Accounting for Yield Risk in Pre-Harvest Commodity Pricing Decisions

by

Steve Monson and Marvin Hayenga

Suggested citation format:

Monson, S., and M. Hayenga. 1991. “Accounting for Yield Risk in Pre-Harvest Commodity Pricing Decisions.” Proceedings of the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. Chicago, IL. [http://www.farmdoc.uiuc.edu/nccc134].

Accounting For Yield Risk in Pre-Harvest Commodity Pricing Decisions

by Steven Monson and Marvin Hayenga*

Introduction

Farmer can use futures and options markets to reduce price risk. Research on the appropriate hedge ratio often addresses only hedges placed after harvest (storage hedges). Many hedging advisors, however, recommend placing hedges prior to harvest, and recent research by Wisner has shown pre-harvest hedging as a viable marketing alternative in terms of revenue enhancement when compared to cash sales at harvest. Grant examined planting time hedges at the county, state, and national level, but did not consider options hedges or use individual farm yield data. Karp also addressed hedging with stochastic production outcomes, but only included futures markets in the analysis. Greenhall, Tauer, and Tomek evaluated preharvest futures hedges for a few individual corn farmers in New York state and in central Illinois.

The objective of this study is to determine the risk-return tradeoffs associated with varying levels of preharvest futures or options positions for individual farms producing corn in Iowa. Since the distribution of returns for commodity options positions are truncated, non-normal distributions, the standard regression approaches to optimum hedge ratio estimation do not apply to options positions. In addition, if price and quantity are correlated, (as they are often assumed to be), a price risk minimizing futures hedge ratio will not correctly estimate the optimum pre-harvest hedge ratio. Since the quantity estimate and error distribution would be expected to vary as new information changes the estimate of final production, the optimum futures or options position will also change as harvest approaches.

We consider the change in the expected yield distribution by evaluating hedges placed at planting time and hedges placed on or near August 1. The choice of hedging instruments (futures or options) is also considered in determining the optimum preharvest hedge ratio for corn in Iowa. To analyze both futures and options hedging strategies consistently and to account for the interaction between price and quantity, we evaluate the performance of preharvest hedging positions by numerical simulation of the returns from a wide range of possible hedge ratios. We use yield data from 250 individual farms and compared the results to similar analyses using county, state, and national yield data. We consider hedges placed at planting-time (May) and lifted at harvest (October 1 through November 15) from 1981 through 1989. At the state and national level, we also evaluate hedges placed at the first of August, when little yield risk remained.

* Graduate research assistant and Professor, respectively, Department of Economics, Iowa State University

Optimum Hedge Ratio Estimators

The simplest approach to hedge ratio estimation is the equal and opposite rule - for each bushel held in the cash market, a bushel should be sold in the futures market. This approach is based on the idea that as prices rise or fall in the cash market, the profits (losses) in the cash market will be exactly offset by losses (profits) in the futures market. This approach has some justification if the futures contract specifications exactly match the cash position. Since the futures contract price is an estimate of supply and demand conditions for a specific location and time in the future, and the cash price reflects local supply and demand conditions at the present, there is little reason to expect these prices to move in perfect unison.

The "one to one" hedge ratio also presumes a known quantity, which is not appropriate for a pre-harvest hedge. At the national level, low yields often lead to high prices and high yields often result in low prices. From a risk management perspective, this negative correlation between price and yield reduces the variability of revenue, and therefore it reduces the optimum hedge ratio. Grant calls this the "natural hedge" effect.

Many researchers have developed alternative methods of estimating the optimum ratio of futures to cash positions. Most of this research has centered on minimizing price risk with fixed quantities (e.g. storage hedges). Although these optimum hedge ratio estimators do not specifically address the issue of quantity risk, they provide the foundation for hedge ratio estimators that can.

Most approaches to estimating the optimum hedge ratio rely on regression techniques. Typically, a futures price series is regressed against a cash price series. These price series consist of price levels, price changes, or percentage price changes. Which type of price series to use has created considerable debate. Witt, Schroeder, and Hayenga addressed this issue and concluded that the objective function of the hedger should determine which type of price series was most appropriate. A pre-harvest hedger, because he or she is not hedging a current cash position, would not be concerned with changes in the current cash price. Therefore, a price level regression, relating the cash price at harvest to the futures price, provides the most reasonable framework for a pre-harvest hedge ratio estimator to minimize price risk. The price level regression, however, does not account for the impact of variable quantities and would only be applicable to futures hedge positions.

