options. Analysis of options as a hedge for farmers is lacking probably due to a lack of historical data regarding option premiums. However, option premiums can be estimated through the use of the commonly accepted "Black formula."

The Black formula. The most prominent formula for estimating option premiums was derived by Fisher Black (3). The formula determines option premiums as a function of the underlying futures price, the strike price, the short-term interest rate, time until option expiration

and market price volatility. The Black formula or the "Black-Scholes formula" seems to be accepted by most people who deal with options.

While the Black-Scholes or the Black model is widely accepted for pricing commodity options, the universal acceptance of the models has been questioned. Asay (1) distinguished between the models saying the Black-Scholes model is not equivalent to the Black model for commodity options since some options are written on the futures contract, while others are written on the physical commodity.

> Black has analyzed commodity options stylized after those traded on the London Commodities Exchange. There, a put or a call gives the holder the right to sell or purchase a futures contract. Such contracts should be distinguished from options written directly on the physical commodity, such as those offered by Mocatta Metals on gold, or the Government Security options to be traded on the stock exchanges.
>
> The focus of pricing analysis differs between the two kinds of options. Options valued relative to the physical commodity should, for the general case, follow the original Black-Scholes (1973) and Merton (1973) derivations....

For the mathematical arguments see Asay (1), Black (3) and Black and Scholes (4).

5. Objectives of the Research

The objectives of this research were twofold:

1. To simulate, via computer analysis, a Tennessee hog finishing operation using historical price and cost data and to evaluate the following marketing/pricing strategies:
   a. routine traditional cash sales,
   b. routine cash contracting,
   c. routine hedging with futures contracts,

d. routine purchase of put options,

e. selective cash contracting,

f. selective hedging with futures contracts, and

g. selective purchase of put options.

2. To identify optimal marketing/pricing strategies from those mentioned above, using mean and variance analysis of net returns to the hog producer.

By identifying optimal strategies, an attempt can be made to broaden the knowledge base of hog producers and thereby increase the average profitability of the swine finishing enterprise, while increasing the producer's ability to avoid price risks associated with hog finishing.

CHAPTER II

PRICING STRATEGIES EVALUATED

1. Introductory Comments

This chapter explains the various pricing strategies analyzed in this study. The rationale underlying each strategy will be discussed. The benchmark strategies will be discussed first. The benchmark strategies are routine in that the simulation executed the action during every production period regardless of market conditions. Second, the selective strategies involving the futures market will be examined. Third, selective strategies involving a cash contract between a buyer and a producer will be discussed. Some of the selective strategies involving futures and contracting have been evaluated in a previous study (16). Since some of these strategies were considered to be beneficial in the previous study, they were re-examined in this study over the 1976-1984 time period. Finally, selective strategies involving put options on live hog futures were evaluated. In all the strategies discussed in this study, the producer was not allowed to lift a hedge, option or contract position once it was established (until the end of the production period).

2. Routine Benchmark Strategies

The simplest pricing strategies tested in this study are naive in nature. These are nonselective strategies that were routinely executed for each of the 92 production periods included in the study without any

pricing alternatives being considered. The strategies considered naive and routine in this study would probably not be used by a hog producer (excluding traditional cash marketing), because most farmers would be more selective in their marketing/pricing approaches. The routine strategies are simple, but served as benchmarks or guidelines for evaluating the selective strategies. The six different benchmark strategies are:

1. Traditional cash marketing,
2. Routine futures market hedge,
3. Routine cash contract,
4. Routine at-the-money put option purchase,
5. Routine in-the-money put option purchase, and
6. Routine out-of-the money put option purchase.

When the term "routine" is used, it refers to pursuing an individual marketing/pricing approach during each production period, regardless of conditions or alternatives.

Traditional Cash Marketing

A traditional cash marketing approach refers to simultaneously pricing, selling and delivering hogs on the local cash market at the end of each production period without considering any other pricing alternative. This approach was included because most hog producers use this method. Since this method is used by hog producers frequently, it was considered to be the major benchmark strategy for comparisons with other pricing alternatives.

The main advantage of using a traditional cash marketing approach is simplicity. The cash marketing approach requires little or no marketing expertise. The hog producer simply delivers the hogs to a local market when slaughter weight is reached. The problem of a fluctuating or uncertain local cash market price is the major disadvantage of this strategy. The producer is forced to accept the price that the local market is offering that day.

Routine Futures Market Hedging

A routine hedge approach refers to routinely placing a hedge at the beginning of each production period. This is a three-step process. First, the producer contacts a broker and informs the broker that he would like to sell a futures contract for live hogs (the contract specifications are stated in the next chapter). The first step is executed on the first day of production (the day the feeder pigs are purchased). Second, the hog producer sells the actual physical commodity in the local cash market at the end of the production period. Third, on the same day the hogs are sold the producer buys back the futures contract to offset the contract that was sold at the beginning of the production period.

Routine Cash Contracting

The routine cash contract strategy does not directly involve the futures market. Under the cash contract strategies the hog producer agrees to a price quoted to him by a buyer on the first day of the production period. Four months later when the feeder pigs have grown to

market weight, the producer delivers the hogs to the buyer for the price that was agreed upon at the beginning of the production period. This strategy assures the producer a final price and the buyer assumes the risk of price changes (which he typically hedges on the futures market). For simulation purposes, the contract price quoted by the buyer was the price for the futures contract maturing immediately after the hogs were to be delivered minus $3.00 per hundredweight. For hogs to be delivered in May and November, $4.00 per hundredweight was deducted from the futures price (20). The amount deducted represented the expected basis (what the buyer expected) at the time the hogs were delivered.

Routine Put Option Purchases

As discussed earlier, there are three different types of put options. Thus, there are three different types of nonselective, benchmark put option strategies. The benchmark put option strategies are the routine purchase of at-the-money, in-the-money and out-of-the-money options. Key components of the routine option purchase strategies are: 1) the producer purchases the put option on the first day of the production period; 2) the producer sells the option at the end of the production period at its market value; and 3) the producer does not exercise the option. Market value is determined by an option's intrinsic value plus time value. Intrinsic value is the amount that would be received if the option was exercised. Time value is determined by factors such as the time till expiration, market price volatility, the short-term rate of interest and the relationship between market and strike prices (6, p. 10). If hog prices move up significantly from the beginning to

the end of the production period, the value of the option to be sold will be very small. The option will simply be allowed to expire if it's value is less than the commission charged for selling it. On the other hand, if hog prices move down significantly the value of the option could be large. The proceeds received from selling the option at the end of the production period will be added to net returns for that period. All three types of routine option purchases were simulated for the 92 production periods included in the study. Methods used for calculating option premiums will be discussed in the next chapter.

The in-the-money and out-of-the-money put option strategies utilized options priced at $2.00 per hundredweight above and $2.00 below the at-the-money option, respectively. In other words, the simulation did not consider the purchase of deep in-the-money or out-of-the-money options.

3. Selective Futures Market Hedging Strategies

Selective futures market hedging strategies are decision-making systems in which the hedge is not placed unless a certain criterion is met. Several different criteria were evaluated. Some of these require the use of a "localized futures price." When this term is used, it refers to a net price that a hog producer <u>expects</u> to receive at the end of the production period if he hedges on the futures market. It is calculated by subtracting the local basis estimate for the period when the hogs will be sold from the appropriate futures price at the beginning of the production period. The success of strategies using basis

estimates depends to some extent upon how accurate the prediction of the basis was. Three relatively simple selective futures market hedging strategies using the localized futures concept were evaluated. In addition two types of technical analysis strategies for hedging were simulated--moving averages and oscillators.

Localized Futures Price Greater Than Starting Cash Price

This strategy calculated the localized futures price at the beginning of the production period. If the localized futures price was greater than the current local cash price for hogs, a hedge was executed. The hedge was lifted at the end of the production period. The hedged profit (or loss) was the starting futures price (a sell) minus the ending futures price (a buy) less deductions for commission and interest. These consisted of a $75.00 commission charge to a broker for buying and selling the futures contract and a $28.00 interest cost on the initial margin requirement for the four-month period. The total of $103.00 round turn cost of hedging was deducted from returns for all futures hedging strategies for each simulation.

When comparing the localized futures price to a starting cash price, the simulated producer is looking for an opportunity to hedge only when the futures market appears to be more profitable than the local cash market given his basis estimate. Each simulation that did not meet the rules for hedging at the beginning of the production period was simulated as a cash market strategy.

In addition to requiring the localized futures price to be greater than starting cash, $1.00 increments were added to the cash

price to derive a new price to be used as a decision criterion. The increments added ranged from -$2.00 to $10.00 per hundredweight. For example, the producer might hedge only when the localized futures price exceeded the local cash price by $4.00 per hundredweight or more. This method was used with all "localized" strategies.

Localized Futures Price Greater Than Starting Break-Even Price

This strategy is similar to the one just discussed except it uses the starting breakeven price for a comparison to the localized futures price. If the break-even price (all variable costs) is greater than the appropriate localized futures price at the beginning of the production period, that production period is simulated as a cash market strategy. If localized futures is greater than break-even, a hedge is placed. The method of using dollar increments added to the break-even price was used in this strategy also. The increments evaluated ranged from $1.00 to $10.00 per hundredweight. When comparing the localized futures price to a break-even price, the simulated producer is looking for an opportunity to hedge only when the futures market price can cover all the variable costs of production or can cover variable costs plus some increment of net returns. If the basis estimate is accurate, the variable costs of production can be covered and the net return increment locked in for that group of hogs. The simulated producer's estimate of the basis is very important when using strategies that attempt to anticipate the final cash price.

Expected Returns from Futures Hedging Greater Than a Given Percent Above Starting Break-Even Price

This strategy calculates the expected net returns generated from hedging at the beginning of the production period. These net returns were expressed as a percentage of break-even and compared to a specified criterion percentage to determine whether a hedge was placed. A hedge was placed only if the percent net returns from hedging equaled or exceeded the criterion percentage. If the percent-returns-above-break-even criterion was not met, that group of hogs was simulated as a cash market strategy. The formula used to calculate the net returns from hedging is as follows:

$$\text{Expected net returns from hedging} = \frac{\text{localized futures} - \text{deductions}}{\text{starting break-even price}} - 1.00$$

The percentages that the expected net returns from hedging were required to exceed ranged from 1 percent to 18 percent for the production period. It is important to remember that this selective strategy also relies on the simulated producer's estimate of the basis (localized futures appears in the formula above). The concept underlying this strategy is that the producer would hedge only when he could lock in a given percent return on his expenses represented by breakeven price.

Moving Average Strategies

A variety of moving average strategies were simulated. In most cases two moving averages were used. Graphically, when the shorter length moving average crossed the longer length moving average from above a sell signal was generated and a hedge was placed. The computer

checked the averages daily from the beginning of the production period. If, at the beginning of the production period, the shorter length moving average was already less than the longer length moving average a hedge was placed immediately (in theory, indicating a downward price trend). If a hedge was not placed at the beginning of the period, the simulation continued to check the criterion daily to determine whether a sell signal was generated. If a hedge was placed, it was offset at the end of the production period by buying a futures contract, regardless of whether buy signals were generated prior to that date.

The combinations of moving averages evaluated were: 3-day and 10-day moving averages, 5-day and 10-day moving averages, and 5-day and 15-day moving averages. "Penetration" rules were also used with all three moving average combinations. The rules required that the shorter length moving average cross the longer length moving average by 2, 4, or 6 cents per hundredweight before a sell signal was generated. This rule was applied in an attempt to eliminate false sell signals.

Two strategies which used three moving averages were simulated. The intermediate length average was used to either confirm or deny the sell signal generated by the shortest length moving average. This approach was also an attempt to eliminate false signals. The two strategies used were: 1) 3-day and 5-day and 15-day moving averages, and 2) 5-day and 10-day and 15-day moving averages.

All moving average strategies were tested until one month prior to when the hogs would reach market weight. If a hedge was not placed by that time, that group was sold on the cash market at the end of the

production period with no other consideration of hedging for that period. Moving average strategies do not require a basis estimate.

Oscillator Strategies

Three different oscillator strategies were used. Oscillator systems usually consist of a base line, an upper limit, a lower limit and a moving average of daily futures prices. The oscillators used in this study consisted of a moving average, a base line and an upper limit only, since no buy signals were needed. The base line was the starting break-even price. The upper limit ranged from $2.00 to $14.00 above the base line. Sell signals were generated when the moving average oscillator was less than the previous day while it was above the upper limit. The offsetting buy was made at the end of the production period. Three alternative moving averages were tested: 5-day, 10-day and 15-day moving averages. All oscillator strategies were tested until one month prior to the hogs reaching market weight. If a hedge had not been placed during that period of time, that group was sold on the cash market at the end of the production period with no other consideration of hedging for that period.

4. Selective Cash Contracting Strategies

Selective cash contracting strategies were simulated with contracting triggered by comparisons of contract prices with starting cash prices and starting break-even prices. If the criteria for contracting was not met at the beginning of the production period, that group of hogs was sold using the cash marketing strategy. The prices offered by

the buyer were calculated by subtracting $3.00 from the appropriate futures price ($4.00 for hogs to be delivered in May and November). The amounts to be deducted from the futures price were determined for the simulation after consulting the two major hog buyers in Tennessee (20). While cash contracting did not directly involve the futures price, the price offered by the buyer was related to the price on the futures market. Since a futures trade was not involved there was no deductions for commission and interest on margin money.

Cash Contract Price Greater Than Starting Cash Price

The cash contract price offered by the buyer at the beginning of each production period was compared to the starting cash price for this selective strategy. The hogs were contracted when the contract price exceeded the starting cash price. When the cash contract price did not exceed the starting cash price the hogs were sold on the cash market at the end of the production period. If the criterion was met for cash contracting the producer delivered the hogs to the buyer when the hogs reached market weight. Variations on this strategy included various dollar increments added to the starting cash price. Increments ranged from -$2.00 through +$8.00 per hundredweight.

Cash Contract Price Greater Than Starting Break-Even Price

The cash contract price offered by the buyer at the beginning of each production period was compared to the breakeven price for this selective strategy. The hogs were contracted when the contract price exceeded the break-even price. When the cash contract price did not

exceed the starting break-even price, the hogs were sold on the cash market at the end of the production period. If the criterion was met for cash contracting the producer delivered the hogs to the buyer when the hogs reached market weight. This selective strategy insured that at least all the costs of variable inputs of production will be covered by the cash contract per hundredweight.

Variations on this strategy included various dollar increments added to the starting cash price. The increments ranged from 0 through $10.00.

5. Selective Put Option Strategies

Selective put option strategies were simulated for at-the-money, in-the-money and out-of-the money options on live hogs futures contracts offered by the Chicago Mercantile Exchange. Each strategy required selling the option at the end of production for its market value rather than exercising the put option. Thus, the producer was never involved with the offsetting sale and purchase of a live hog futures contract.

Each option strategy involved the use of two estimates: a basis estimate and an estimate of the option premiums for the three different types of put options. The basis estimate was the same as that used with the futures hedging strategies. The estimate of option premiums, is calculated using the widely accepted Black formula for option pricing. It was necessary to use the estimate for option premiums since historical data were not available. The Black formula and calculation of option premiums are discussed in the next chapter. At-the-money strike

prices were determined by finding the even dollar nearest to the underlying futures price. In-the-money and out-of-the-money strike prices were determined by adding $2.00 and subtracting $2.00, respectively, from the at-the-money strike price.

A wide variety of methods are used for charging commissions on the purchase and sale of options. Some brokers charge a flat fee while others use formulas. The method used in this study can be represented by the following formula:

$$\text{Commission on the option} = \$15.00 + [(\text{the premium}) \times 0.02]$$

Thus, the more expensive the option, the higher the commission. This calculation is made at the beginning and the end of each production period and the commission is charged at both the purchase and the sale of the option.

Localized Strike Price Greater Than Starting Cash Price

This strategy is similar to the selective futures hedging strategy that compared localized futures prices to the starting cash price. The localized strike price was calculated at the beginning of the production period by subtracting the appropriate basis estimate, commissions and the option premium from the strike price. If the resulting localized strike price was greater than the starting cash price, the option was purchased. The option was sold at the end of the production period if the remaining premium value on the option was greater than the cost of selling it. If the cost of selling (commission) the option exceeded its value, the producer simply let the option expire. When

comparing the localized strike price to a starting cash price, the simulated producer is looking for an opportunity to purchase an option when the option appears to provide a net minimum price which is more attractive than cash price, given the basis estimate, premium cost and commissions. The potential positive return is theoretically unlimited.

