Hog Profit Margin Hedging:
A Long-Term Out-of-Sample Evaluation

by

Gary D. Kee and David E. Kenyon

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This paper is a long-term evaluation of the profit margin hedging strategy suggested by Kenyon and Clay. To implement this strategy an expected profit margin is estimated based on the amount of pork, corn price, and soybean meal price. Additionally, the profit margin that can be 'locked in' by the futures market is calculated from the futures prices of live hogs, corn and soybean meal with an allowance for other cost. The hedging rule is to hedge hogs, corn and soybean meal when a profit margin of fifty-five percent above the expected profit margin can be 'locked-in' with the futures. In their original paper, using data from 1975-82, Kenyon and Clay found this method of hedging stabilized cash flow while increasing the overall profit level. Using data from 1983-98, we find no difference in profits from hedging versus not hedging. The most obvious reason for the lack of success is the inability to predict the expected profit margin with the simple model used by Kenyon and Clay. Additionally, in this study as with any long-term study dealing with cost, a continuous, realistic cost structure that is available throughout the study period is a serious limitation.

Introduction

The current literature suggests that there are no income enhancement opportunities in the futures markets to routine (naïve) hedging strategies (futures prices follow a random walk) or to those based on price forecasts using publicly available information (semi-strong form market efficiency). However, Zulauf and Irwin (1997) found an increase in profits from corn storage between 1964-1989 based upon Working's basis forecast strategy. They term Working's strategy a market-generated forecast and identify profit-margin hedging as another form of this strategy. Profit-margin hedging is the simultaneous hedging of inputs and outputs of a production process. Prominent examples of profit-margin hedging are the soybean crush, cattle feeding and the crude oil crack. This paper provides a long-term, out-of-sample evaluation of a hog profit margin hedging strategy published by Kenyon and Clay (1987). Their study used an in-sample test of thirty-five groups from 1975 to 1980 with additional out-of-sample test of thirteen groups from 1980 to 1982. They find a significant reduction in variance with an increase in profits. This study is an out-of-sample test of their "optimal" strategy using data from 1983-1998. We find the profit increase as well as the variance reduction to be statistically insignificant.

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Previous Research

The foundation for profit margin hedging was formed by Working (1949) and extended by Brennan (1956) in their seminal works on the price of storage. Paul and Wesson (1966, 1967) relate the storage theory to the soybean crush and cattle feeding and make the observation that storage theory can be used to relate the price of any group of unpriced services to the prices of related items for which the market price is observable. Hieronymus (1977) documents hedging strategies that use these principles to hedge the profit of various processes. Prior empirical profit margin hedging or related studies include: Kenyon & Shapiro (1976), [chickens, corn, SBM], Shafer, et al (1978), Leuthold & Mokler (1979), Spahr & Sawaya (1981), Schroedor and Hayenga (1988), [fed cattle, corn, and feeder cattle], Kenyon and Clay (1987), [hogs, corn and SBM], Johnson *et al.*, (1991) [soybeans, soybean meal and soybean oil]. (See Table 1 for summaries of these studies.) Previous research has applied two types of rules to initiate hedging: fixed profit levels or variable profit levels. To implement the fixed hedging rule, an implied profit margin is calculated using the futures prices for the inputs and outputs with an allowance for other cost. For example, Leuthold and Mokler (1980) calculate the cost of producing live cattle from futures prices of feeder cattle and corn with the addition of non-feed cost from university extension production data yielding an implied total cost of production. Implied total income is calculated from the futures price of live cattle with the difference being the implied profit margin. They analyze hedging results when the implied profit margin varies from one to fifteen dollars in one dollar increments. While Kenyon and Clay (KC) report fixed rule hedging, they also note that the profit level that a producer should expect is negatively related to the expected level of production at the time the output (hogs) is sold. They propose a variable trigger level based on the projected profit margins determined by expected pork production and the cost of corn and soybean meal. They report the result of hedging when the implied profit margin was above the projected profit margin by 0 to 100 percent, in 10 percent increments. They conclude that a producer could increase profits while simultaneously reducing risk by hedging when the futures market offered an implied profit margin that exceeded the projected profit margin. The remaining studies summarized in Table 1 also imply an increase in profits from profit margin hedging. The combination of increased profits and reduced risk implies a violation of Fama's weak-form efficient market hypothesis that states that market participants cannot earn a risk adjusted profit from trading strategies based on publicly available information.