Price level regressions may be subject to problems with autocorrelation and they imply certain restrictions on the price determination process. To solve these problems, Myers and Thompson proposed moving to a generalized optimum hedge ratio estimation model. Price level regressions rely on the unconditional variance and covariance of prices, while the generalized model uses the conditional variance and covariance of prices and also allows variables other than price to enter the model (e.g. grain stock levels). The generalized model begins by specifying a model for the determination of equilibrium cash and futures prices based on information available when the hedge is placed. In its simplest form, the regression equation is specified as:

$$p_t = \alpha_0 + \beta f_t + a(L)p_{t-1} + b(L)f_{t-1} + e_t$$

where p_t is the spot price
f_t is the futures price and
$a(L)$ and $b(L)$ are polynomial lag operators

The models discussed above move beyond the naive assumptions of the one to one hedging rule, but do not address variable quantities or options hedging. Dwight Grant addresses the price and yield risk associated with pre-harvest pricing. Grant assumes farmers maximize their one period expected utility of income and that futures prices and income are bivariate normal variables. This separates the model into a wealth increasing and a variance minimizing component. This yields the familiar variance minimizing hedge ratio estimate with the addition of a yield risk component. Grant's model is specified as:

$$h^* = -[E(q)cov(p,f) + E(p)cov(q,f) + cov(\theta_p\theta_q,f)] / var(f)$$

where h^* is the hedge ratio, q is the quantity, p is the spot price, f is the futures price, θ_p is $[p-E(p)]$ and θ_q is $[q-E(q)]$.

At the county level in Iowa, during 1961 to 1983, Grant estimated the average optimum planting time futures hedge position for corn to be 73% of expected production. Grant goes on to say, however, that because of the cost of selling futures and the relative insensitivity of overall risk to changes in the hedge ratio estimate, the true planting time optimum futures hedge position for farmers may average less than 30% to 50% of expected production.

The first component in Grant's equation is equivalent to the optimum hedge ratio estimate of a standard price level regression. The second and third terms come into play when both price and yield are variable. The second term, $E(p)cov(q,f)/var(f)$, adjusts the hedge ratio estimate for the relationship between price and yield. At the national level, we would expect this term to be negative because high prices typically are associated with low yields, and low prices with high yields. For any given farmer, however, individual farm production will not have any impact on national price levels. The covariance between q and f, when calculated from farm level data, reflects the extent to which national prices have been correlated with an individual farmer's yields.

For producers in major growing regions, there could be a high correlation between yields and national prices. The existence of localized droughts or other isolated production failures, however, could keep this relationship from being stable over time. The effects of soil type, drainage, and/or climatic differences will have a long term impact on the optimum farm level hedge ratio and may cause it to deviate significantly from the optimum for the county, state, or nation. The problem of stability through time will be inherent in any hedge ratio estimator that relies on farm level yield data. Therefore, optimum hedge ratio estimates calculated at the farm level will be optimum into the future only to the extent that the correlation between a farm's yields and national prices remains stable.

Pre-harvest Hedging With Futures and Options

The approaches outlined above provide the framework for pre-harvest hedging in the futures market, but they do not address hedging with options. To solve the problem of hedging prior to harvest with either futures or options, it is necessary to go back and re-examine the goals of hedging and some of the assumptions regarding the optimum hedge ratio estimators.

Many different objective functions have been assigned to the hedger. These functions range from Working's profit maximization view of hedging to the idea that hedgers are trying to eliminate all risk. The portfolio theory of hedging falls between these two extremes and attempts to find the optimum tradeoff between risk and return. The minimum variance hedge has now become the most popular with economists.

The minimum variance hedge ratio can be considered the true optimum hedge ratio if there are no trading costs and no expected revenue from holding the futures position. Trading costs can be considered negligible when compared to the value of the positions being hedged, and Myers and Baillie found no expected returns to holding six different commodities, including corn.