In addition to requiring the localized strike price to be greater than starting cash, increments of $1.00 were subtracted from or added to the cash price to derive a new price for comparison with the localized strike price. The increments ranged from $0 to $9.00. This method was used with all "localized" strategies, including those involving the purchase of put options. When the criterion for buying an option at the beginning of the production period was not met, the production was simulated as a cash market strategy.

Localized Strike Price Greater Than Starting Break-Even Price

This strategy is identical to the strategy discussed above except that the starting break-even price was used for comparison instead of cash price. If purchasing a put option could enable the producer to at least cover the cost of production, without limiting potential profits, it should be considered a feasible pricing tool.

Expected Returns from Selective Purchase of Put Options Greater Than a Given Percent Above Starting Break-Even Price

This strategy is similar to the futures market hedging strategy discussed above which compared the expected returns from hedging to a given percentage above break-even costs. The simulated producer

purchased a put option only if the expected return from hog finishing using the option was greater than a specified percentage of break-even price. The percentages required to trigger purchase of a put option ranged from 1 percent to 20 percent above break-even. In all production periods when expected net returns were less than the necessary percentage the cash market strategies were be used. The higher the percentage of required returns, the more likely a production period was simulated as a cash market strategy. The formula used for calculating the expected percent net returns from the purchase of a put option is as follows:

$$\text{Expected percent net returns} = \frac{\text{strike price} - \text{basis estimate} - \text{option premium} - \text{commission}}{\text{starting break-even price}} - 1.00$$

CHAPTER III

METHODOLOGY

Simulation models were used to represent the various pricing strategies for a producer who purchases feeder pigs and feeds them to the appropriate slaughter weight before selling them (referred to as a finish hog operation). The pricing strategies to be evaluated were discussed in the previous chapter. Simulation models were constructed to follow the rules of the given pricing strategy in the same manner as a finish hog producer given his estimate of the basis and his cost of production.

The simulations required four arrays of price data and price estimates. The largest set of data consisted of cash-market hog prices and live hog futures prices. A method was constructed for the simulated producer to arrive at a basis estimate from past data readily available to him. Budgets were constructed to provide a monthly break-even price for the hog finishing operation. Options premiums for the time period were calculated using the Black formula. The method used for operating the simulation model was a computer program written in the FORTRAN programming language.

The weight specified for a live hogs futures contract on the Chicago Mercantile Exchange is 30,000 pounds. Thirty thousand pounds equates to approximately 131 head of live hogs averaging 230 pounds each. For the simulations, the producer purchased enough feeder pigs to fulfill the weight requirement of the contract (including enough pigs to

cover a 3 percent death loss). The feeder pigs were purchased on the fifth of each month beginning January 5, 1977, and ending August 5, 1984 (92 simulations). The feeding period was four months in length and hogs were sold on the fifth of each month.

Commission charges on futures market hedges were considered constant at $75.00 for each "round-trip" transaction (selling a contract and buying a contract). During the time period of this study, the Commodity Futures Trading Commission maintained a relatively stable margin requirement for hedgers. For the purposes of simulation, a $700.00 margin requirement was assumed over the time period from 1976 through 1984.

1. Live Hog Futures and Cash Market Prices

Live Hog Futures Data

Daily live hog futures prices were collected from 1975 through 1984 for each contract month from the Chicago Mercantile Exchange (8). These data provided the primary set of information used in the study. The actual data were used directly in simulations. Also, live hog futures prices were used to estimate the basis and estimate option premiums.

The prices at the end of the trading day were used for the live hogs futures price. From the beginning of January, 1975, through September, 1978, the price used for each day was the "close." From October, 1978, through 1984, the "settlement" price was used. Thus, the

majority of the data series consisted of daily "settlement" prices on live hog futures contracts.

The months for which live hog futures contracts are traded on the Chicago Mercantile Exchange are February, April, June, July, August, October and December. The "nondelivery months" are January, March, May, September and November. If production ended in a nondelivery month, the next available live hog futures contract was used for the simulation. Table 2 shows which live hog futures contract was used for each simulation.

Table 2. Determination of the Appropriate Live Hog Futures Contract For Hedging Simulations

Begin Production	End Production[a]	Appropriate Futures Contract
January 5	May 5*	June
February 5	June 5	June
March 5	July 5	July
April 5	August 5	August
May 5	September 5*	October
June 5	October 5	October
July 5	November 5*	December
August 5	December 5	December
September 5	January 5*	February
October 5	February 5	February
November 5	March 5*	April
December 5	April 5	April

[a]An asterisk indicates that the end of the production period fell during a nondelivery month.

All of the live hog futures contracts traded on the Chicago Mercantile Exchange expire on the twentieth of the month or the last business day

prior to the twentieth. Since the production period ended on the fifth, the producer should have had no difficulty purchasing a live hog futures contract at the end of the production period to complete the hedge in delivery or nondelivery months.

Cash-Market Data

Cash-market price data were collected from hog buying stations in Tennessee from 1975 through 1984 (9). The buying station market is normally referred to as the "direct" market. When these data first became available in 1975, only weekly average prices were quoted. These weekly averages were placed in the data set as if they were daily prices. For example, if the direct weekly average price was $48.32, that price was used for the daily price for Monday through Friday of that particular week. Daily direct prices became available January 1, 1979, and replaced the weekly price averages in the data set. The direct prices were for USDA grades 1-3, weighing between 200 and 240 pounds.

While a portion of the daily cash-market data was actually a weekly average and the remainder was actual daily price quotes (an unattractive characteristic from a statistical viewpoint), this problem was not considered serious. Of the four years in which weekly average prices were used, the first two years were used only for estimating the basis. Only 1977 and 1978 used the weekly average prices directly in simulations. The alternative source of cash-market prices was a weekly average of Tennessee auction market prices. Direct prices were con-

sidered more appropriate and realistic than auction market prices due to the small volume of finished hogs sold through auctions (20).

2. Basis Estimation

In order for many of the futures hedging strategies and all of the option purchase strategies to be simulated, an estimate of the basis was required by the producer. An accurate prediction of the basis is essential to successful pricing strategies using the futures market. However, as stated earlier, accurate prediction of the basis is difficult at best.

Three assumptions were used to develop a method for calculating a basis estimate. First, producers require a method that could be implemented without the use of a computer or advanced calculator. Second, the data required should be readily available. Finally, the basis estimate should come from recent data.

In order to estimate the basis, each month was divided into three 10-day periods (days 1 through 10, days 11 through 20 and days 21 through the end of the month). An average basis for each 10-day period was calculated as follows:

$$\text{10-day basis average} = \frac{\sum_{\text{days}} \left(\text{each day's futures market price} - \text{the same day's cash market price} \right)}{\text{number of price observations during the 10-day period}}$$

In order to obtain an estimate for any future 10-day period, the corresponding 10-day basis averages from the previous two years were added together and divided by two. For example, suppose a producer wanted to estimate his basis for hogs to be sold during the first 10 days of

January in 1984. Given that the average basis for the first 10 days in January, 1983, was -$3.50 and that the average basis for the first 10 days in January, 1982, was -$2.50, the producer would estimate his basis at -$3.00 for the first 10 days of January, 1984 ([-$3.50 + -$2.50]/2), for the February, 1984, futures contract (refer to Table 2). While this method is not expected to be totally accurate, the three simplifying assumptions are met and reasonable accuracy should be expected. Basis estimates are given in Table A1 of Appendix I.

3. Break-Even Price Estimates

Break-even estimates were required by the simulation for two purposes. The first is that exceeding the break-even price was a criterion for a pricing action to be executed in several of the different pricing strategies. The other purpose is that variable costs represented by the break-even price were required for calculating total net returns for each simulation period. Break-even prices were calculated monthly over the 1977-1984 period.

The break-even price estimates were calculated from budgets given in Tennessee Farm Planning Manuals (19) and data from Tennessee Agricultural Statistics bulletins (24). Only variable costs were considered in break-even price estimates.

The break-even price estimates included feeder pig prices, corn prices and protein supplement prices as the major costs of production (19). Other costs included the following:

1. Annual interest costs for operating capital offered by Production Credit Associations (26),
2. Veterinary and medicine costs,
3. Transportation costs (19),
4. Contract labor costs (19),
5. Feed grinding and mixing costs (19), and
6. Interest expense for feeder pigs (26).

The feeder pig is the largest variable expense to a finished hog producer (19). Sufficient feeder pigs were purchased at a weight of 45 pounds per head for each production period to achieve a total weight of 30,000 pounds when the pigs matured four months later. The total weight of the feeder pigs was multiplied by a monthly average price per hundredweight for feeder pigs from Tennessee Agricultural Statistics bulletins (24). A death loss expense of 3 percent was added for each production period.

Corn and protein supplement are the second largest variable costs of a finished hog operation. Monthly average prices for corn and protein supplement were taken from Tennessee Agricultural Statistics (24). A usage rate of 9.7 bushels per pig was used for corn. This usage rate was taken from Tennessee Farm Planning Manuals (19). Protein supplement in the form of 44 percent protein soybean meal (132 pounds per hog) was mixed with the corn.

Interest rates were obtained from U. S. Agricultural Statistics annual bulletins (26). The rate utilized was the average annual interest rate charged by Production Credit Associations for operating capi-

tal. This rate was divided by three to adjust for the four-month production period. Interest expense for the feeder pigs was calculated by multiplying one-third the interest rate times the cost of the feeder pigs, since interest on the feeder pigs was an expense from the beginning of the production period. However, feed and other variable expenses were incurred at different times over the production period, and interest expense was calculated for only half of these expenditures.

The remaining estimates of expenses for transportation, veterinary services and medicine, labor, and grinding and mixing feed were obtained from Tennessee Farm Planning Manuals (19). Straight line interpolation was used to develop estimates for the years in which the manual was not published. While this estimation may not be as accurate as having the actual budget costs, these expenses account for only a small amount of the total variable expenses.

After the variable expenses were estimated, the total was divided by 2.3 to obtain a price per hundredweight rather than a price per head, because an average market weight of 230 pounds per hog was assumed throughout the study. The monthly break-even price estimates for the Tennessee hog finishing operation are shown in Table A2 of Appendix I.

4. Put Option Premium Estimates

Put option premiums were calculated for use in simulating strategies involving the purchase of put options on live hog futures contracts. It was necessary to calculate (estimate) the premiums because of the lack of actual historical data. The widely accepted Black

formula (3) for option pricing was used for the calculations. Put option premiums had to be calculated for the beginning and end of each production simulation to determine the cost of the option and its salvage value at the end of the production period. The requirement data for calculating option premiums using the Black formula at a given point in time are: the futures price, the strike price, the short-term interest rate, the variance of market returns on an annual basis and the time until expiration of the option. Option premium estimates for the 1977-1984 period may be found in Table A3 of Appendix I.

The Black Formula for Option Pricing

The Black formula is a rather complex equation commonly used to calculate an estimate for the price of calls and puts. Although the Black formula is not the only formula used for calculating option premiums, it is the most popular one (6). The Black formula and variable definitions appear below (6):

$$PP = -e^{-rt} [\{UN(-d_1)\} - \{SN(-d_2)\}]$$

where:

PP = the put premium ($/cwt)

$d_1 = [\{\ln(U/S)\} + \{(sd^2t)/2\}] / (sd /t)$

$d_2 = [\{\ln(U/S)\} - \{(sd^2t)/2\}] / (sd /t)$

U = the underlying live hog futures price ($/cwt)

S = the strike price ($/cwt)

r = the short term interest rate in decimal form

t = time remaining before the option expires (in years)

sd = market volatility (or the standard deviation of market returns on an annual basis)

N = the normal cumulative probability distribution

e = 2.7183 (the base of the natural logarithm)

ln = the natural logarithm of the term

Determining the Time Before an Option Expires

In order to solve the Black formula for the option premiums, it was necessary to determine the time before the option expired (t) both at the beginning and at the end of the production period. Options on live hog futures expire prior to the delivery period on the underlying futures contract. The amount of time before the option expired for pigs beginning the feeding process in January, February, March, May, July, September and November was 135 days (0.37 years) from the beginning of the production period, and 15 days (0.04 years) from the end of the production period. The amount of time before the option expired for pigs put on feed during the remaining months was 165 days (0.45 years) from beginning of the production, and 45 days (0.12 years) from the end of the production period.

Time before the option expired was determined by assuming the option would expire one month prior to the last trading date on the underlying futures contract. Thus, the specific futures contract that is appropriate for futures hedging is not necessarily appropriate for the purchase of a put option since the option would expire before the end for the production period for hogs sold on the fifth of delivery months. Therefore, for hogs sold during delivery months the option was

on the next closest futures contract (beyond the futures contract that would be appropriate for futures hedging). Table 3 shows the underlying futures contracts used for each month and the approximate time until expiration.

Table 3. Determination of the Approximate Amount of Time Until Option Expiration for the Beginning and Ending of Each Production Period

Production Ends	Underlying Futures Contract	Option[a] Expires	Days Until Expiration at the Beginning	Days Until Expiration at the End
May 5	June	May 20	135	15
June 5	July	June 20	135	15
July 5	August	July 20	135	15
August 5	October	September 20	165	45
September 5	October	September 20	135	15
October 5	December	November 20	165	45
November 5	December	November 20	135	15
December 5	February	January 20	165	45
January 5	February	January 20	135	15
February 5	April	March 20	165	45
March 5	April	March 20	135	15
April 5	June	May 20	165	45

[a]The option does not expire on the dates listed above. However, the dates were standardized to ease the computer simulation effort.

Market Volatility

The volatility of prices (sd) of the underlying futures contract is an important element in the determination of option premiums. In most applications of the Black formula, market volatility is measured by calculating the annualized standard deviation of the natural logarithm of daily changes in the price of the underlying futures contract over

some specified period of time. This study used the following formula for calculation of this standard deviation:

$$sd = \sqrt{365 \frac{\sum_n \left((\ln U_t/U_{t-1})^2\right) - \left(\frac{\sum_n (\ln U_t/U_{t-1})}{n}\right)^2}{n - 1}}$$

where:

sd = market price volatility

U_t = is the underlying futures price in day t

U_{t-1} = is the underlying futures price in day t-1

n = is the number of prices in the calculation

In this study the value for volatility (sd) used in the Black formula was the simple average of the calculated standard deviations from two different time periods. For determining the option premium at the <u>beginning</u> of production, the first time period consisted of the 120 days immediately preceding the date on which the option was priced. For example, if the option premium was to be computed for January 5, 1983, the standard deviation was calculated over the period from September 5, 1982, through January 4, 1983. The second period consisted of the period one year earlier which corresponded to the remaining life of the option to be priced. For example, if the option premium was to be computed for January 5, 1983, the standard deviation was calculated over the period from January 5, 1982, through May 20, 1982. The futures prices used during both periods would apply to the June contract. However, for the first period, prices would apply to the June, 1983, contract, while for the second period, they would apply to the June, 1982, contract. The inclusion of the period corresponding to the

remaining life of the option one year earlier was intended to allow the volatility measure to reflect seasonal patterns in price movements which could not be reflected in the period immediately prior to the pricing of the option.

For the solution of the Black formula for the option premium at the end of the production period, an average sd from two periods was again used. The first period was the 30 days immediately preceding the day for which the option premium was determined. For example, if the premium was to be determined for May 5, 1983, the standard deviation was calculated from April 5 through May 4, 1983. The second period consisted of the period one year earlier which corresponded to the remaining life of the option. If the premium was to be computed for May 5, 1983, the standard deviation was calculated for the period from May 5 through May 20, 1982. In this example, the June futures contracts for 1983 and for 1982 would be used.

Short-Term Rate of Interest

Interest rates (r) used in the calculation of option premiums consisted of the monthly average rate on three-month certificates of deposit in the secondary market. These data were available from the Federal Reserve Bulletin (5).