As a general rule, these studies are hampered by data restrictions. In particular, the cattle studies were restrained by the fact that futures for feeder cattle began trading in November 1974. Grain experienced a structural change in 1972-73, which increased both the price level and price variance, thus making inferences drawn from prior data questionable. For these reasons, the earlier studies lacked the possibility of rigorous statistical analysis of the hedging strategies with out-of-sample data. Perhaps these weaknesses are the reason Johnson *et. al.* (1991) and Zulauf and Irwin (1997) call for additional research in the area of profit margin hedging. With the availability of additional data, this study attempts to address those shortcomings. Specifically, this study applies the variable profit margin hedging strategies proposed by KC to ninety-six out of sample lots for the period between 1983 and 1998.

Data and Models

In KC, "a high-intensity 150 sow commercial farrow-to-finish enterprise was assumed to be located near Smithfield, Virginia" that replicates the system described in Bache and Foster (1977). The Bache and Foster system was a state-of-the-art total confinement system with realistic cost and return assumptions for efficient managers using July 1975 as the base year. KC estimate cash profit margins (CPM) from 1975 through 1980 with six groups of hogs sold at two month intervals each year. They use Virginia cash prices for hogs, corn and soybean meal while other production costs were estimated over time using U.S. Production Costs Indices. These cash profit margins (CPM) were regressed against per capita quarterly pork production, corn prices and soybean meal prices. The regression coefficients were used to estimate an expected profit margin (EPM) using futures prices for corn and soybean meal and forecasted per capita pork production as determined from quarterly sow farrowings intentions, pig crop, and market hog inventory estimates reported in the USDA/NASS *Hogs and Pigs* report. Implied profit margins (IPM) were calculated using the inflation adjusted Bache and Foster budget and futures prices adjusted for Virginia basis. Both the expected profit margins (EPM) and the implied profit margins (IPM) were calculated on a daily basis. Hedges were placed for feed and hogs when the implied profit margin was above the expected profit margin (EPM) at various percentage levels. Feed hedges remained in place until the feed was bought (four months prior to the sale of the hogs) while the hog hedge remained in place until the hogs were sold. While KC report results of hedging one, two, three and four quarters ahead of hog sales and at differing trigger levels, their best results, in terms of increased profit and reduced risk, are for the two quarters ahead forecast and the 70 percent trigger level. Specifically, beginning to place hedges up to two quarters ahead and continuing until the hogs were marketed, at an implied profit margin 70 percent greater than the expected profit margin increased profits from $0.57 per cwt. to $1.21 per cwt. while lowering variance from $105.95 per cwt. to $43.31 per cwt. during the December 1981 to December 1982 out-of-sample test period containing thirteen observations.

In this paper, we only examine the two quarters ahead strategy as KC found this strategy dominated all others using a mean variance criteria. Following KC, we assume that hogs are sold on the first day of the month, beginning in February, at two-month intervals throughout the year. This results in six of the seven available live hog contracts being used to hedge with no contract being used twice. Corn and soybean futures contracts that expired nearest to but after the date feeding began are used. The farrowing and beginning of feeding are four and six months prior to the date of the sale of the hogs. Table 2 summarizes the pertinent dates and futures contracts.

This paper follows the same concept as KC but differs in two major respects: KC assumed that the production facilities were in Virginia and included basis in the calculations. Costs in KC were based on Bache and Foster. We do not assume a location and therefore no basis is included in our calculations. Costs in this paper are based on USDA data, which are regularly published. These changes do not alter the hedging concept of KC, but they do make this paper more applicable to the industry in general. The remainder of this section describes the models and data used and explains any other minor differences between this paper and KC. Since the original data set was not available, some minor assumptions were made. No changes are made with the intent to improve the results of the hedge strategy. All changes are consistent with reasonable implementation of the KC strategy by a swine producer or marketing consultant.