Their research validates using the simpler and more broadly applicable minimum variance hedge ratios as an estimate of the optimum hedge ratio. However, in an agricultural production context, the hedge ratio presented as optimum is really only the optimum allocation between two marketing alternatives - place a hedge in May or sell in the spot market at harvest. In reality, a producer has many different marketing alternatives available and a true optimal hedge ratio estimator would have to account for each of these different marketing alternatives.

For a pre-harvest hedger, none of the goals or models outlined may provide the true optimal hedge ratio estimate. The decision of how much to sell in any time period is influenced by storage availability, cash flow needs, tax considerations, a farmer's unique utility function, and a farmers own expectations about future price movements. The true optimum hedge ratio for a given farmer, therefore, will vary from year to year.

For the farmer who needs or wants to sell a portion of his crop prior to harvest, the minimum variance hedge ratio may be considered a reasonable proxy for the true optimum hedge ratio. Once the decision to hedge prior to harvest has been made, the farmer must still address the issue of hedge ratio determination. If quantity was known precisely, a price level optimum hedge ratio might be appropriate. Since quantity can only be estimated, a different approach is needed.

Determining the best approach to estimating the hedge ratio requires us to re-evaluate the hedgers goals. A farmer deciding to hedge prior to harvest is trying to insure that he will achieve some target revenue. Since most farmers do not have advanced degrees in statistics or mathematics and are limited in the time they can spend deriving the appropriate hedge ratio, several simplifying assumptions are made.

The current futures price is assumed to be an unbiased estimator of the futures price that will prevail when the futures contract expires. This leads to no expected revenue from holding a futures position and allows estimating the harvest cash price from the current futures price. The estimate of the harvest cash price will be the current futures price less some expected harvest time basis. Iowa State University Extension publications on basis patterns suggest using an average of the last three years basis to estimate basis for a future period. The covariance between yields and prices for an individual farm is assumed to equal zero because of the atomistic nature of agricultural production. Following these assumptions for a futures market hedge, the target revenue is specified by:

$$\text{Target Revenue} = [f_{t-1} - E(\text{basis})] * E(q)$$

where t is harvest time, t-1 is the time when the hedge is placed, f_{t-1} is the current futures price, E(basis) is the farmer's estimate of harvest basis, and E(q) is the farmer's expected production.

When options are considered, target revenue becomes a minimum revenue and not an equality as with futures. If options premiums are also considered unbiased and commission and interest costs are ignored, the revenue for an options hedge is:

$$\text{Revenue} \geq pq + [(\text{Strike price}_{t-1} - \text{premium}_{t-1} - E(\text{basis}_t)) * E(q)]$$

Since at-the-money options were used, the minimum revenue is equivalent to:

$$\text{Minimum Revenue} = pq + [(f_{t-1} - E(\text{basis}) - \text{Prem}_{t-1}) * E(q)]$$

The deviations from expected revenue, defined as expected revenue minus actual revenue, were categorized as positive, (E(rev) < actual rev), and negative, (E(rev) > actual rev).

We calculated the revenue deviations for various planting time hedge ratios and determined the optimum futures and options positions for several situations:

250 individual farms
50 farms in Boone county
50 farms in Webster county
7 Iowa counties
Iowa
U.S.

The "optimum" hedge position was determined using the following criteria:

a) minimize the sum of all squared deviations for futures hedges

b) minimize the sum of negative squared deviations for futures hedges

c) minimize the sum of negative squared deviations for options hedges

The state and national optimum hedge ratios were also determined for hedges placed in August, when the first USDA yield estimates are made, and lifted at harvest.

Data

Price Data:

The closing prices on the Chicago Board of Trade December corn contract were collected for each Thursday from 1974 through 1989. The options premiums for the at-the-money strike price were also collected for each Thursday from the start of options trading through 1989. At-the-money options premiums for 1980 through 1984 were calculated using the Black-Scholes equation. Cash prices were calculated as the midpoint of the closing range on Thursday for North Central Iowa elevator bids as compiled by the Federal-State Grain Market News Department in Des Moines, Iowa. An average of the premiums and prices for the month of May was used as a proxy for the prices and premiums trading at planting time. An average of the prices and premiums for the month of October and the first two weeks in November were used as a proxy for prices available at harvest. In Iowa, most of the corn harvest is completed during this time period.