Determination of the Strike Price

Strike prices (S) vary by commodity. The strike (or exercise) prices for live hog options are quoted in even $2.00 increments only. For example, $46.00, $48.00, $50.00, $52.00 and $54.00 could be strike

prices available for live hog options contracts at a given point in time. For this study, the producer was not allowed purchase options more than $2.00 away from the at-the-money strike price. For example, if the settlement price was $51.22, the at-the-money strike price was rounded to $52.00 (the nearest even dollar). The out-of-the-money strike price would be $50.00. The in-the-money strike price would be $54.00. If the settlement price was $50.99, the at-the-money strike price would be $50.00. The out-of-the-money strike price would be $48.00, and the in-the-money strike price would be $52.00.

5. Criteria for Comparison of Strategies

The performance criteria for comparing pricing strategies consisted of mean net returns and the variance of net returns over the 1977-1984 period. Strategies having the lowest variance and highest mean over the 92 simulations were considered the most desirable. Net returns, as used here, refers to revenue in excess of the variable cost of production (break-even price).

In many cases, strategies which yield higher mean net returns also have higher variances. Higher mean net returns are desirable, while higher variances are undesirable. In these cases whether the strategy is, on balance, superior to strategies with lower means and lower variances depends upon the individual producer's preferences between net returns and risk. Thus, in some cases the overall desirability of a given strategy must be left to judgement of the potential

user. The researcher can only provide quantitative measures of net returns and risk.

CHAPTER IV

RESULTS

1. Introductory Comments

The quantitative results of this study appear in two forms--tables and graphs. Tables contain mean net return levels, variances of net returns, maximum and minimum net returns that occurred during the 92 simulations and total number of noncash marketings for each strategy. Figures illustrate the tabular results in graph form. Each graph has mean net returns plotted on the X axis and variance of net returns plotted on the Y axis. To facilitate comparisons, reference lines are shown at the mean net returns and variance of net returns for the traditional cash marketing strategy. A few data points were not plotted because their proximity to other data points did not allow space for separation and labeling. The points not plotted are identified by footnotes in the tables.

Strategies which result in larger net returns and smaller variances than those obtained by the traditional cash marketing approach are considered to be desirable strategies. However, many of the strategies tested meet these requirements. Also, some strategies have superior variances while other strategies have superior mean net returns. Other strategies have superior means and variances. These strategies are easily identified on the graphs by visual inspection. Strategies considered to be clearly superior were strategies with no other strategies below and to the right of them on the graph.

2. Cash Contracting Strategies

Cash contracting provided several strategies that produced more desirable means and variances than the traditional routine cash marketing approach (see Table 4 and Figure 3). Routine cash contracting produced a mean net return $430.00 less than routine cash marketing over the 1976-1984 period. However, the variance of those net returns was considerably less. Three strategies were considered superior to all other cash contracting strategies. These strategies were cash contracting if the contract price exceeded breakeven by $3.00, $4.00 and $5.00 (see Figure 3, labels 20, 21 and 22, respectively).

Cash contracting when the contract price exceeded break-even by $5.00 (label 22) produced the highest mean net returns of <u>any</u> strategy tested, with a mean net return of $1,864.00 and a variance of net returns of $1,924,000.00. This strategy caused a contract to be executed in 31 of the 92 production simulations. The strategy with the lowest variance ($932,000.00) was to contract if the contract price exceeded break-even by $0 (label 17). The mean net return was $1,379.00. Cash contracting strategies that were triggered by a comparison to the starting cash price did not perform as well as those triggered by a comparison to starting break-even price, although several of them did perform better than traditional cash marketing approach.

Table 4. Mean and Variance of Net Return, Maximum and Minimum Net Return Levels and the Number of Noncash Marketings for Simulated Finish Hog Operations in Tennessee Using Cash Contracting Strategies, 1976-1984

Marketing Strategy	Mean	Variance (1,000)	Maximum	Minimum	Number of Noncash Marketings
	----------dollars----------				
Routine cash	1,435	3,178	5,385	-1,909	0
Routine contract	1,005	1,000	3,152	-1,651	92
Contract *if* the contract price exceeds:					
Starting cash price - $5	1,375	1,302	4,645	-1,206	71
Starting cash price - $4	1,482	1,433	4,645	-1,206	62
Starting cash price - $3	1,448	1,491	4,645	-1,206	55
Starting cash price - $2	1,596	1,734	5,385	-1,171	47
Starting cash price - $1	1,584	1,739	5,385	-1,125	42
Starting cash price + $0	1,542	2,132	5,385	-1,909	36
Starting cash price + $1	1,503	2,286	5,385	-1,909	33
Starting cash price + $2	1,545	2,410	5,385	-1,909	28
Starting cash price + $3	1,582	2,731	5,385	-1,909	23
Starting cash price + $4	1,529	2,972	5,385	-1,909	15
Starting cash price + $5	1,503	3,018	5,385	-1,909	13
Starting cash price + $6	1,531	3,091	5,385	-1,909	8
Starting cash price + $7	1,513	3,116	5,385	-1,909	7
Starting cash price + $8	1,477	3,148	5,385	-1,909	4
Starting break-even + $0	1,379	932	4,645	-615	76
Starting break-even + $1	1,363	1,019	4,645	-1,909	74
Starting break-even + $2	1,602	1,239	4,645	-1,909	62
Starting break-even + $3	1,649	1,216	4,645	-1,909	55
Starting break-even + $4	1,846	1,612	4,966	-1,909	38
Starting break-even + $5	1,864	1,924	4,966	-1,909	31
Starting break-even + $6	1,788	2,306	4,966	-1,909	20
Starting break-even + $7	1,712	2,730	5,385	-1,909	12
Starting break-even + $8	1,585	2,990	5,385	-1,909	8
Starting break-even + $9[a]	1,503	3,100	5,385	-1,909	3
Starting break-even + $10[a]	1,480	3,143	5,385	-1,909	1

[a]This strategy was not plotted in Figure 3 because of its proximity to other strategies.

Figure 3. Mean and Variance of Net Returns for Cash Contracting Strategies with Routine Cash Strategy for Comparison, Tennessee, 1976-1984

1. Routine cash
2. Routine contract
3. Contract price greater than cash price - $5
4. Contract price greater than cash price - $4
5. Contract price greater than cash price - $3
6. Contract price greater than cash price - $2
7. Contract price greater than cash price - $1
8. Contract price greater than cash price
9. Contract price greater than cash price + $1
10. Contract price greater than cash price + $2
11. Contract price greater than cash price + $3
12. Contract price greater than cash price + $4
13. Contract price greater than cash price + $5
14. Contract price greater than cash price + $6
15. Contract price greater than cash price + $7
16. Contract price greater than cash price + $8
17. Contract price greater than break-even price
18. Contract price greater than break-even price + $1
19. Contract price greater than break-even price + $2
20. Contract price greater than break-even price + $3
21. Contract price greater than break-even price + $4
22. Contract price greater than break-even price + $5
23. Contract price greater than break-even price + $6
24. Contract price greater than break-even price + $7
25. Contract price greater than break-even price + $8

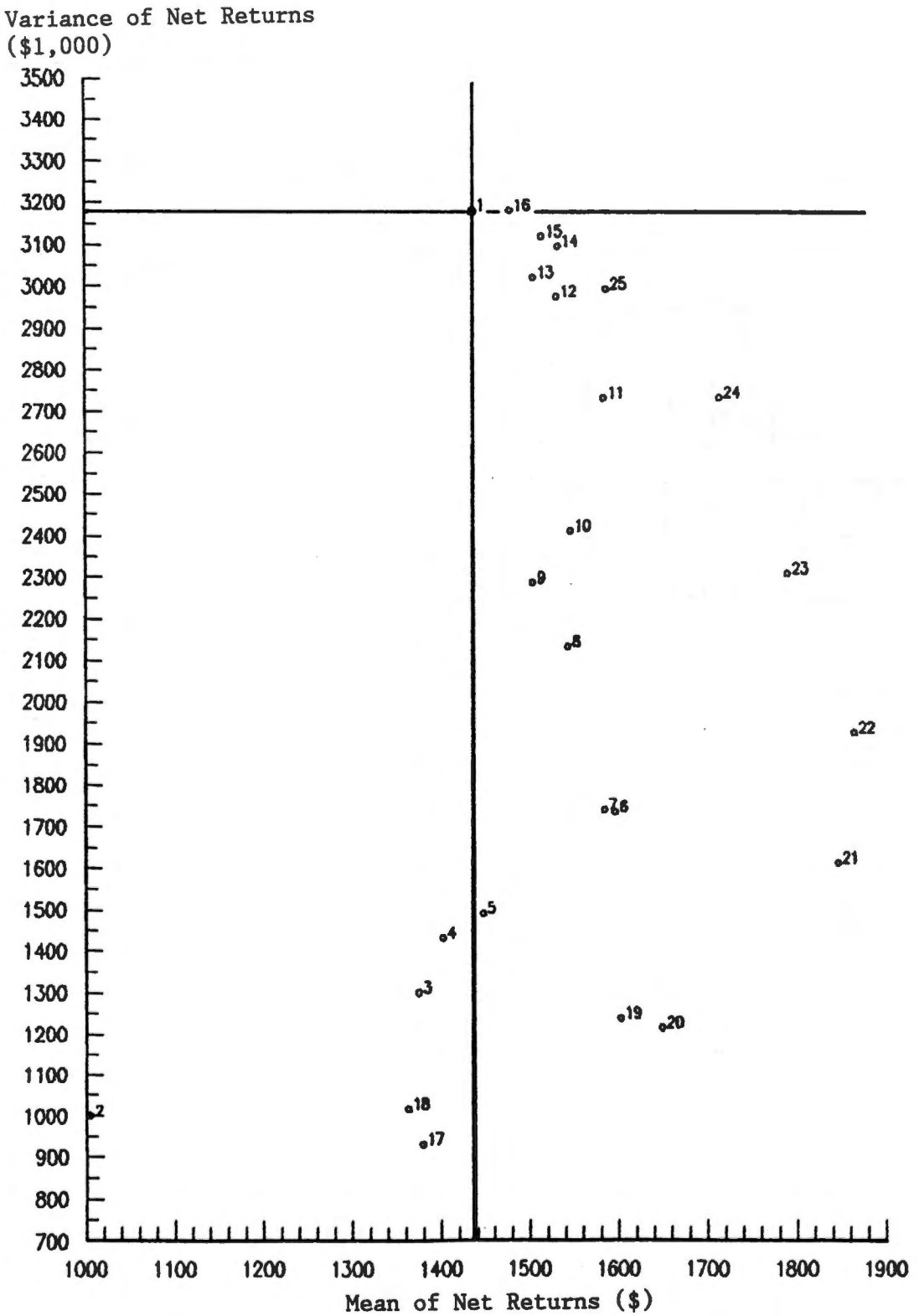

Figure 3 (continued)

3. Futures Hedging Strategies

Four different groups of futures hedging strategies were evaluated. The first group consisted of strategies triggered by a comparison of a localized futures price (calculated by subtracting the basis estimate from the starting futures price) to starting cash prices and starting break-even prices. The second group consisted of strategies that were triggered when the expected net returns from placing a futures hedge exceed the starting break-even price by a given percentage. Both of the foregoing groups relied upon the basis estimate (futures price minus cash price at time of sale). The third group consisted of futures hedges triggered by moving average sell signals. The final group consisted of futures hedges triggered by an oscillator using the starting break-even price as the base line. Moving average and oscillator strategies did not rely upon a basis estimate, but the oscillator strategies were influenced by the accuracy of the starting break-even estimate.

Routine futures hedging produced a mean net return that was about $200.00 less than routine cash marketing over the study period. However, the variance of net return was approximately one-third that of the traditional cash marketing approach.

Localized Futures Strategies

Under the localized futures strategies, futures hedges were executed when 1) the localized futures price exceeded the starting cash price plus or minus a given dollar amount, and 2) the localized futures

price exceeded the starting breakeven price by a given dollar amount. This type of strategy is easy for a hog producer to formulate provided the producer has a simple, fairly accurate method of calculating a basis estimate and the producer knows what the break-even price will be.

Superior localized futures strategies were those in which the localized futures price exceeded the starting breakeven price by $2.00, $3.00, $4.00, $6.00 and $7.00 (Table 5 and Figure 4, labels 14, 15, 17 and 18). It is interesting to note that two of the same dollar increment amounts above starting break-even price ($3.00 and $4.00) resulted in superior cash contracting strategies discussed previously. In comparisons between superior cash contracting strategies and superior localized futures strategies, the mean net returns were higher for cash contracting while the variance of net return was lower for futures hedging, given the same dollar increment above starting break-even prices.

As with the cash contracting strategies, using a comparison of localized futures prices to starting cash prices usually did not perform as well as a comparison to starting break-even prices. The only strategy that used the starting cash price for comparison which could be considered clearly superior was one in which the localized futures price was less than the starting cash price by $1.00 (Figure 4, label 4).

Expected Net Returns from Futures Hedging Greater Than Starting Break-Even by a Given Percent

Under the second group of futures hedging strategies, futures hedges were executed when expected net returns (calculated at the

Table 5. Mean and Variance of Net Return, Maximum and Minimum Net Return Levels and the Number of Noncash Marketings for Simulated Finish Hog Operations in Tennessee Using Localized Futures Prices and Expected Net Returns from Futures Hedging Strategies, 1976-1984

Marketing Strategy	Mean	Variance (1,000)	Maximum	Minimum	Number of Noncash Marketings
	----------dollars----------				
Routine cash	1,435	3,178	5,385	-1,909	0
Routine futures hedge	1,194	1,043	3,846	-1,594	92
Place futures hedge *if* the localized futures price exceeds:					
Starting cash price - $2	1,467	1,451	5,385	-1,125	58
Starting cash price - $1	1,655	1,771	5,385	-1,124	50
Starting cash price + $0	1,632	1,968	5,385	-1,482	44
Starting cash price + $1	1,618	2,186	5,385	-1,482	39
Starting cash price + $2	1,561	2,487	5,385	-1,909	32
Starting cash price + $3	1,512	2,622	5,385	-1,909	29
Starting cash price + $4[a]	1,553	2,856	5,385	-1,909	23
Starting cash price + $5	1,549	2,871	5,385	-1,909	20
Starting cash price + $6[a]	1,552	2,963	5,385	-1,909	17
Starting cash price + $7	1,486	3,025	5,385	-1,909	14
Starting cash price + $8	1,538	3,085	5,385	-1,909	9
Starting cash price + $9	1,482	3,172	5,385	-1,909	6
Starting cash price + $10[a]	1,482	3,172	5,385	-1,909	5
Starting break-even + $0	1,366	931	4,966	-1,420	86
Starting break-even + $1[a]	1,375	902	4,966	-1,375	83
Starting break-even + $2[a]	1,447	893	4,966	-616	78
Starting break-even + $3	1,509	1,085	4,966	-1,909	68
Starting break-even + $4	1,647	1,402	4,966	-1,909	57
Starting break-even + $5	1,598	1,716	5,385	-1,909	49
Starting break-even + $6	1,659	2,545	5,385	-1,909	31
Starting break-even + $7	1,684	2,792	5,385	-1,909	20
Starting break-even + $8	1,599	2,892	5,385	-1,909	13
Starting break-even + $9	1,579	2,994	5,385	-1,909	9
Starting break-even + $10[a]	1,576	3,070	5,385	-1,909	5
Place futures hedge *if* expected net returns exceed:					
Starting break-even by 1%	1,375	902	4,966	-1,420	83
Starting break-even by 3%[a]	1,372	907	4,966	-1,420	81
Starting break-even by 4%	1,447	893	4,966	-616	78

Table 5 (continued)

Marketing Strategy	Mean	Variance (1,000)	Maximum	Minimum	Number of Noncash Marketings
	----------dollars----------				
Starting break-even by 5%	1,459	919	4,966	-616	75
Starting break-even by 6%[a]	1,465	1,035	4,966	-1,909	70
Starting break-even by 7%	1,483	1,033	4,966	-1,909	69
Starting break-even by 8%	1,563	1,185	4,966	-1,909	60
Starting break-even by 9%	1,533	1,284	4,966	-1,909	58
Starting break-even by 10%	1,538	1,461	4,966	-1,909	54
Starting break-even by 12%	1,535	1,866	4,966	-1,909	44
Starting break-even by 14%	1,648	2,440	5,385	-1,909	30
Starting break-even by 16%	1,574	2,597	5,385	-1,909	21
Starting break-even by 18%	1,546	2,968	5,385	-1,909	10

[a]This strategy was not plotted in Figure 4 because of its proximity other strategies.