Profit Margins Calculations: Cash and Implied

Equation (1) is used to calculate both the Cash Profit Margin (CPM) and the Implied Profit Margin (IPM):

(1) $PM = LH + CULLRET - (C \times CCF \times 1/5600) - (SM \times SMCF \times 1/2000) - DC$

where: PM = Profit Margin, $/cwt.

LH = Live Hog futures price,[1] $/cwt

CULLRET = Cull Returns, income from cull breeding stock

C = Corn futures price, cents/bu

CCF = Corn Conversion Factor

1/5600 = Converts C x CCF into $/cwt of hogs

SM = Soybean Meal futures price,[2] $/ton

SMCF = Soybean Meal Conversion Factor

1/2000 = Converts SM x SMCF into $/cwt of hogs, and

DC = Direct Cost excluding feed, $/cwt.

CPM is the cash profit margin calculated using futures prices of corn and soybean on the day the feed is purchased at the beginning of the feeding period, the live hog futures price of live hogs the day the hogs are sold, and direct cost and conversion factors for the current year. CPM is used as the dependent variable in the estimation of the Expected Profit Margin (EPM) regression. During the hedging period, IPM is calculated daily using the closing futures prices of the relevant contracts and direct cost and conversion factors for the prior year. IPM is the profit margin that is implied by the futures prices. The IPM is compared to the EPM to determine whether a hedge is placed.

In the May 1986 issue of the *Livestock Dairy and Poultry Situation and Outlook* (LDP) a profit simulator was published for a 1600 head farrow to finish operation with backcasted data to 1980. We assume these data were available for use at the beginning of the study. Data for 1975 through 1979 were estimated from the USDA/ERS *Cost of Producing U.S Livestock* (COP) series. These assumptions are reasonable and valid because the LDP simulator is based on the COP series. The budget from the LDP simulator was chosen because it is the most likely public source of data for a producer who was implementing this hedging strategy. It is not without

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[1] Lean Hog contract prices which began with the Feb 1997 contract were converted to live hog equivalent by multiplying by 0.74.

[2] The CBOT Soybean Meal contract was originally based on 44 percent protein. Beginning with the September 1992 contract, it is based on 48 percent protein. Soybean meal futures prices after September 1992 are converted to 44 percent equivalent by dividing the stated price by 1.09 (48 percent ÷ 44 percent).

problems, the most notable is that feed conversion factors have not been changed since 1980. Additionally, Direct Cost increased slowly through the 1980's with a distinct jump in the early 90's.

Feed Conversion Factors

The LPD simulator uses 345.6 pounds of corn, 70.6 pounds of soybean meal and 14.3 pounds of mixing concentrate. The 1976 COP budget uses 357 pounds of corn and 83 pounds of protein supplements. The COP budget term 'protein supplements' includes the mixing supplements. Therefore, 83 pounds of protein supplement is equivalent to 69 pounds of soybean meal. These conversion factors are on a cwt. of pork produced. These were converted to a cwt. of market hog produced yielding 388.04 pounds of corn and 75.00 pounds of soybean meal for 1975-1979. The feed usage changed to 366.68 pounds of corn and 74.91 pounds of soybean meal in 1980. For comparison, KC feed usage was 353.21 pounds of corn and 73.16 pounds of soybean meal.

Direct Cost

Total Cash Cost and Capital Replacement Cost as given in the COP and LDP budgets were used to calculate direct costs. Total Cash Cost includes all cash cost of production. Direct Cost (DC) are calculated from the LDP budgets as:

(2) DC = Total Cash Cost – Total Feed Cost + Mixing Concentrates Cost + Capital Replacement Cost

The May 1986 LDP contains yearly budget estimates for 1980-85. After that date, monthly budgets were published regularly. The monthly budgets were used to obtain a yearly average. Direct Costs are updated yearly. Table 3 lists production cost for each year in this study. For comparison, KC's direct cost were $14.75 cwt. in 1975 and $22.02 in 1980 compared to our $14.08 cwt. and $19.61 cwt., respectively.