The harvest basis was calculated as the average of the futures price minus the cash price for each Thursday in the harvest period. Expected harvest basis was defined as the average of three previous years actual harvest basis. The expected cash price was defined as the futures price at planting less the expected basis. The expected harvest futures price was the planting period futures price.

Yield Data:

Individual farm yield data was compiled by National Crop Insurance Services. This data consisted of farm specific yields for farms in Iowa from 1980 to 1989. Only those farms with a complete ten year production history were included in this study and a random sample of 250 (approximately 10%) farms were used for the analysis. The farm locations were specified at the county level and represented nearly all counties in Iowa. The average yields from the National Crop Insurance Services farm population were highly correlated with state and county level average yields, and appear to provide a representative sample of farm level yield variability for Iowa.

County level yield data was also collected for each of the ninety-nine counties in Iowa from 1965 to 1989. This data came from the Iowa Agricultural Statistics publications and was compiled by the Iowa Department of Agriculture and Land Stewardship and by the U.S. Department of Agriculture, National Agricultural Statistics Service.

Yield expectations play a crucial role in determining the optimum pre-harvest hedge ratio. The best method for determining expected yields would be to interview farmers when the hedge would have been placed and record their expectations. Unfortunately, this type of data was not available. Another proposed solution was to use a moving average of lagged yields, but our data set was too short. We used the projected county yields as a starting point for estimating farmers yield expectations. The differences between each farms actual yields and the actual county yields were calculated and this farm/county differential was used to adjust the projected county yields for differences in each farms likely production capability. We estimated a farmers 1981 yield expectation by subtracting 1980's farm/county differential from 1981's expected county yield. The expected yield for 1982 was the projected county yield for 1982 minus the average of the farm/county differential for 1980 and 1981. This process of adding an additional lagged farm/county differential each year was repeated until we used a maximum of four lagged farm/county differentials to calculate the expected yields for 1984 to 1989. This process maintained unique estimates for each farm and allowed us to estimate yields without using data unavailable to the farmer at the time when the hedge would have been placed.

Yield expectations at the county, state and national level were calculated by simple linear regressions forecast one period into the future. For the state and national level hedges placed in August, the USDA's August 1st yield estimates were used as yield expectations.

Results

To illustrate the methods we used, the expected and actual revenues (Rev) for an individual farm were calculated for hedge ratios ranging from short 200% of expected production to long 100% of expected production. The following formulas show the calculations for a futures market hedge:

$$E(Rev) = (f_{t-1} - E(basis))*E(q)$$

$$Rev = h^{*}(E(q))*(f_{t-1} - f_{t}) + (p_{t}q)$$

Figure 1 provides a chart of positive, negative and total deviations from expected revenue, squared and summed from 1981 to 1989, for this sample farm.

All deviations from expected revenue are minimized when the futures hedge ratio is equal to a short position of 52% of expected production. This is the hedge ratio that a regression based model would have returned. Negative deviations from expected revenue are minimized when the futures hedge ratio is set equal to 67% of expected production. From a hedger's perspective, positive deviations represent revenue windfalls, while the negative deviations represent undesirable outcomes. It seems reasonable for a hedger to be more concerned about eliminating the negative outcomes explicitly rather than doing it implicitly by minimizing the magnitude of both positive and negative outcomes.

Average revenue was maximized at the largest short position considered. The returns to holding a short futures from planting until harvest have been positive, on average, from 1981 to 1989. Therefore, the larger the short futures position, the higher average revenue was. If a hedger's goal was revenue maximization, holding the largest short futures position possible would have been optimum for the 1981 to 1989 period.

Figure 2 shows the outcomes from options hedges for the same farm. The characteristic of unlimited upside potential makes it undesirable to minimize all deviations from expected revenue, therefore, the optimum options hedge ratio will occur when the negative deviations are minimized (i.e. where the expected price floor is most effective). For this particular farm, negative deviations are minimized at a hedge ratio equal to purchasing puts at 255% of expected production. It should be noted, however, that very little risk reduction occurs after the hedge ratio reaches 150%. For this particular farm, the negative deviations remain very close to zero until the hedge ratio surpasses 400% of expected production.