Figure 4. Mean and Variance of Net Returns for Localized Futures Hedging Strategies with Routine Cash Strategy for Comparison, Tennessee, 1976-1984

1. Routine cash
2. Routine hedge
3. Localized futures price greater than cash price - $2
4. Localized futures price greater than cash price - $1
5. Localized futures price greater than cash price + $0
6. Localized futures price greater than cash price + $1
7. Localized futures price greater than cash price + $2
8. Localized futures price greater than cash price + $3
9. Localized futures price greater than cash price + $5
10. Localized futures price greater than cash price + $7
11. Localized futures price greater than cash price + $8
12. Localized futures price greater than cash price + $9
13. Localized futures price greater than break-even + $0
14. Localized futures price greater than break-even + $3
15. Localized futures price greater than break-even + $4
16. Localized futures price greater than break-even + $5
17. Localized futures price greater than break-even + $6
18. Localized futures price greater than break-even + $7
19. Localized futures price greater than break-even + $8
20. Localized futures price greater than break-even + $9
21. Localized futures price greater than break-even + $10
22. Net returns greater than break-even by at least 1%
23. Net returns greater than break-even by at least 4%
24. Net returns greater than break-even by at least 5%
25. Net returns greater than break-even by at least 7%
26. Net returns greater than break-even by at least 8%
27. Net returns greater than break-even by at least 9%
28. Net returns greater than break-even by at least 10%
29. Net returns greater than break-even by at least 12%
30. Net returns greater than break-even by at least 14%
31. Net returns greater than break-even by at least 16%
32. Net returns greater than break-even by at least 18%

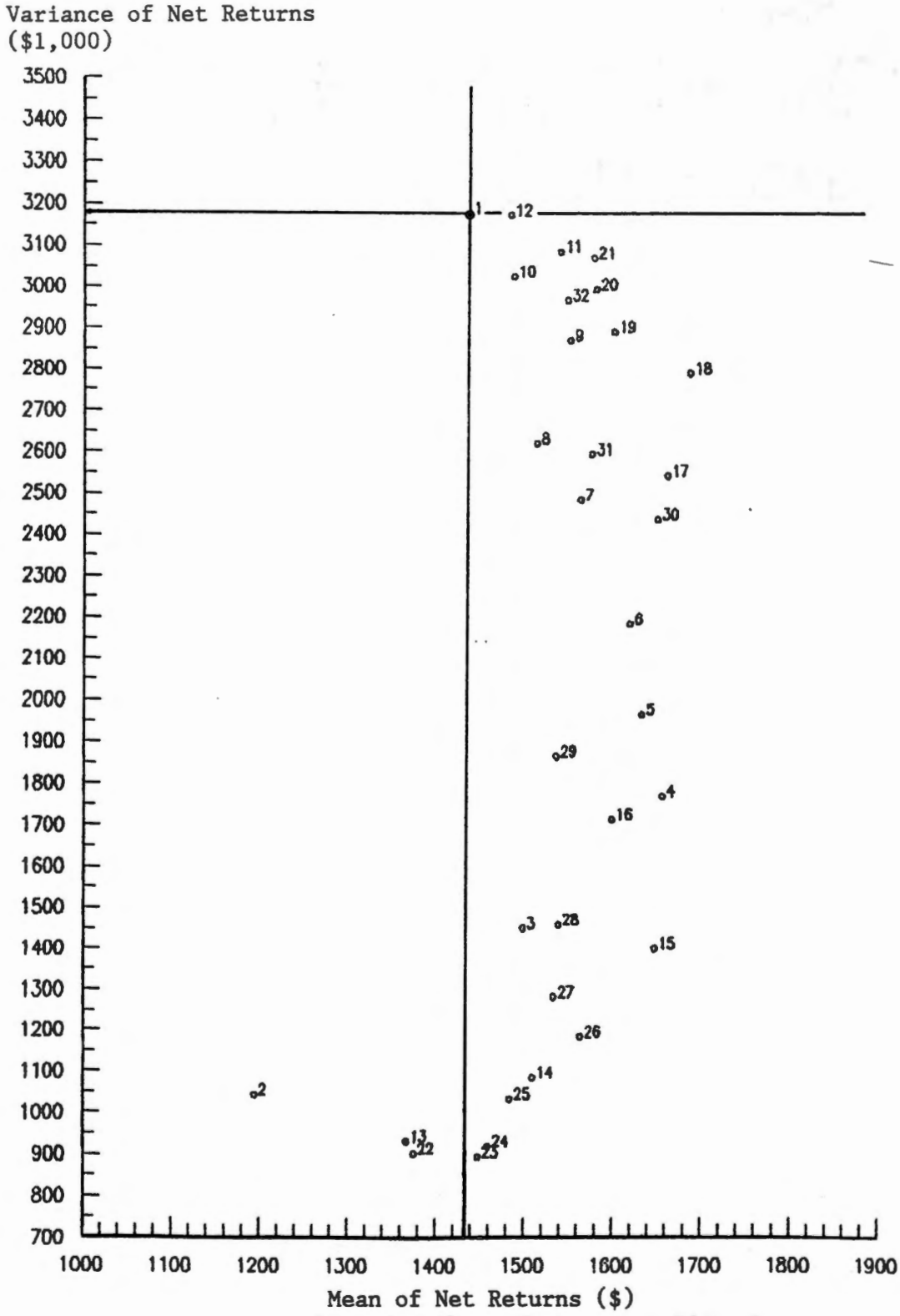

Figure 4 (continued)

beginning of production) from placing a hedge exceeded the starting break-even price by a given percentage. Superior strategies were those in which the expected net returns exceeded starting breakeven prices by 4 percent, 5 percent, 7 percent and 8 percent (Table 5 and Figure 4, labels 23, 24, 25, and 26). Each time the requirement for placing a hedge was increased the variance of net return increased. However, the highest risk (variance of net return) associated with the above-mentioned strategies was only $1,185,000.00 (8 percent), considerably less than a routine cash marketing approach. These four strategies executed a hedge during at least 60 of the 92 simulated production periods.

Moving Average Futures Hedging Strategies

Various moving average strategies were evaluated as a means of placing futures hedges for a finish hog producer. Moving average strategies did not require basis estimates or breakeven estimates to determine whether a hedge should be placed. Moving average strategies were based strictly on the ability of the moving averages to identify price trends and sell signals. A penetration rule was used with some moving average strategies in an effort to avoid false sell signals.

None of the moving average strategies produced a mean net return greater than routine cash marketing (Table 6 and Figure 5). All of the moving average strategies did, however, have a low variance of net return. The moving average strategies might be referred to as being routine, since they executed a hedge in either 91 or 92 of the produc-

Table 6. Mean and Variance of Net Return, Maximum and Minimum Net Return Levels and the Number of Noncash Marketings for Simulated Finish Hog Operations in Tennessee Using Moving Average and Oscillator Futures Hedging Strategies, 1976-1984

Marketing Strategy	Mean	Variance (1,000)	Maximum	Minimum	Number of Noncash Marketings
	----------dollars----------				
Routine cash	1,435	3,178	5,385	-1,909	0
Routine futures hedge	1,194	1,043	3,846	-1,909	92
Place futures hedge <u>if</u> a sell signal is indicated by:					
<u>Moving Average Strategies</u>					
3-10 day moving average[a]	1,206	1,163	3,785	-1,594	92
3-10 day moving average,[a] 2 cents penetration	1,206	1,163	3,785	-1,594	92
3-10 day moving average,[a] 4 cents penetration	1,204	1,163	3,785	-1,594	92
3-10 day moving average, 6 cents penetration	1,198	1,185	3,959	-1,594	92
5-10 day moving average	1,212	1,158	3,959	-1,594	92
5-10 day moving average,[a] 2 cents penetration	1,191	1,185	3,959	-1,594	92
5-10 day moving average,[a] 4 cents penetration	1,206	1,180	3,959	-1,594	92
5-10 day moving average,[a] 6 cents penetration	1,190	1,160	3,959	-1,594	92
5-15 day moving average[a]	1,180	1,126	4,228	-1,594	91
5-15 day moving average, 2 cents penetration	1,175	1,110	4,228	-1,594	91
5-15 day moving average,[a] 4 cents penetration	1,172	1,115	4,228	-1,594	91
5-15 day moving average,[a] 6 cents penetration	1,174	1,121	4,228	-1,594	91
3-5-15 day moving average	1,166	1,131	4,228	-1,594	91
5-10-15 day moving average[a]	1,186	1,154	4,228	-1,594	91
<u>Oscillator Strategies</u>					
<u>5-day moving average</u>					
$2 upper limit on break-even	1,234	813	3,785	-1,405	89
$4 upper limit on break-even	1,336	716	3,785	-1,405	85
$6 upper limit on break-even	1,479	920	4,180	-1,909	78
$8 upper limit on break-even	1,659	1,067	4,180	-1,909	67
$9 upper limit on break-even	1,762	1,511	4,645	-1,909	58

Table 6 (continued)

Marketing Strategy	Mean	Variance (1,000)	Maximum	Minimum	Number of Noncash Marketings
	----------dollars----------				
$10 upper limit on break-even	1,688	1,937	4,645	-1,909	43
$11 upper limit on break-even	1,633	2,245	4,645	-1,909	34
10-day moving average					
$2 upper limit on break-even	1,236	873	3,779	-1,585	89
$4 upper limit on break-even	1,329	797	3,779	-1,585	86
$6 upper limit on break-even[a]	1,456	1,070	4,645	-1,909	76
$8 upper limit on break-even	1,652	1,344	4,645	-1,909	61
$9 upper limit on break-even	1,683	1,631	4,645	-1,909	53
$10 upper limit on break-even	1,702	2,009	4,645	-1,909	40
$11 upper limit on break-even	1,554	2,387	4,645	-1,909	29
15-day moving average					
$2 upper limit on break-even	1,327	1,127	4,564	-1,570	85
$4 upper limit on break-even	1,466	1,092	4,645	-1,570	80
$6 upper limit on break-even	1,503	1,202	4,645	-1,570	70
$8 upper limit on break-even	1,650	1,369	4,645	-1,909	59
$9 upper limit on break-even	1,701	1,838	5,385	-1,909	46
$10 upper limit on break-even	1,680	2,044	5,385	-1,909	40
$11 upper limit on break-even	1,532	2,451	5,385	-1,909	26
$12 upper limit on break-even	1,549	2,722	5,385	-1,909	12
$14 upper limit on break-even	1,491	3,056	5,385	-1,909	4

[a]This strategy was not plotted in Figure 5 because of its proximity to other strategies.

Figure 5. Mean and Variance of Net Returns for Moving Average and Oscillator Hedging Strategies with Routine Cash Strategy for Comparison, Tennessee, 1976-1984

1. Routine cash
2. Routine hedge

Moving Averages

3. 3-10 day moving average, with 6 cents penetration
4. 5-10 day moving average
5. 5-15 day moving average, with 2 cents penetration
6. 3-5-15 day moving average

5-Day Moving Average Oscillators

7. $2 upper limit on break-even
8. $4 upper limit on break-even
9. $6 upper limit on break-even
10. $8 upper limit on break-even
11. $9 upper limit on break-even
12. $10 upper limit on break-even
13. $11 upper limit on break-even

10-Day Moving Average Oscillators

14. $2 upper limit on break-even
15. $4 upper limit on break-even
16. $8 upper limit on break-even
17. $9 upper limit on break-even
18. $10 upper limit on break-even
19. $11 upper limit on break-even

15-Day Moving Average Oscillators

20. $2 upper limit on break-even
21. $4 upper limit on break-even
22. $6 upper limit on break-even
23. $8 upper limit on break-even
24. $9 upper limit on break-even
25. $10 upper limit on break-even
26. $11 upper limit on break-even
27. $12 upper limit on break-even
28. $14 upper limit on break-even

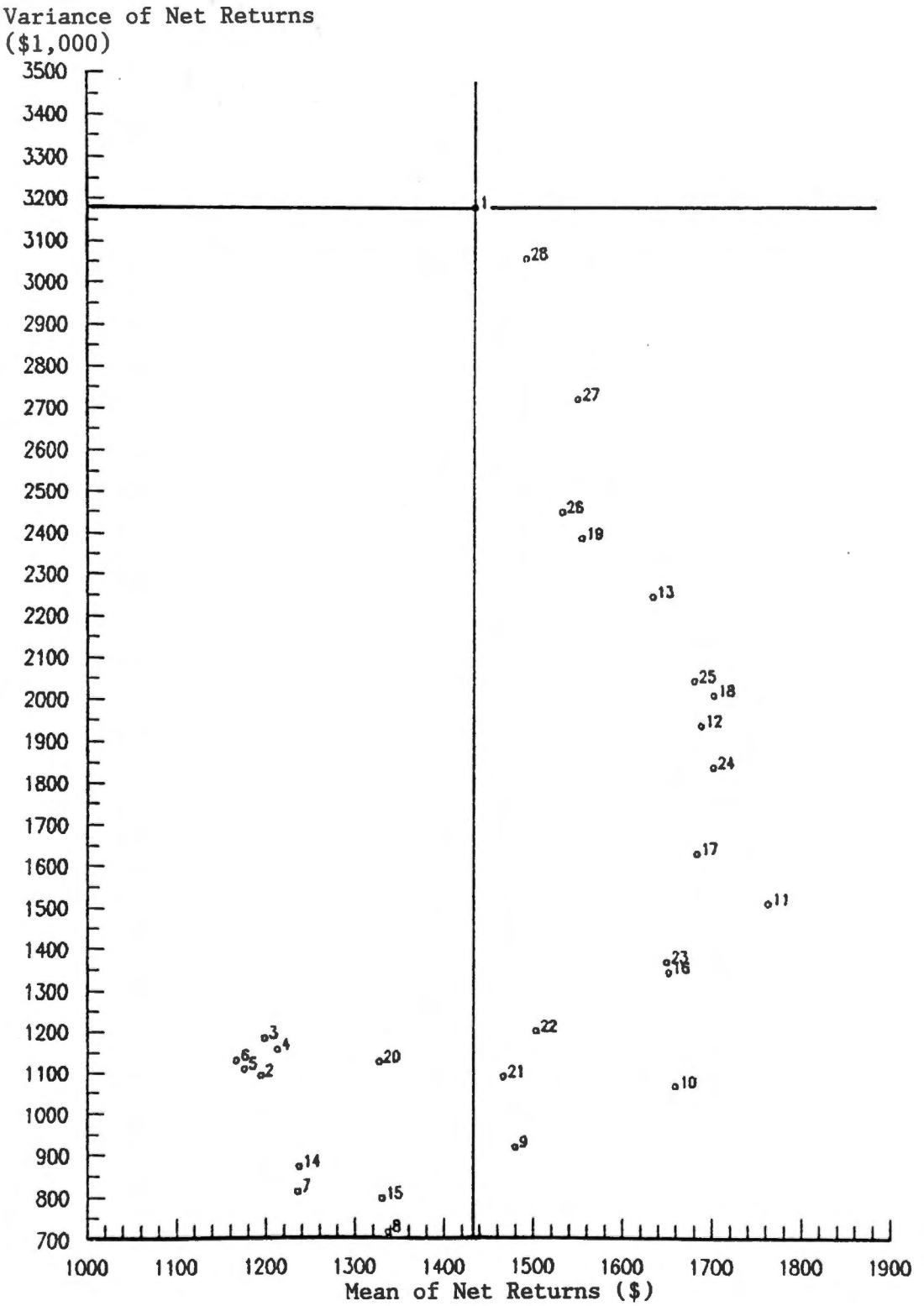

Figure 5 (continued)

tion periods. The moving average strategies used in this study did not perform well.

Oscillator Futures Hedging Strategies

Oscillator strategies were evaluated as a means of placing futures hedges. Sell signals were generated after the oscillator crossed an upper limit determined by a given dollar increment above starting breakeven price and at the first occurrence when the oscillator was less than the previous day. Superior oscillator strategies were oscillators constructed as a five-day moving average of futures prices with $6.00, $8.00 and $9.00 upper limits above starting break-even prices (Table 6 and Figure 5, labels 9, 10, and 11).