Cull Returns

Cull Returns (CULLRET) is an estimate of the value of cull breeding stock sold and is based on the price of live hogs. CULLRET is estimated by multiplying the cwt. of breeding stock sold per cwt. of market hogs by an estimated cull sow price. The cull rates in COP and LDP are 8.01 cwt. per 91.99 cwt. market hogs and 5.75 cwt. per 94.25 cwt. market hogs, respectively. Conversion to cwt. of market hogs sold produces a cull rate of 8.71 for 1975-1979 and 6.10 for 1980-1998. Following KC, the relationship between live hog and sow price was estimated with the following equation:

(3) Sow Price = $\alpha + \beta$ live hog price.

USDA/AMS monthly sow price for U. S. 1-2, 6/7 markets are regressed against barrow and gilt price for U.S. 1-3, Iowa/S. Minn, 230-250 market hogs. The equation was estimated using monthly prices for the previous ten years and was updated yearly. The predictive power of equation (3) declines from greater than 90 percent to near 80 percent in the 1990's.

Expected Profit Margins (EPM)

The KC hedging strategy estimates the profit margin that a producer should expect given production and cost conditions. KC identified per capita pork production, cash corn and soybean meal prices as significant determinates of profit margins. They estimated the following equation:

(4) $EPM = \alpha + \beta_1 \, QPKP + \beta_2 \, PC + \beta_3 \, PSBM$

where: EPM = Expected Cash Margin ($/cwt.)

QPKP = Per capita commercial pork production, carcass weight, (lbs/person)

PC = Corn price at beginning of feeding period, (cents/bu) and,

PSBM= Soybean meal price at beginning of feeding period ($/ton).

To estimate equation (4), the CPM's of the past ten years (sixty observations) were used as the dependent variable. Corn and soybean meal futures prices at the beginning of the feeding period and actual QPKP were used as the independent variables. Depending upon the ten year window, Equation (4) explains 56-68 percent of the variation in actual cash margins. The estimated coefficients change substantially over time, indicating that the equation is quite sensitive to the time period used to estimate the equation.

Estimation of Quarterly Per Capita Pork

Quarterly Per Capita Pork production (QPKP) is estimated using equation (5):

(5) QPKP = (Slaughter Hogs x Carcass Weight) ÷ Population.

Each of the components of equation (5) are estimated by regression and projected two quarters ahead. Slaughter Hogs and Carcass Weight are each estimated with four quarterly regressions, thus allowing for seasonality. This procedure differs slightly from KC where the Slaughter Hogs and Carcass Weight regressions were combined into one regression to estimate Commercial Pork Production directly. KC also used four quarterly regression to allow for seasonality.

Slaughter Hogs

Equation (6) was used to estimate quarterly head of slaughter hogs:

(6) $SltHogs = \alpha + \beta \, PigCrop$

where: SltHogs = Quarterly Commercial Hog Slaughter (# of head), and

PigCrop = Pig Crop lagged two quarters (# of head).

Final commercial hog slaughter is obtained from USDA/NASS *Livestock Slaughter* and represents the total number of barrows and gilts, sows and boars slaughtered per calendar quarter. Pig crop is the most recently revised USDA estimates as printed in *Livestock Price Outlook* published by Illinois and Purdue Extension Services. These estimates may be revised up until the final estimates are published which may be from three to six years after the initial estimate. This step was taken to insure that no data were used before they were publicly available. Ten States data were used until September 1990. Beginning with the group of hogs sold April 1991 and corresponding to the change in January 1991 *Livestock Price Outlook*, US data were used. In 1991, only four years of US historical data were available which reduced the number of observation to four for 1991. Where available, the ten prior years of data were used to estimate the equation. Thus, the number of observations for each equation ranged from four to a maximum of ten observations.