There was little difference among strategies using 5-day, 10-day or 15-day moving averages of futures prices when the same upper limit was used. The most notable influence on the oscillator strategies was a large increase in mean net returns when the upper limit was increased from $6.00 to $8.00 regardless of which of the three oscillators were used. All of the oscillator strategies with upper limits of $8.00, $9.00 and $10.00 reduced the variance of net return significantly while increasing the mean net return. The best of the oscillator strategies performed better than any other futures hedging strategies evaluated.

4. Purchase of Put Options

The purchase of three types of put options was evaluated as a means of increasing mean net returns and reducing risk of adverse price movements in the cash market. The three types of put options were: 1)

at-the-money, 2) in-the-money and 3) out-of-the money options. Localized strike prices (calculated in a manner similar to localized futures prices) were compared to starting cash prices and starting break-even prices plus specified dollar increments for the three types of put options. In addition, expected net returns from use of the put options were compared to a given percent above starting break-even prices. Put option premiums were estimated based on the Black formula since historical data did not exist for the period of the study.

The results of the three types of options exhibited similar characteristics (Tables 7, 8 and 9 and Figures 6, 7 and 8). First, mean net returns for each strategy remained relatively near the benchmark value of $1,435.00 from the routine cash marketing strategy. Second, the highest mean net returns usually resulted from a strategy that would have purchased a put option in less than 10 percent of the production periods simulated. Third, the routine purchase of put options reduced the variance and the mean net return level for the hog producer.

The strategies considered clearly superior in the comparisons of at-the-money strategies would purchase an at-the-money option if the localized strike price exceeded cash by $3.00 or starting break-even by $10.00, or if expected net returns were greater than the starting break-even price by 11 percent and 13 percent. These results are shown in Table 7 and Figure 6 (labels 6, 18, 26 and 27, respectively).

The pattern of in-the-money strategies shown in Figure 7 is similar to that shown for at-the-money option in Figure 6. Results for in-the-money options are shown in Table 8. The strategies considered

superior in the comparisons of in-the-money strategies would purchase an in-the-money options if: 1) the localized strike price exceeded starting cash prices by $4.00 and $5.00, 2) the localized strike price exceed starting breakeven price by $9.00 and $12.00 and 3) expected net returns were greater than the starting break-even price by 15 percent (Figure 7 labels 7, 8, 19, 21 and 29, respectively).

In comparisons among out-of-the-money strategies (Table 9 and Figure 8) the only strategies considered superior would purchase an out-of-the-money option if the localized strike price exceeded the starting break-even price by $8.00 (label 14) or if expected net returns were greater than the starting break-even price by 6, 7 and 10 percent (labels 16 and 17). The pattern of results shown in Figure 8 is similar to the patterns observed for at-the-money and in-the-money strategies (Figures 6 and 7).

Table 7. Mean and Variance of Net Return, Maximum and Minimum Net Return Levels and the Number of Noncash Marketings for Simulated Finish Hog Operations in Tennessee Using at-the-Money Put Option Strategies, 1976-1984

Marketing Strategy	Mean	Variance (1,000)	Maximum	Minimum	Number of Noncash Marketings
	----------dollars----------				
Routine cash	1,435	3,178	5,385	-1,909	0
Routine purchase	1,129	1,554	4,130	-1,383	92
Purchase an at-the-money put option *if* localized strike price exceeds:					
Starting cash price + $0	1,344	2,355	5,385	-1,909	44
Starting cash price + $1	1,383	2,373	5,385	-1,909	40
Starting cash price + $2	1,429	2,552	5,385	-1,909	32
Starting cash price + $3	1,439	2,766	5,385	-1,909	28
Starting cash price + $4	1,431	2,832	5,385	-1,909	25
Starting cash price + $6	1,430	2,925	5,385	-1,909	18
Starting cash price + $7	1,447	2,925	5,385	-1,909	16
Starting cash price + $8	1,426	3,047	5,385	-1,909	12
Starting cash price + $9	1,430	3,072	5,385	-1,909	8
Starting break-even + $0[a]	1,156	1,696	4,966	-1,909	85
Starting break-even + $1	1,168	1,692	4,966	-1,909	83
Starting break-even + $2	1,262	1,625	4,966	-1,909	74
Starting break-even + $3	1,323	1,652	4,966	-1,909	66
Starting break-even + $4	1,391	1,776	4,966	-1,909	57
Starting break-even + $5[a]	1,311	1,146	4,966	-1,909	47
Starting break-even + $6	1,362	2,452	4,966	-1,909	33
Starting break-even + $7	1,479	2,844	5,385	-1,909	20
Starting break-even + $8[a]	1,503	2,885	5,385	-1,909	11
Starting break-even + $9[a]	1,499	2,949	5,385	-1,909	8
Starting break-even + $10	1,521	3,009	5,385	-1,909	6
Starting break-even + $11	1,505	3,033	5,385	-1,909	5
Purchase an at-the-money put option *if* expected net return exceeds:					
Starting break-even by 1%[a]	1,374	1,773	4,966	-1,909	58
Starting break-even by 2%	1,371	1,875	4,966	-1,909	52
Starting break-even by 3%	1,353	1,997	4,966	-1,909	49
Starting break-even by 4%	1,361	2,108	4,966	-1,909	44
Starting break-even by 5%	1,363	2,330	4,966	-1,909	37
Starting break-even by 6%	1,395	2,570	5,385	-1,909	30
Starting break-even by 8%	1,460	2,868	5,385	-1,909	17
Starting break-even by 10%[a]	1,486	2,859	5,385	-1,909	13
Starting break-even by 11%	1,493	2,846	5,385	-1,909	12

Table 7 (continued)

Marketing Strategy	Mean	Variance (1,000)	Maximum	Minimum	Number of Noncash Marketings
	----------dollars----------				
Starting break-even by 12%[a]	1,514	2,880	5,385	-1,909	9
Starting break-even by 13%	1,514	2,880	5,385	-1,909	9
Starting break-even by 14%[a]	1,511	2,977	5,385	-1,909	7
Starting break-even by 15%	1,478	3,049	5,385	-1,909	5
Starting break-even by 16%[a]	1,472	3,106	5,385	-1,909	3
Starting break-even by 18%[a]	1,472	3,106	5,385	-1,909	3
Starting break-even by 20%[a]	1,472	3,106	5,385	-1,909	3

[a]This strategy was not plotted in Figure 6 because of its proximity to other strategies.

1. Routine cash
2. Routine purchase of put option
3. Localized strike price greater than cash + $0
4. Localized strike price greater than cash + $1
5. Localized strike price greater than cash + $2
6. Localized strike price greater than cash + $3
7. Localized strike price greater than cash + $4
8. Localized strike price greater than cash + $6
9. Localized strike price greater than cash + $7
10. Localized strike price greater than cash + $8
11. Localized strike price greater than cash + $9
12. Localized strike price greater than break-even + $1
13. Localized strike price greater than break-even + $2
14. Localized strike price greater than break-even + $3
15. Localized strike price greater than break-even + $4
16. Localized strike price greater than break-even + $6
17. Localized strike price greater than break-even + $9
18. Localized strike price greater than break-even + $10
19. Localized strike price greater than break-even + $11
20. Net returns greater than 2% above break-even price
21. Net returns greater than 3% above break-even price
22. Net returns greater than 4% above break-even price
23. Net returns greater than 5% above break-even price
24. Net returns greater than 6% above break-even price
25. Net returns greater than 8% above break-even price
26. Net returns greater than 11% above break-even price
27. Net returns greater than 13% above break-even price
28. Net returns greater than 15% above break-even price

Figure 6. Mean and Variance of Net Returns for Purchase of at-the-Money Put Options with Routine Cash Strategy for Comparison Tennessee, 1976-1984

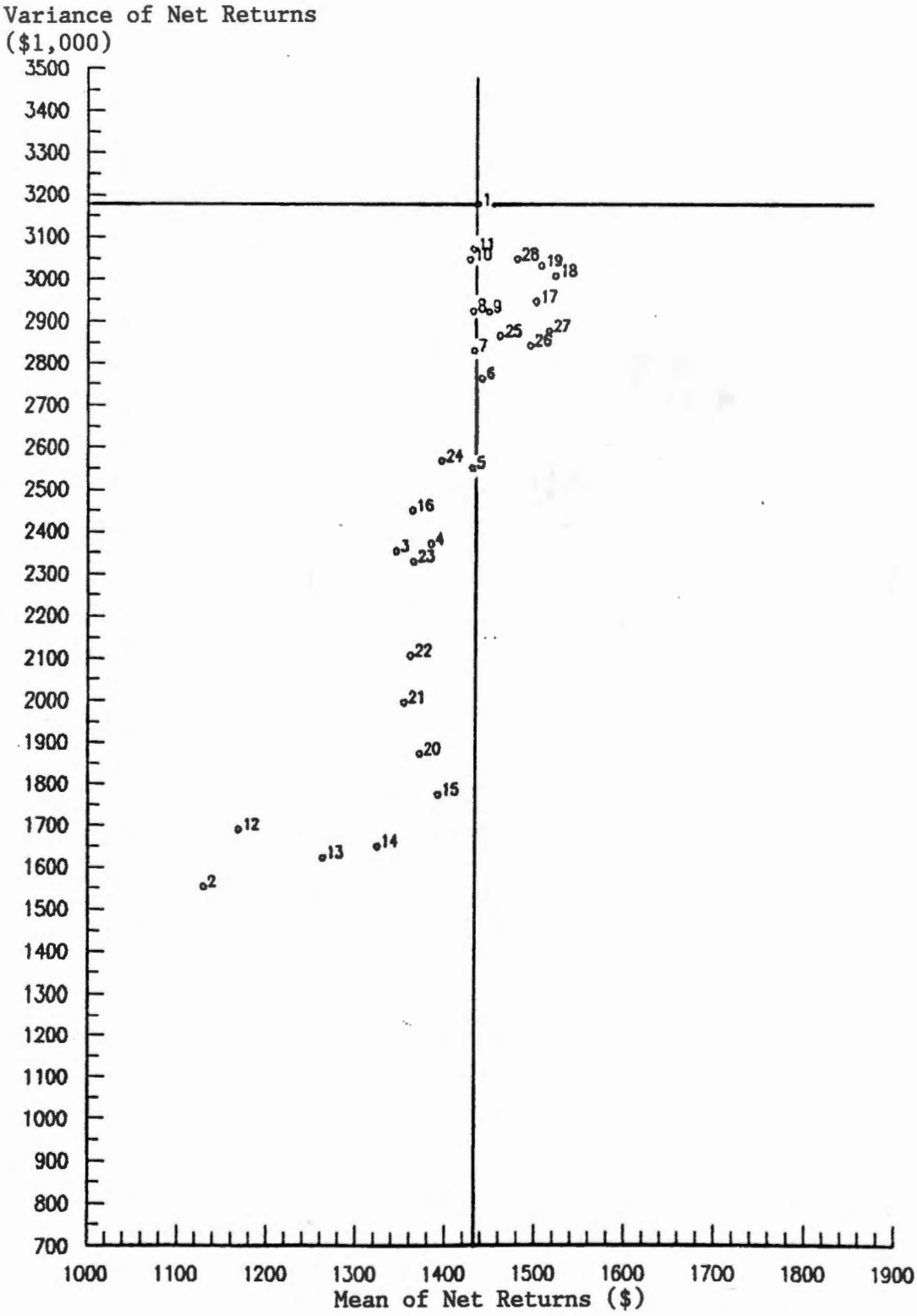

Figure 6 (continued)

Table 8. Mean and Variance of Net Return, Maximum and Minimum Net Return Levels and the Number of Noncash Marketings for Simulated Finish Hog Operations in Tennessee Using in-the-Money Put Option Strategies, 1976-1984

Marketing Strategy	Mean	Variance (1,000)	Maximum	Minimum	Number of Noncash Marketings
	----------dollars----------				
Routine cash	1,435	3,178	5,385	-1,909	0
Routine purchase	1,095	1,322	3,818	-1,528	92
Purchase an in-the-money put option *if* localized strike price exceeds:					
Starting cash price + $0	1,329	1,962	5,385	-1,909	56
Starting cash price + $1	1,361	2,088	5,385	-1,909	50
Starting cash price + $2	1,343	2,265	5,385	-1,909	44
Starting cash price + $3	1,388	2,292	5,385	-1,909	40
Starting cash price + $4	1,444	2,486	5,385	-1,909	32
Starting cash price + $5	1,457	2,710	5,385	-1,909	28
Starting cash price + $6	1,446	2,786	5,385	-1,909	25
Starting cash price + $7	1,437	2,896	5,385	-1,909	19
Starting cash price + $8	1,445	3,164	5,385	-1,909	1
Starting break-even + $0	1,117	1,263	3,818	-1,384	90
Starting break-even + $1	1,109	1,352	3,818	-1,909	88
Starting break-even + $2[a]	1,134	1,473	4,966	-1,909	85
Starting break-even + $3	1,148	1,466	4,966	-1,909	83
Starting break-even + $4	1,256	1,417	4,966	-1,909	74
Starting break-even + $5	1,323	1,454	4,966	-1,909	66
Starting break-even + $6	1,397	1,604	4,966	-1,909	57
Starting break-even + $7	1,308	1,991	4,966	-1,909	47
Starting break-even + $8[a]	1,361	2,374	4,966	-1,909	33
Starting break-even + $9	1,497	2,821	5,385	-1,909	20
Starting break-even + $10[a]	1,513	2,870	5,385	-1,909	11
Starting break-even + $11	1,507	2,939	5,385	-1,909	8
Starting break-even + $12	1,535	3,008	5,385	-1,909	6
Purchase an in-the-money put option *if* expected net return exceeds:					
Starting break-even by 1%	1,346	1,530	4,966	-1,909	64
Starting break-even by 2%[a]	1,373	1,571	4,966	-1,909	60
Starting break-even by 3%	1,370	1,598	4,966	-1,909	58
Starting break-even by 4%	1,342	1,650	4,966	-1,909	53
Starting break-even by 5%	1,333	1,768	4,966	-1,909	50
Starting break-even by 6%	1,366	2,002	4,966	-1,909	43
Starting break-even by 8%	1,374	2,385	4,966	-1,909	31
Starting break-even by 10%	1,466	2,840	5,385	-1,909	17
Starting break-even by 12%[a]	1,491	2,827	5,385	-1,909	13

Table 8 (continued)

Marketing Strategy	Mean	Variance (1,000)	Maximum	Minimum	Number of Noncash Marketings
	----------dollars----------				
Starting break-even by 14%[a]	1,512	2,873	5,385	-1,909	11
Starting break-even by 15%	1,524	2,863	5,385	-1,909	9
Starting break-even by 16%[a]	1,524	2,863	5,385	-1,909	9
Starting break-even by 17%	1,484	3,045	5,385	-1,909	5
Starting break-even by 18%	1,465	3,067	5,385	-1,909	4
Starting break-even by 20%	1,478	3,106	5,385	-1,909	3

[a]This strategy was not plotted in Figure 7 because of its proximity other strategies.

Figure 7. Mean and Variance of Net Returns for Purchase of in-the-Money Put Options with Routine Cash Strategy for Comparison, Tennessee, 1976-1984

1. Routine cash
2. Routine purchase of put option
3. Localized strike price greater than cash + $0
4. Localized strike price greater than cash + $1
5. Localized strike price greater than cash + $2
6. Localized strike price greater than cash + $3
7. Localized strike price greater than cash + $4
8. Localized strike price greater than cash + $5
9. Localized strike price greater than cash + $6
10. Localized strike price greater than cash + $7
11. Localized strike price greater than cash + $8
12. Localized strike price greater than break-even + $0
13. Localized strike price greater than break-even + $1
14. Localized strike price greater than break-even + $3
15. Localized strike price greater than break-even + $4
16. Localized strike price greater than break-even + $5
17. Localized strike price greater than break-even + $6
18. Localized strike price greater than break-even + $7
19. Localized strike price greater than break-even + $9
20. Localized strike price greater than break-even + $10
21. Localized strike price greater than break-even + $12
22. Net returns greater than 1% above break-even price
23. Net returns greater than 3% above break-even price
24. Net returns greater than 4% above break-even price
25. Net returns greater than 5% above break-even price
26. Net returns greater than 6% above break-even price
27. Net returns greater than 8% above break-even price
28. Net returns greater than 10% above break-even price
29. Net returns greater than 15% above break-even price
30. Net returns greater than 17% above break-even price
31. Net returns greater than 18% above break-even price
32. Net returns greater than 20% above break-even price

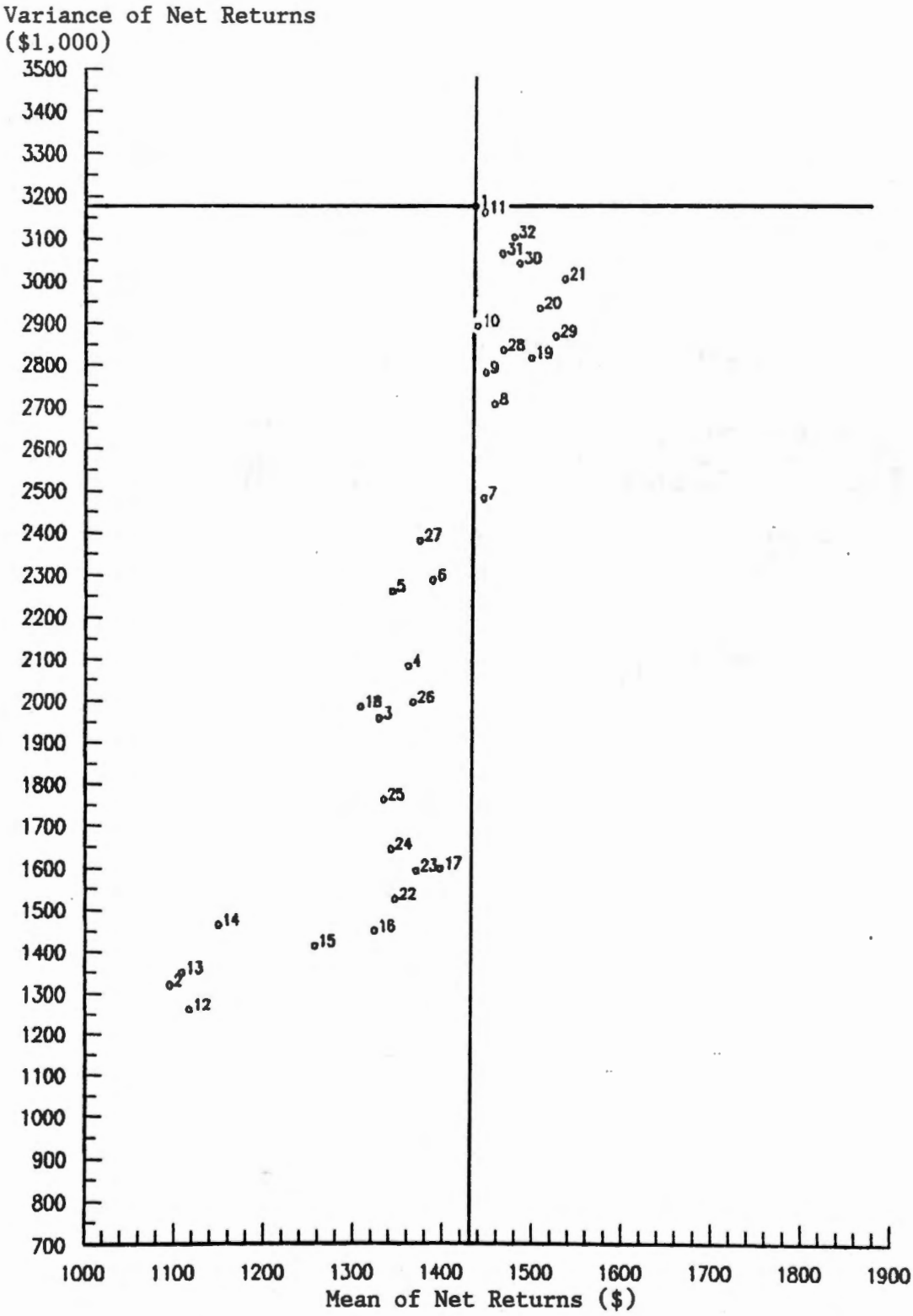

Figure 7 (continued)

Table 9. Mean and Variance of Net Return, Maximum and Minimum Net Return Levels and the Number of Noncash Marketings for Simulated Finish Hog Operations in Tennessee Using Out-of-the-Money Put Option Strategies, 1976-1984

Marketing Strategy	Mean	Variance (1,000)	Maximum	Minimum	Number of Noncash Marketings
	----------dollars----------				
Routine cash	1,435	3,178	5,385	-1,909	0
Routine purchase	1,173	1,821	4,433	-1,172	92
Purchase an out-of-the money option *if* localized strike prices exceeds:					
Starting cash price + $0	1,420	2,633	5,385	-1,909	32
Starting cash price + $1	1,427	2,829	5,385	-1,909	28
Starting cash price + $2	1,421	2,883	5,385	-1,909	25
Starting cash price + $3[a]	1,429	2,942	5,385	-1,909	19
Starting cash price + $4	1,429	2,940	5,385	-1,909	18
Starting cash price + $5	1,445	2,939	5,385	-1,909	16
Starting cash price + $6	1,428	3,051	5,385	-1,909	12
Starting break-even + $0	1,277	1,874	4,966	-1,909	74
Starting break-even + $1	1,330	1,892	4,966	-1,909	66
Starting break-even + $2	1,388	1,993	4,966	-1,909	57
Starting break-even + $3[a]	1,321	2,329	4,966	-1,909	47
Starting break-even + $4	1,368	2,556	4,966	-1,909	33
Starting break-even + $5[a]	1,465	2,878	5,385	-1,909	20
Starting break-even + $6[a]	1,492	2,912	5,385	-1,909	11
Starting break-even + $7	1,490	2,968	5,385	-1,909	8
Starting break-even + $8	1,506	3,017	5,385	-1,909	6
Purchase an out-of-the-money option *if* expected net return exceeds:					
Starting break-even by 1%	1,344	2,343	4,966	-1,909	44
Starting break-even by 5%[a]	1,444	2,918	5,385	-1,909	19
Starting break-even by 6%	1,455	2,905	5,385	-1,909	17
Starting break-even by 7%[a]	1,479	2,900	5,385	-1,909	13
Starting break-even by 9%[a]	1,495	2,910	5,385	-1,909	10
Starting break-even by 10%	1,502	2,909	5,385	-1,909	9
Starting break-even by 11%[a]	1,490	2,968	5,385	-1,909	8
Starting break-even by 12%[a]	1,498	2,991	5,385	-1,909	7
Starting break-even by 13%	1,471	3,059	5,385	-1,909	5
Starting break-even by 16%	1,466	3,107	5,385	-1,909	3

[a]This strategy was not plotted in Figure 8 because of its proximity to other strategies.

Figure 8. Mean and Variance of Net Returns for Purchase of Out-of-the-Money Put Options with Routine Cash Strategy for Comparison, Tennessee, 1976-1984

1. Routine cash
2. Routine purchase of put option
3. Localized strike price greater than cash + $0
4. Localized strike price greater than cash + $1
5. Localized strike price greater than cash + $2
6. Localized strike price greater than cash + $4
7. Localized strike price greater than cash + $5
8. Localized strike price greater than cash + $6
9. Localized strike price greater than break-even + $0
10. Localized strike price greater than break-even + $1
11. Localized strike price greater than break-even + $2
12. Localized strike price greater than break-even + $4
13. Localized strike price greater than break-even + $7
14. Localized strike price greater than break-even + $8
15. Net returns greater than 1% above break-even price
16. Net returns greater than 6% above break-even price
17. Net returns greater than 10% above break-even price
18. Net returns greater than 13% above break-even price
19. Net returns greater than 16% above break-even price

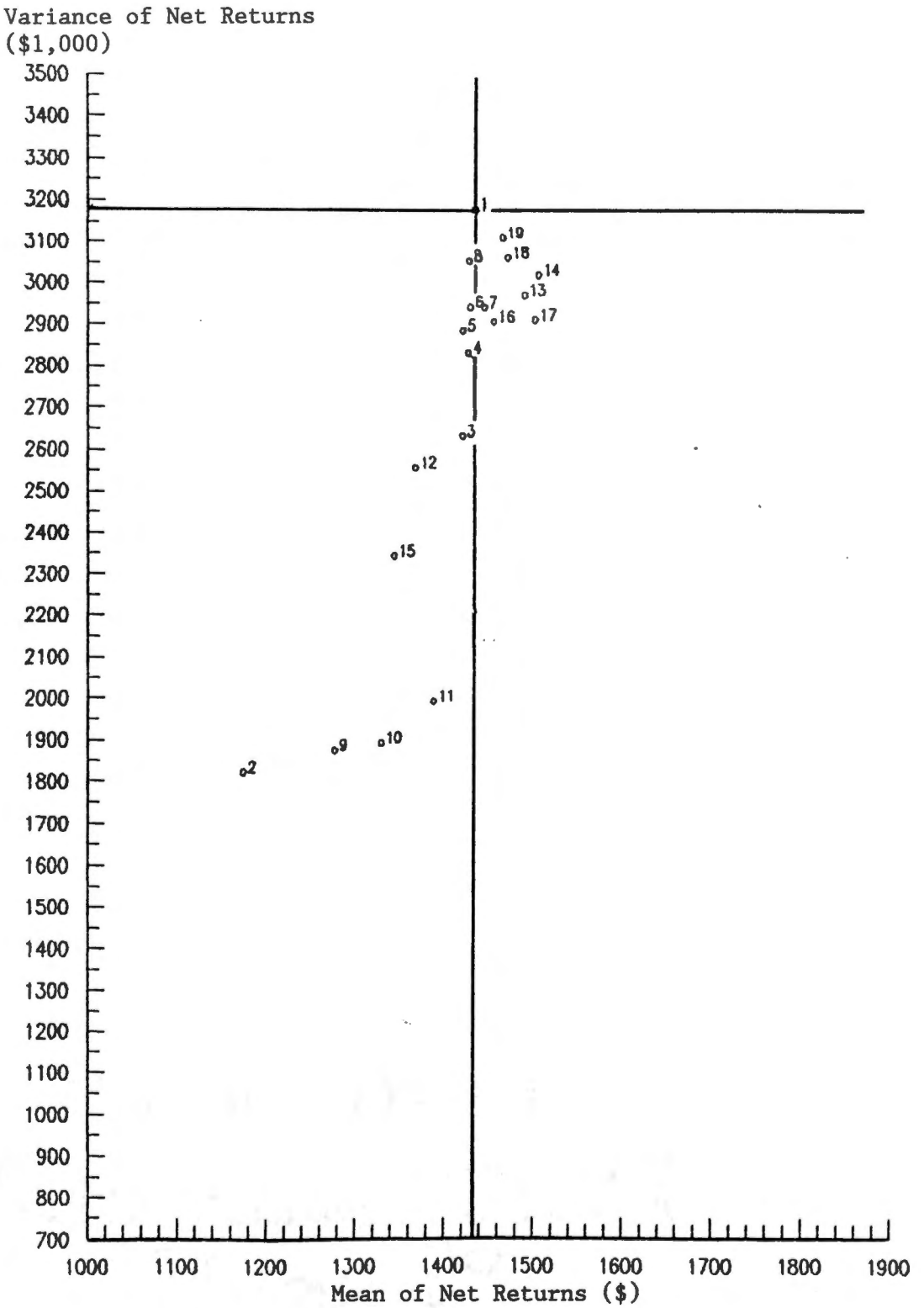

Figure 8 (continued)

CHAPTER V

SUMMARY AND CONCLUSIONS

1. Summary

Producers of agricultural commodities must deal with continuously fluctuating cash prices. Hog producers are no exception. Discovering pricing strategies that avoid problems associated with a fluctuating cash market, while at the same time increasing net returns over the long run, were the objectives of this research. The types of strategies analyzed involved cash contracting, using the futures market as a hedge, and the purchase of put options. Each of the strategies were compared with a traditional routine cash sale. Each strategy was tested over a total of 92 production periods (eight years) from January 5, 1977, through December 5, 1984.

The method used to analyze the various pricing strategies was a computer simulation model for a hog finishing operation. The model simulated production of 131 hogs (approximately the equivalent of one live hog futures contract) purchased as feeder pigs and fed for four months to an average weight of 230 pounds. Budgets included only the variable costs of production for calculation of net returns and for break-even estimation. Mean and variance of net returns were calculated for each pricing strategy over the 92 production simulations. Several strategies produced both higher mean net return levels and lower variance of net return than could be obtained from a traditional routine sell of the hogs on the cash market. In addition, superior strategies

within a given type were identified by placing the strategies on a graph (with the variance of net returns on the Y-axis and mean net returns on the X-axis) and selecting the strategies that had no other strategies below and to their right on the graph. Strategies meeting this criterion were considered clearly superior to other strategies of their type.

Several types of strategies were evaluated. A comparison of all strategies across all types was desired. However, it was not feasible to place all strategies on one graph. Therefore, Figure 8 shows the collection of strategies selected as superior from the individual types of strategies. All of the routine strategies are located in the lower left portion of the graph. All of the routine contracting, hedging and option strategies achieved a mean net return substantially below the benchmark strategy of routine cash marketing. However, all of these strategies had smaller variances than the routine cash marketing strategy. These decreases indicate that reliance on the cash market alone results in higher price risk for the producer.

Futures hedging strategies provided the most protection from price risk while simultaneously achieving mean net returns greater than the routine cash marketing strategy. The superior futures hedging strategies placed a hedge when: 1) the expected net returns from placing a hedge were greater than the starting breakeven price by various amounts, and 2) a sell signal was generated by a five-day moving average oscillator with an upper limit placed at $6.00, $8.00 or $9.00 above the starting break-even price.

Cash contracting strategies provided the largest mean net returns of any strategies evaluated while providing price risk protection considerably better than the traditional cash marketing approach. The superior cash contracting strategies occurred when the cash contract price exceeded starting break-even prices by $4.00 or $5.00.

Moving average strategies used in this study did not perform any better than routine strategies. Perhaps one reason they did not perform very well is that only sell signals were used. The hedge was lifted at the end of the production period regardless of any buy signals that might have been generated during the production period. Buy signals were also ignored for oscillator strategies since there were no lower limits placed on the oscillators. However, the moving average strategies had a low variance of net returns.

Even the "best" put option strategies were only slightly superior to the traditional cash approach with only meager gains in average net returns and price risk given the rules used in this study. It is interesting to note, however, that the in-the-money put option typically performed slightly better than the at-the-money put option, with the out-of-the-money put option being the poorest performer of the three.

Most strategies utilized the starting cash price as a criterion did not perform as well as those that used starting break-even price or expected net returns as criteria. The exceptions were a few strategies using localized futures prices.

The best strategies included in the summary graph (Figure 9) were from futures hedging and cash contracting strategies. Superior futures

hedging strategies included hedging when: 1) expected net returns from futures hedging were greater than break-even by 5 percent (label 11), 2) a five-day moving average oscillator with a $6.00 upper limit above break-even (label 15), 3) a five-day moving average oscillator with a $8.00 upper limit above break-even (label 16) and 4) a five-day moving average oscillator with a $9.00 upper limit above break-even (label 17). Superior cash contracting strategies would have contracted when the cash contract price was greater than break-even by $4.00 and $5.00.

2. Conclusions

The results from computer simulation of a Tennessee finish hog producer indicate pricing alternatives are available that could provide higher mean net returns and a smaller variance of net returns than a traditional routine cash sale to buying stations across the state. Routine strategies did not provide an improvement in both mean net return levels <u>and</u> variance of net returns. Some selective strategies provide improvements in both mean <u>and</u> variance of net returns, although some selective strategies did not reach maximum mean net returns until the strategies became very restrictive. The more restrictive the strategy the fewer times a noncash marketing strategy is executed (see Appendix II).