The pig crop used to predict each quarter is as follows:

Quarterly Commercial Hog Slaughter	Pig Crop
I (Jan-Mar)	Jun-Aug (prior year)
II (Apr-Jun)	Sept-Nov (prior year)
III (July-Sept)	Dec (prior year) - Feb
IV (Oct-Dec)	Mar-May

Some trending in the coefficients was noted in the regressions using Ten States data that does not appear in the regressions using U. S. data. R^2s with Ten States data were generally between 0.8-0.9. There is a marked improvement in the stability and the predictive power of the regressions using U.S. data with R^2s increasing into the mid 0.90's. The notable exception is the fourth quarter equation that remained largely unaffected by the change to U. S. data.

Carcass Weight

Carcass weight is estimated by a simple trend regression over the prior 10 years, using a separate equation for each quarter. Final federally inspected carcass weights for all classes of hogs, as published in USDA/NASS *Livestock Slaughter*, were used in the estimations. The first set of four quarterly equation, estimated by the ten year window from 1974 through 1983, indicated an increase in carcass weight of about 0.25 pounds per year but have relatively low R^2s that average about 0.25. The estimated trend coefficients increased steadily until 1991 at which time the equations indicate that the carcass weights are increasing approximately one pound per year. Subsequent equations continue to indicated that carcass weights are increasing at about one pound per year. The R^2s values in the 1990's range between 0.90 and 0.95.

Population

Population is projected by a simple trend regression over the prior ten years using a total of forty observations. Estimates of US resident population at the first day of each month were obtained from the Bureau of Census. The population of the second month of the quarter was assumed to be the quarterly population. The population regressions were extremely stable with R^2s above .95 throughout the study.

Placing the Hedge

The decision to place the hedge is based upon the relative differences between the IPM and the EPM. The EPM is the expected profit margin based on the projected per capita pork production and the futures price of corn and soybean meal while the IPM is the implied profit margin in the futures market based upon hog futures prices, corn and soybean meal futures and estimates of directs costs with capital replacement. When the IPM exceeds the EPM by a given percentage level, based on the closing futures prices, the hedge is placed by selling the live hog futures and buying both the corn and soybean meal futures on the opening prices of the following day. If the group of hogs is not hedged prior to four calendar months before the hogs are sold (the date feeding begins) corn and soybean meal are purchased at the opening futures price that day. After feeding begins, IPM and EPM are based on the same opening prices of corn and soybean meal on the day the feed was purchased. Once the hedge is in place, it remains in place until the feed is bought (the date feeding begins) and the hogs are sold.

For example, the June *Hogs and Pigs* report contains the initial March-May pig crop estimate that is used to estimate QPKP in the fourth quarter (October-December). When the report is released in late June, the October group of hogs is already on feed as of June 1 which means that the feed cannot be hedged for this group of hogs. We assume that the feed was purchased on June 1 and the EPM is calculated based on those feed prices and the estimated QPKP for the fourth quarter. This implies that there is a single EPM calculation for this group. The IPM is also calculated from the June 1 feed prices but is updated daily with the change in the closing live hog price up to the time of the marketing of the hogs on October 1. If, for example, the EPM is calculated to be $2,the trigger level is 50 percent, and the IPM reaches $3, a hedge will be placed at the open price of the live hogs contract the following trading day. The hedge remains in place until October 1, when the hogs are marketed and the hedge is closed at the opening live hogs price.

The December group hedge works similarly but this group does not go on feed until August 1. Before August 1, the EPM is calculated daily, based on the closing price of corn and soybean meal. The trigger is monitored daily and, if met, hedges are placed on the next trading days opening prices for live hogs, corn and soybean meal. The feed hedges are then closed at the opening prices for feed on August 1 and the hog hedge is closed on December 1. Note that feed hedges can only be placed in the five week window prior to August 1 while the hog hedge can be placed for the entire twenty-two week period.

For hedging purposes, we assume that two live hog contracts of 40,000 pounds, one corn contract of 5000 bushels, and one Mid-America soybean meal contract of 20 tons of 44 percent protein[3] are purchased. This ratio results in slight over hedging of corn and soybean meal.