The practice of routine cash contracting, hedging on the futures market or purchasing a put option did not prove advantageous in this research or other research reviewed. Therefore, the use of any routine type of strategy is not recommended for achieving the assumed goals of

Figure 9. Mean and Variance of Net Returns for Pricing Strategies Selected from Among all Strategies Tested, Tennessee, 1976-1984

Routine Strategies

1. Routine cash
2. Routine futures hedge
3. Routine cash contract
4. Routine purchase of at-the-money put options
5. Routine purchase of in-the-money put options
6. Routine purchase of out-of-the money put options

Futures Hedging Strategies

7. Localized futures greater than cash - $1
8. Localized futures greater than break-even + $4
9. Localized futures greater than break-even + $6
10. Localized futures greater than break-even + $7
11. Expected net returns from futures hedging greater than break-even by 5%
12. Expected net returns from futures hedging greater than break-even by 8%
13. Expected net returns from futures hedging greater than break-even by 14%
14. 5-10 day moving average
15. 5-day moving average oscillator, $6 upper limit above break-even
16. 5-day moving average oscillator, $8 upper limit above break-even
17. 5-day moving average oscillator, $9 upper limit above break-even
18. 10-day moving average oscillator, $10 upper limit above break-even
19. 15-day moving average oscillator, $9 upper limit above break-even

Cash Contracting Strategies

20. Cash contract greater than cash - $2
21. Cash contract greater than break-even + $3
22. Cash contract greater than break-even + $4
23. Cash contract greater than break-even + $5

Purchase of Put Option Strategies

24. Localized strike (at-the-money put option) greater than cash + $3
25. Localized strike (at-the-money put option) greater than break-even + $10
26. Localized strike (in-the-money put option) greater than cash + $4
27. Localized strike (in-the-money put option) greater than break-even + $12
28. Localized strike (out-of-the-money put option) greater than cash + $5
29. Localized strike (out-of-the-money put option) greater than break-even + $8
30. Expected net returns from purchase of at-the-money put option greater than break-even by 12%
31. Expected net returns from purchase of in-the-money put option greater than break-even by 15%
32. Expected net returns from purchase of out-of-the-money put option greater than break-even by 10%

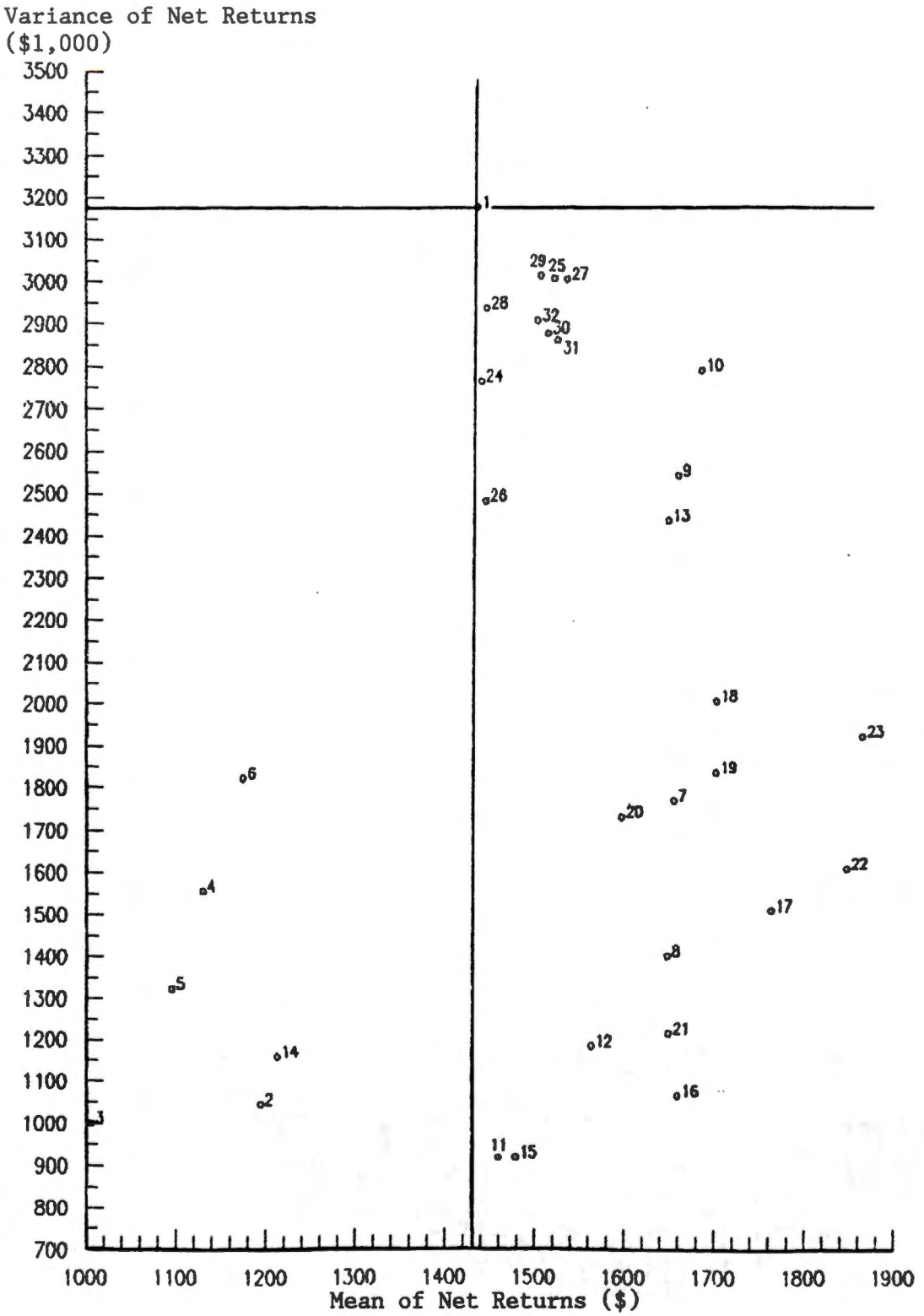

Figure 9 (continued)

higher mean net returns and less price risk. The moving average hedging strategies evaluated in this research did not provide an improvement in mean net returns and cannot be recommended. Strategies which used comparisons to the cash price offered by buying stations did not provide substantial improvements in net returns until the strategies became very restrictive. None of the put option strategies analyzed in this research resulted in significant improvements in net returns.

Cash contracting strategies with starting breakeven price as a comparison proved the most profitable in this research (and previous research). These strategies should be seriously considered by hog producers as pricing alternatives. Strategies involving the use of a localized futures price and break-even prices also performed well with higher mean net returns and lower variances than the routine cash marketing strategy. Both of the previous strategies require little effort on the part of the hog producer. Oscillator strategies involving the futures market also performed well, but require more effort than other selective strategies.

Furthermore, there is very often a trade-off of more price risk for higher average net returns with the selective strategies. Depending upon restriction placed on the producer by his creditor and the individual's willingness to accept risk, the producer might favor a strategy that provides a higher mean net return and less protection against adverse price movements or vice versa. These types of questions are best answered by a producer's own preference.

Implications for future research are evident. This study analyzed put options that were only $2.00 in- or out-of-the-money. Evaluation of put options $4.00 and $6.00 from the at-the-money strike price may provide different results. Moving average strategies executed hedges in almost every production period simulated. This finding might indicate that the moving average strategies were not restrictive enough. Future studies might evaluate longer length moving averages. In addition, buy signals were not considered in moving average or oscillator strategies. If buy signals were included net returns and variance of net returns might be improved. The focus of this study was on the pricing of output (finished hogs) only. Pricing alternatives for inputs such as corn and/or soybean meal could be integrated into future simulation models.

LITERATURE CITED

LITERATURE CITED

1. Asay, M. R. "A Note on the Design of Commodity Option Contracts: A Reply," The Journal of Futures Markets. Vol. 3, 1983, pp. 335-338.

2. Black, Fisher. "Fact and Fantasy in the Use of Options," Financial Analyst Journal. Vol. 31, July/August, 1975, pp. 36-72.

3. Black, Fisher. "The Pricing of Commodity Contracts," Journal of Financial Economics. Vol. 3, 1976, pp. 167-169.

4. Black, Fisher, and Myron Scholes. "The Pricing of Options and Corporate Liabilities," Journal of Political Economy. 81(3), May/June, 1973, pp. 637-654.

5. Board of Governors of the Federal Reserve Board. "Federal Reserve Bulletin," Federal Reserve Board, Government Printing Office, Washington, D. C., 1977-1984.

6. Chicago Board of Trade. Options on Soybean Futures: Fundamentals, Pricing and Applications, Our Next New Dimension. Chicago, Illinois, June, 1984.

7. Chicago Mercantile Exchange. "Options on Futures: A New Way to Participate in Futures," Brochure, Chicago, Illinois, 1983.

8. Chicago Mercantile Exchange. Yearbook and Daily Reports. Chicago, Illinois: Statistical Department of the Chicago Mercantile Exchange, 1975-1984.

9. Federal-State Market News Service. Nashville, Tennessee, unpublished Price Quotations, 1975-1984.

10. Gardner, Bruce. "Commodity Options for Agriculture," American Journal of Agricultural Economics. Vol. 59, No. 5, 1977, pp. 986-992.

11. Gold, Gerald. Modern Commodity Futures Trading. New York, New York: Commodity Research Bureau, Inc., 1975.

12. Hieronymus, Thomas A. Economics of Futures Trading. New York, New York: Commodity Research Bureau, Inc., 1977.

13. Jolly, Robert W. "Risk Management in Agricultural Production," American Journal of Agricultural Economics. Vol. 65, No. 5., December, 1983, pp. 1107-1113.

14. Kenyon, David. "Agricultural Commodity Options: A Teachers Guide, Section II," The University of Georgia, Extension Agricultural Economics, 1983.

15. Kenyon, David. "Farmers' Guide to Trading Agricultural Commodity Options," Agricultural Information Bulletin Number 463. United States Department of Agriculture, Economic Research Service. Washington, D. C.: Government Printing Office, April, 1984.

16. McLemore, Dan L., C. B. Sappington, E. L. Rawls and J. R. Adams. "An Evaluation of Alternative Pricing Strategies Slaughter Hog Producers in Tennessee," Bulletin 602. University of Tennessee, Agricultural Experiment Station, January, 1981.

17. McLemore, Dan L., and Craig D. Miyat. "An Evaluation of Hedging Strategies for Backgrounding Feeder Cattle in Tennessee," Bulletin 607. University of Tennessee, Agricultural Experiment Station, February, 1982.

18. Purcell, W. D., and Don A. Riffe. "The Impact of Selected Hedging Strategies on the Cash Flow Position of Cattle Feeders," Southern Journal of Agricultural Economics. Vol. 12, July, 1980, pp. 85-88.

19. Ray, R. M., and H. N. Walch. Farm Planning Manual. University of Tennessee, Agricultural Extension Service, 1975-1984.

20. Rawls, Emmit L. Personal communications. University of Tennessee, Agricultural Extension Service, 1984-1985.

21. Russell, James R., and John R. Franzmann. "Oscillators as Decision Guides in Hedging Feeder Cattle: An Economic Evaluation," Southern Journal of Agricultural Economics. Vol. 11, July, 1979, pp. 83-88.

22. Sappington, Charles B. "Estimated Returns from Feeding Out Purchased Feeder Pigs in Tennessee With and Without Using the Futures Market," Bulletin 526. University of Tennessee Agricultural Experiment Station, January, 1974.

23. Shafer, Carl E., Wade L. Griffin and Larry D. Johnston. "Integrated Cattle Feeding Strategies 1972-1976," Southern Journal of Agricultural Economics. Vol. 10, December, 1978, pp. 35-41.

24. Tennessee Crop Reporting Service. Tennessee Agricultural Statistics. Nashville, Tennessee, Annual Bulletins, 1975-1986.

25. Ward, Ronald W., and Gregory E. Schimkat. "Risk Ratios and Hedging Florida Feeder Cattle," Southern Journal of Agricultural Economics. Vol. 11, July, 1979, pp. 71-77.

26. United States Department of Agriculture. Agricultural Statistics. Washington, D. C.: Government Printing Office, Annual Bulletins, 1975-1984.

27. United States Department of Commerce, Bureau of Census. 1982 Census of Agriculture. Washington, D. C.: Government Printing Office, 1984, pp. 17-34.

28. United States Department of Commerce, Bureau of Census. 1982 Census of Agriculture: Geographic Area Series - TN. Vol. 1, Part 42, Washington, D. C.: Government Printing Office, 1984, p. 129.

29. United States Department of Commerce, Bureau of Census. 1982 Census of Agriculture: Graphic Summary. Vol. 2, Part 1, Washington, D. C.: Government Printing Office, 1984, p. 129.

30. University of Tennessee. Tennessee Statistical Abstract, 1985/1986. Center for Business and Economic Research, College of Business Administration, Knoxville, Tennessee, August, 1985.

APPENDIX I

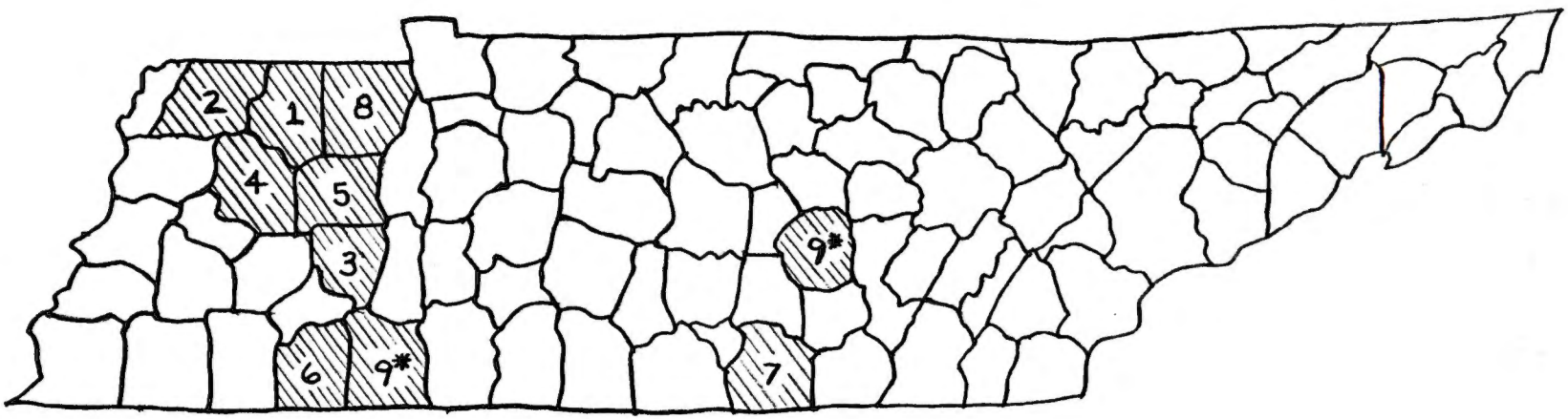

Figure A1. The Top 10 Hog Producing Counties in Tennessee.

* Tied for ninth place.

Sources: Tennessee Crop Reporting Service. Tennessee Agricultural Statistics. Nashville, Tennessee, Annual Bulletins, 1975-1984.

United States Department of Commerce, Bureau of Census. 1982 Census of Agriculture: Graphic Summary. Vol. 2, Part 1, Washington, D.C.: Government Printing Office, 1984, p. 129.

Table A1. Basis Estimates for Live Hog Futures for the Fifth of Each Month, Tennessee Direct Markets, 1977-1984

Month	Dollars Per Hundredweight
1977	
January	-1.2550
February	-0.2950
March	-3.0487
April	0.9140
May	7.1357
June	3.0775
July	1.4100
August	-0.6500
September	-3.2550
October	-0.8967
November	0.6962
December	2.0243
1978	
January	0.6717
February	2.0737
March	-1.0212
April	2.1467
May	5.8125
June	3.8186
July	1.0880
August	1.4312
September	-0.1960
October	1.7800
November	1.9900
December	3.6450
1979	
January	1.0928
February	2.4371
March	1.1014
April	2.7428
May	5.2937
June	2.0233
July	1.5183
August	-1.1512
September	-1.0860
October	0.1637
November	5.8214
December	2.9467

Table A1 (continued)

Month	Dollars Per Hundredweight
1980	
January	5.0885
February	2.3500
March	2.4283
April	1.5028
May	5.2528
June	3.4866
July	0.7343
August	1.3756
September	-0.1386
October	-0.2300
November	4.1620
December	3.4537
1981	
January	5.8433
February	2.9943
March	3.6485
April	1.0587
May	8.2000
June	3.4525
July	2.0157
August	0.5817
September	1.7628
October	1.3600
November	5.2300
December	1.3075
1982	
January	3.8060
February	1.5575
March	0.3825
April	1.7283
May	3.8817
June	2.1000
July	0.0250
August	0.4928
September	-0.3100
October	-0.1733
November	2.2050
December	3.8525

Table A1 (continued)

Month	Dollars Per Hundredweight
1983	
January	4.0417
February	1.1737
March	1.1225
April	3.1450
May	3.8885
June	2.2137
July	0.9760
August	2.0657
September	-2.6450
October	0.0783
November	4.8150
December	3.0914
1984	
January	3.1100
February	1.7475
March	4.2014
April	2.3729
May	8.7362
June	3.5083
July	1.4667
August	0.9487
September	0.3300
October	1.0686
November	3.6287
December	3.2800

Table A2. Monthly Break-Even Price Estimates for a Finished Hog Producer, Tennessee, 1976-1984

Month	Dollars Per Hundredweight
1976	
January	37.34
February	39.13
March	40.28
April	41.34
May	38.73
June	38.37
July	37.97
August	36.30
September	34.13
October	30.60
November	29.35
December	31.61
1977	
January	32.49
February	36.07
March	39.07
April	40.19
May	40.15
June	37.12
July	36.08
August	36.55
September	33.41
October	31.57
November	31.16
December	31.30
1978	
January	33.41
February	37.45
March	40.67
April	43.35
May	43.68
June	39.64
July	39.18
August	42.67
September	41.53
October	40.60
November	38.69
December	38.02

Table A2 (continued)

Month	Dollars Per Hundredweight
1979	
January	39.61
February	43.62
March	44.12
April	42.80
May	38.97
June	34.60
July	35.26
August	34.64
September	35.16
October	32.16
November	32.80
December	32.94
1980	
January	33.60
February	35.75
March	35.32
April	31.57
May	31.11
June	32.33
July	34.63
August	39.58
September	41.76
October	42.72
November	43.13
December	41.99
1981	
January	41.22
February	44.75
March	44.20
April	45.32
May	44.24
June	45.95
July	43.31
August	45.08
September	43.88
October	40.48
November	37.84
December	36.52

Table A2 (continued)

Month	Dollars Per Hundredweight
1982	
January	39.57
February	41.93
March	46.78
April	49.20
May	50.33
June	48.22
July	49.71
August	51.87
September	51.54
October	45.13
November	44.30
December	44.73
1983	
January	46.15
February	47.71
March	48.36
April	45.79
May	41.95
June	38.27
July	36.05
August	38.19
September	40.07
October	39.87
November	39.97
December	41.51
1984	
January	42.62
February	44.92
March	50.17
April	50.43
May	46.91
June	44.99
July	44.22
August	44.84
September	43.12
October	41.01
November	38.97
December	38.90

Table A3. Purchase and Salvage Put Premium Estimates for the Fifth of Each Month for at-the-Money, in-the-Money and Out-of-the-Money Put Options on Live Hog Futures Contracts, 1977-1984

Month	At-the-Money		$2 In-the-Money		$2 Out-of-the-Money	
	Purchase Cost	Salvage Value	Purchase Cost	Salvage Value	Purchase Cost	Salvage Value
	dollars					
1977						
January	2.70	0.00	3.77	0.02	1.82	0.00
February	3.51	0.00	4.76	0.03	2.46	0.00
March	3.04	0.00	4.26	0.03	2.03	0.00
April	2.94	3.95	4.07	5.63	2.01	2.51
May	2.86	2.29	4.06	4.08	1.95	0.93
June	3.07	2.63	4.19	4.10	2.16	1.48
July	3.75	1.28	4.96	2.98	2.71	0.29
August	3.37	0.03	4.59	0.15	2.35	0.00
September	2.34	0.00	3.41	0.00	1.50	0.00
October	2.64	0.00	3.85	0.00	1.67	0.00
November	2.41	0.00	3.63	0.00	1.46	0.00
December	3.04	0.04	4.28	0.10	2.03	0.00
1978						
January	2.92	0.00	4.16	0.00	1.92	0.00
February	3.51	0.02	4.74	0.08	2.47	0.00
March	2.89	1.09	3.96	2.24	2.01	0.41
April	3.64	2.04	4.75	3.14	2.68	1.21
May	3.95	1.59	5.15	3.30	2.91	0.49
June	3.48	0.15	4.55	0.41	2.57	0.04
July	3.88	0.07	5.09	0.35	2.85	0.01
August	3.62	0.23	4.76	0.54	2.65	0.08
September	3.37	0.03	4.51	0.20	2.40	0.00
October	3.49	1.05	4.54	1.82	2.59	0.54
November	3.13	0.14	4.23	0.41	2.20	0.03
December	4.26	3.99	5.42	5.58	3.24	2.63
1979						
January	3.04	0.33	4.11	4.24	2.15	0.04
February	3.36	1.74	4.42	11.73	2.46	7.75
March	3.39	11.83	4.44	13.82	2.50	9.84
April	2.90	9.57	3.94	11.53	2.04	7.64
May	2.81	4.59	3.87	6.51	1.93	2.83
June	3.51	3.78	4.71	5.40	2.48	2.40

Table A3 (continued)

Month	At-the-Money Purchase Cost	At-the-Money Salvage Value	$2 In-the-Money Purchase Cost	$2 In-the-Money Salvage Value	$2 Out-of-the-Money Purchase Cost	$2 Out-of-the-Money Salvage Value
	dollars					
July	3.19	0.62	4.40	1.70	2.19	0.14
August	2.61	0.03	3.68	0.10	1.74	0.01
September	3.38	0.45	4.52	1.36	2.41	0.09
October	3.09	0.59	4.19	1.34	2.16	0.20
November	3.25	2.45	4.38	4.25	2.30	1.06
December	3.97	8.84	5.51	10.76	2.99	6.97
1980						
January	3.36	9.76	4.48	11.75	2.42	7.78
February	3.59	9.20	4.77	11.19	2.59	7.21
March	3.83	3.20	5.00	4.98	2.82	1.74
April	4.05	0.67	5.22	1.24	3.03	0.32
May	3.20	0.01	4.31	0.04	2.27	0.00
June	3.76	0.75	4.89	0.14	2.78	0.02
July	3.92	0.01	5.01	0.05	2.97	0.00
August	5.05	0.82	6.19	1.43	4.02	0.42
September	4.87	4.91	5.94	6.81	3.75	3.17
October	4.44	5.59	5.54	7.41	3.48	3.93
November	4.54	12.56	5.67	14.54	3.54	10.57
December	5.50	10.22	6.60	12.00	4.51	8.52
1981						
January	3.97	4.91	5.02	6.81	3.06	3.17
February	3.88	0.20	4.92	0.56	2.97	0.05
March	4.27	0.14	5.40	0.41	3.29	0.04
April	5.11	4.89	6.23	5.45	4.11	3.51
May	3.71	0.83	4.74	1.76	2.81	0.30
June	5.21	7.96	6.31	9.83	4.22	6.16
July	5.91	6.57	7.03	8.56	4.89	4.63
August	4.65	13.40	5.77	15.37	3.66	11.45
September	3.83	10.08	4.92	12.06	2.89	8.09
October	3.37	1.22	4.23	1.98	2.47	0.68
November	3.71	1.71	4.87	2.96	2.72	0.85
December	3.99	0.01	5.14	0.05	3.00	0.00

Table A3 (continued)

Month	At-the-Money Purchase Cost	At-the-Money Salvage Value	$2 In-the-Money Purchase Cost	$2 In-the-Money Salvage Value	$2 Out-of-the-Money Purchase Cost	$2 Out-of-the-Money Salvage Value
	dollars					
1982						
January	3.49	0.00	4.58	0.00	2.57	0.00
February	4.01	0.01	5.09	0.08	3.06	0.00
March	5.50	0.10	6.60	0.33	4.51	0.02
April	3.76	0.41	4.81	0.82	2.85	0.18
May	3.78	0.11	4.88	0.35	2.83	0.02
June	3.60	1.09	4.66	1.83	2.69	0.59
July	3.83	2.23	5.00	3.73	2.83	1.12
August	6.56	2.58	7.68	3.75	5.52	1.65
September	6.67	1.12	7.80	2.43	5.63	0.47
October	4.66	1.79	5.79	2.87	3.66	1.01
November	3.98	1.36	5.09	2.73	3.01	0.51
December	3.95	2.29	5.07	3.72	3.98	1.21
1983						
January	3.57	6.23	4.69	8.22	2.62	4.27
February	4.02	8.97	5.16	10.96	3.03	7.01
March	2.68	7.85	3.73	9.84	1.83	5.87
April	4.70	3.80	5.78	5.44	3.73	2.41
May	4.84	2.18	5.99	3.87	3.82	0.93
June	2.89	1.78	4.00	3.00	1.97	0.91
July	2.59	0.21	3.64	0.80	1.74	0.03
August	3.29	1.41	4.40	2.72	2.35	0.57
September	2.94	0.00	4.06	0.03	2.02	0.00
October	3.81	1.40	4.99	2.55	2.79	0.65
November	2.26	0.55	3.29	1.70	1.45	0.09
December	2.98	0.38	4.05	0.81	2.09	0.15
1984						
January	2.73	0.57	3.80	1.40	1.87	0.17
February	2.82	0.12	3.92	0.61	1.91	0.01
March	3.54	0.67	4.64	1.79	2.60	0.16
April	3.17	7.15	4.23	9.05	2.28	5.35
May	2.97	8.21	4.03	10.20	2.09	6.23
June	3.52	11.63	4.63	13.61	2.58	9.67
July	3.28	4.47	4.46	6.46	2.29	2.56
August	3.67	1.12	3.73	2.12	1.81	0.49

APPENDIX II

THE EFFECTS OF INCREASING RESTRICTIONS ON SELECTIVE STRATEGIES

The selective strategies simulated in this study displayed a consistent pattern as the criteria for executing the strategy became more stringent. When a strategy was simulated with minimal restrictions (e.g., execute if net returns exceed breakeven by $1.00), the strategy was executed a large percentage of the 92 simulations. These strategies had a low variance of net returns, but also a mean net return considerably lower than a routine cash marketing strategy. When the restrictions increased, the number of noncash marketings decreased, the variance of net returns increased, and mean net returns increased up to a point. As the restrictions became more stringent, mean net returns reached a maximum and then started to decline. Also, the number of noncash marketings continued to decline and the variance of net returns continued to increase. As the stringency of the execution criteria continue to increase, the results of the strategy approach the values of the routine cash marketing strategy. Figure A2 graphically displays the effect of increasing the demands of a strategy.

Some strategies do not obtain a mean that is above the routine cash market strategy unless the criteria are very restrictive. Subjectively, a producer might not consider a strategy viable unless it executes at least a certain percent of the time. In other words, if a strategy only executed as a noncash market strategy four out of the 92 simulations, it might not be worth a producer's effort to monitor the decision variable.

Figure A2. An Illustration of the Relationship Between Mean Net Returns and the Variance of Net Returns as Greater Restrictions Are Placed on an Oscillator Strategy, Tennessee, 1976-1984

	Mean Profit	Variance (1,000)	Number of Noncash Marketings
	------dollars-----		
1. Routine cash	1,435	3,178	0
15-day moving average oscillator			
2. $2 upper limit on break-even	1,327	1,127	85
3. $4 upper limit on break-even	1,466	1,092	80
4. $6 upper limit on break-even	1,503	1,202	70
5. $8 upper limit on break-even	1,650	1,369	59
6. $9 upper limit on break-even	1,701	1,838	46
7. $10 upper limit on break-even	1,680	2,044	40
8. $11 upper limit on break-even	1,532	2,451	26
9. $12 upper limit on break-even	1,549	2,722	12
10. $14 upper limit on break-even	1,491	3,056	4

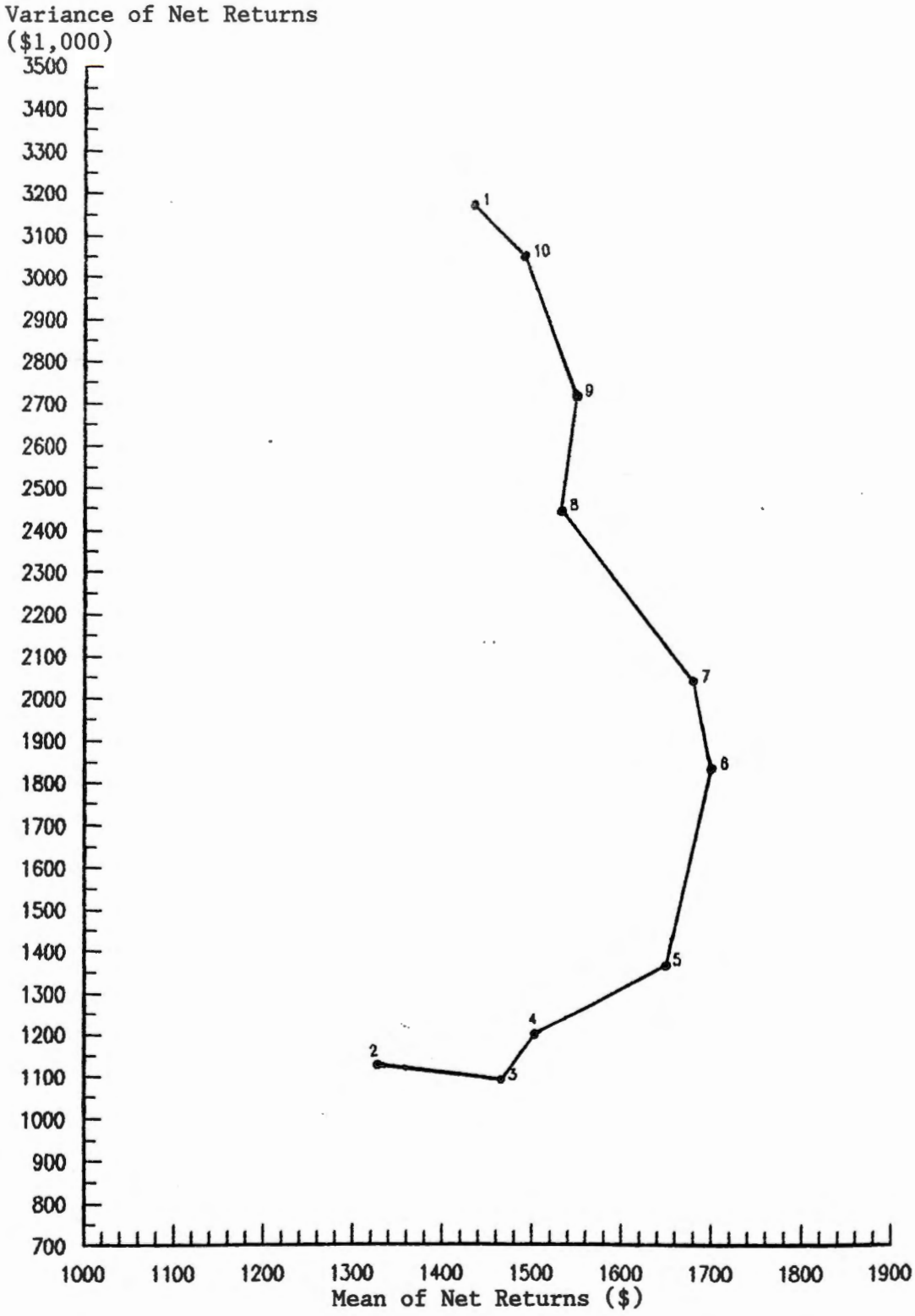

Figure A2 (continued)

VITA

Kevin D. Banker was born in Faulkner Springs, Tennessee, on April 22, 1960. He attended and graduated White County High School in May, 1978. In the fall of 1978 he entered the University of Tennessee at Knoxville and received a Bachelor of Science degree in Animal Science with a minor in Agricultural Business in December, 1982. He enrolled at the University of Tennessee at Knoxville in January, 1983, to work toward a Master of Science degree in Agricultural Economics. He is a member of Alpha Gamma Rho social/professional fraternity and Alpha Zeta honor fraternity for agriculture majors.