In-Sample Results

The preferred trigger level found by KC was to hedge when IPM was 70 percent greater than the EPM. The CPM and therefore the EPM and IMP in our model will differ from KC because of the different assumptions concerning direct cost, technical coefficients and the use of futures prices instead of cash prices. Additionally, we provide results with the hedging of soybean meal that were not reported in the KC study. These changes require the re-estimation of

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[3] The Mid America contract originated in 1985 as 20 tons and increased to 50 tons with the August 1995 contract. Prices from the CBOT SBM contract were used.

the preferred trigger level over the 1975-82 period used by KC. Hedges were simulated for this time period using the predicted in-sample QPKP for estimation of the EPM. Figure 1 illustrates the results in a mean-variance framework. The 55 percent trigger dominates the 60-90 percent triggers and the cash returns. The 55 percent level was chosen for analysis because it had the highest average return with only a small increase in variance over lower trigger levels.

The 55 percent trigger strategy resulted in thirty of a possible forty-eight hedges placed during 1975-1982. As compared to cash, the strategy increased profits from \$5.41 per cwt. to \$7.10 per cwt. while reducing the variance from \$98.75 per cwt. to \$74.01 per cwt. when a three-way hedge including hogs, corn and soybean meal was implemented. The two-way hedge of hogs and corn is basically identical to the three-way hedge with a profit of \$7.19 per cwt. and a variance of \$73.25 cwt.

KC's results were similar. In comparing individual contract results, the KC model and our model, hedged the same contract with the exception of three additional contracts by the KC model. Profits from individual contracts differed little between the two models. Taking into consideration that KC allowed for basis, we consider our re-estimation to be an accurate replication of the KC strategy.

Out-of-Sample Results

The out-of-sample test was conducted using only data that are available at the time. All equations are updated yearly in December and are used to begin hedging the April group the following year.

The three-way hedging strategy produced an average profit of \$2.45 cwt. with a variance of \$64.23 cwt. during 1983-1998. Hogs were hedged forty-three times of which twenty-one were profitable. Feed was hedged nineteen times with five corn hedges profitable and fifteen soybean meal hedges profitable. Using Dunnett's t-test for mean and Bartlett's test for variance, these results are not statistically different from the cash profit of \$2.28 cwt. and variance of \$68.50 cwt.[4]. Examination of the sub periods of the hedge suggest that the years 1983 and 1984 behave similarly to the 1975-82 in-sample period. During this period of twelve groups, five of seven three-way hedges placed were profitable and increased profit from \$0.24 cwt. to \$2.44 cwt. while only increasing variance from \$53.40 cwt. to \$56.71 cwt. But from February 1985 through October 1989 only one hedge was placed. During the in-sample period some hedges occurred each year. From December 1989 through December 1998, cash profits were \$0.92 cwt. while the three-way hedge decreased to \$0.84 cwt. The variance decreased from \$62.81 cwt. with the cash strategy to \$53.99 cwt. with the three-way hedge.

The out-of-sample hedging results do not show the increase in profit per cwt. and the reduction in variance that the in-sample results report. The obvious question is why. There are three basic components of the model: 1) the estimation of feed cost and returns, 2) the prediction of QPKP, and 3) the estimation of the expected profit margin (EPM). One or all three of these components must be changing substantially during the out-of-sample test.

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[4] A 70 percent trigger level as proposed by KC yielded virtually identical results.

A limitation of any study estimating cost over an extended period of time is updating costs in an appropriate fashion and taking into account technological improvements. The LDP 1600-head simulator was chosen because it is both publicly available and extends throughout the out-of sample period. However, it is based on 1980 data from the COP budgets and has not been updated to reflect either the known increase in feed efficiency or the dramatic shift to larger and presumably more cost efficient hog operations. For example, the cost of producing hogs in August 1998 was estimated at $49.42 cwt. including replacement cost with $2.50 per bushel corn and $165 per ton soybean meal. Industry sources place current operating costs of the mega producers which now constitute a significant portion of the industry at around $36-38 per cwt., hence our cost estimates appear high and our returns low. These cost changes could partially explain the poor results in the later period. However, the production cost structure did not begin to change dramatically until the early 1990's, but the EPM equation began changing substantially in 1985.

Potential problems associated with estimating QPKP were tested by replacing the predicted QPKP with the actual QPKP. Hedging with the actual QPKP yielded virtually identical results. Therefore, predicting the quantity of pork is not the source of the change in the in-sample versus the out-of-sample results.

The EPM regression results indicate a major shift in the estimated coefficients between the equation that was estimated using data from 1975-84 and the equation that was estimated using data from 1976-85. Another less prominent shift occurs in the equation for 1980-89 and the 1981-90 equation. These shifts approximately correspond to the 1985-90 time period where hedges were not placed. These shifts occur as the ten year window is moved by one year with six old observations being deleted and six new observations being added. These large changes in coefficient estimates suggest that the EPM regression is unstable during the period under consideration and may have caused the failure of the hedging strategy. Figure 2 compares the actual CPM to the predicted EPM using the actual QPKP, corn and soybean meal prices for both the in-sample and out-of-sample years. Using actual input values means that the errors are in the EPM equation itself and not the input factors. The in-sample years demonstrate a randomness in the errors that continues through 1985. At that point, the EPM begins to consistently overestimate the CPM and continues to do so until 1990. Since the EPM equation consistently over-estimated returns, the IPM never exceeded the EPM, and hedging did not occur.

Conclusion and Implications

A producer would not have profited from following the profit margin hedging strategy proposed by KC in 1987, at least as updated and evaluated in this study. The basic KC strategy failed in the out-of-sample period because the EPM equation could not accurately predict the expected profit margin. Without an accurate prediction of the EPM, the trigger mechanism frequently failed to hedge at the appropriate time. If the demand for pork is relatively stable over time, it should be possible to develop a model to predict the profit margin given a set of market conditions. However, without such a model, the current profit margin strategy was not successful.

This study demonstrates the necessity of any hedging strategy to be evaluated over an out-of-sample period of sufficient length to provide statistically significant analysis. The task is to provide a set of rules that will function through time, not a set of rules that has functioned over a specific time period. With a few notable exceptions, most profit margin hedging strategies do not provide sufficient out-of-sample testing. Therefore, the results of hedging strategy studies without a true out-of-sample test should be viewed with much skepticism. Of course, one could argue that the out-of-sample test in this study could be improved by better cost estimates, by the inclusion of technological change, by continuously adding new data to each equation rather than a constant ten year window, by a periodic review of the whole model, etc. These changes are being evaluated, but we are not overly optimistic that they will change the basic conclusions of this study.

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Table : A Comparison of Profit Margin Hedging Studies

Authors	Commodities	Sample Period	In-Sample Observations	Out-of-Sample Observations	Results Report in Split Sample	Hedging Rule
Kenyon & Shapiro (1976)	Broilers, Corn, SBM	1970-75	72	0	Yes	Fixed
Shafer et.al (1978)	Fed Cattle, Corn, Feeder Cattle	1972-76	47	0	Yes	Fixed
Leuthold & Mokler (1980)	Fed Cattle, Corn, Feeder Cattle	1972-76	234	0	No	Fixed
Sphar & Sawaya [1] (1981)	Fed Cattle, Corn, Feeder Cattle	1974-78	728	0	Yes	Fixed
Kenyon & Clay (1987)	Live Hogs, Corn, SBM	1975-83	34	13	Yes	Fixed and Variable
Schroeder & Hayenga (1988)	Fed Cattle, Corn, Feeder Cattle	1978-85	90	0	Yes	Fixed
Johnson et.al [1] (1991)	Soybeans, Soyoil, SBM	1966-88	1266	0	Yes	Fixed

1. Overlapping observations, not distinct observations.

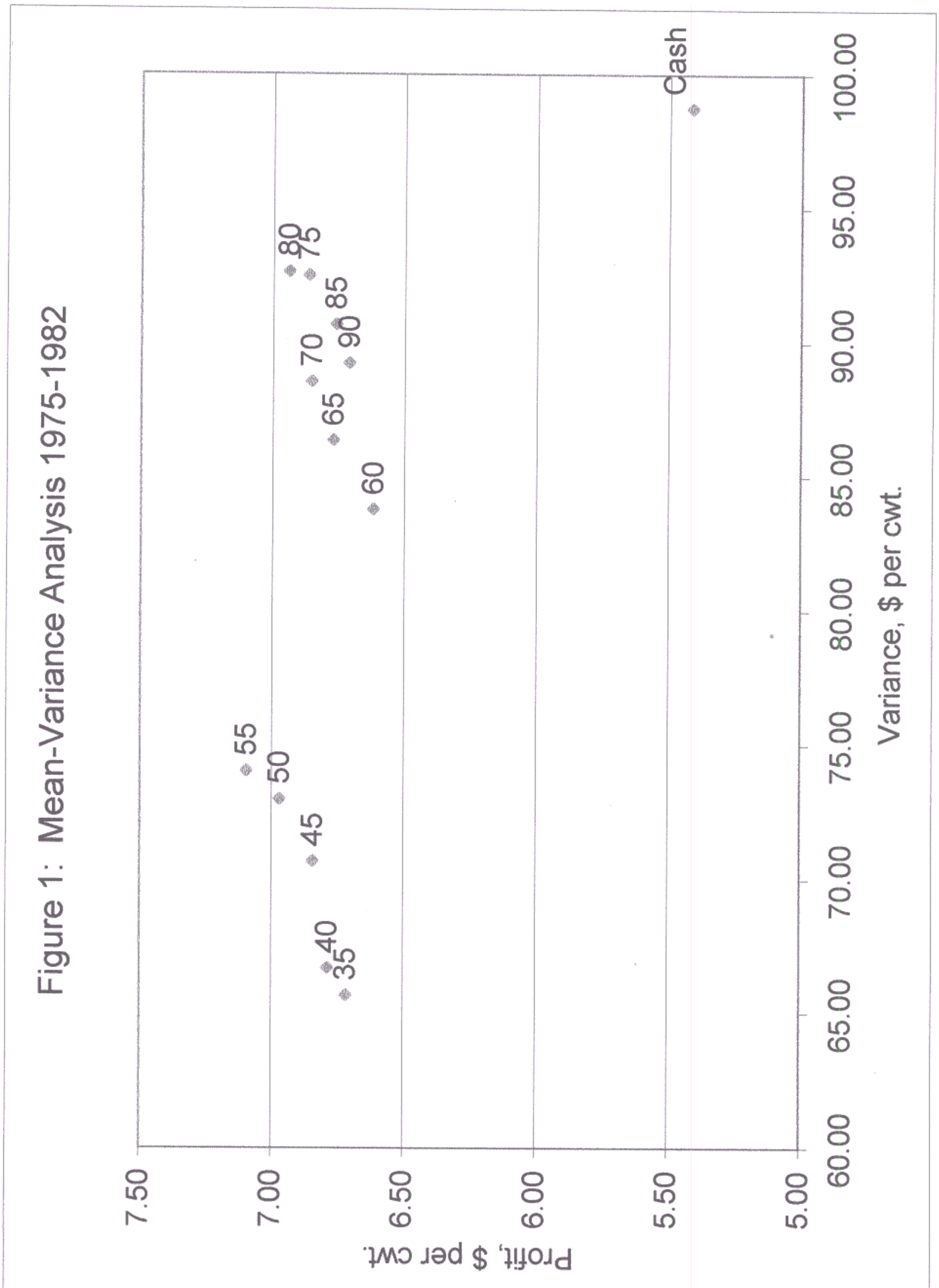

Figure 1: Mean-Variance Analysis 1975-1982

Figure 2: Comparison of CPM and EPM