Similar to the futures hedging example, revenue is maximized at the largest long put option position. This is because, on average, there was a net gain from holding a long put option position from May until harvest.

Individual Farm Optimum Hedge Positions:

Averaging across all 250 farms studied, optimum planting time futures hedges could have reduced all deviations from expected revenue by 27% with an average optimum hedge ratio of -.39. Under the alternative objective of hedging to reduce only the negative deviations from expected revenue, futures hedging reduced negative deviations by 36% with an average optimum hedge ratio of -.49. For some farmers, up to 87% of the revenue deviations could have been eliminated and 100% of the negative deviations could have been prevented. However, on some farms futures hedging would not have caused any reduction in the deviations from expected revenue. In addition, the optimum "risk reducing" futures position for some farms was a net long position.

During the 1980's, holding a short futures position generated positive revenue. The average increase in revenue created by futures hedging was 3% for hedging at the level that minimized all deviations from expected revenue and 4% for hedging at the level that minimized negative deviations from expected revenue.

Put options hedges, placed with the intention of establishing a revenue floor, produced an average reduction in negative deviations of 62%. The average optimum long put option position for the 250 farms was 1.21. Some farmers could have eliminated all negative deviations from expected revenue, while hedging with options would not have eliminated any of the deviations from expected revenue for others. Hedging at the optimum options level could have increased revenues, on average, by 9%. Since interest and commission charges were not calculated, the true increase in average revenue would have been somewhat smaller. The summary statistics from simulated hedges at the farm level are found in Table 1.

Individual Farm versus County Hedge Ratios

County level hedge ratios were calculated for seven counties in Iowa (two in the North Central district and one in each of the other five price reporting districts). The optimum positions for fifty farms from Boone and fifty farms from Webster county were also determined to compare with the hedge ratios calculated using aggregate county data.

Optimum hedge ratios determined with aggregate county data were reasonably close to the average hedge ratio calculated from farms within the county. Individually, many of the farms within a county had quite different optimum futures and options positions than the county average. This suggests that while county level hedge ratios may provide insight into the optimum position for a "typical" producer within that county, the optimum position for many producers could be significantly different than the county average. The summary statistics for these hedges are in Table 2.

Planting versus August 1 Hedge Placement

The planting time hedge ratio that minimized all deviations from expected revenue for the U.S. was -.34 versus -.27 for the state of Iowa. Optimum put options hedge ratios were -.91 and -.69 for the U.S. and Iowa, respectively. Using August 1 prices and yield estimates released in the USDA's August 1 crop report, we re-estimated the hedge ratios for Iowa and the U.S. The optimum August 1 futures positions for the U.S. and Iowa were -.68 and -.88, respectively. Optimum options positions for August 1 hedges were -.83 and -.97 for the U.S. and Iowa.

As the distribution of final yields becomes known, the pre-harvest optimum hedge ratio approaches the price risk minimizing hedge ratio. The summary statistic for Iowa and U.S. hedges placed at planting and at August 1 are in Table 3. The optimum price risk minimizing hedge ratios at planting time and August 1 were also determined. Since the same cash prices series was used to calculate all of the hedge ratios, this illustrates the effect of yield risk and the interaction between price and yield on the optimum hedge ratio. The optimum price risk minimizing hedge ratios are also presented in Table 3.

Conclusions

Pre-harvest optimum futures hedge ratios at the farm level vary from net long positions to very large short positions. This is due to the correlation between price and yield, which is highly variable from farm to farm. Farms that performed well in the drought years or did poorly in years when most farmers experienced bumper crops tended to minimize risk with long positions or very small short positions. The optimum options positions were larger than the corresponding optimum positions in the futures market, but there was little change in overall risk reduction near the optimum position. Although that sensitivity will vary across farms, Figure 2 shows that the optimum hedge ratio for one particular farm could be changed from a long put position of 255% of expected production to a long put position of 155% of expected production with only a small increase in risk exposure.

Measures of hedge effectiveness also vary widely across farms. Some farms cannot reduce revenue risk by hedging with either futures or options, while other farms can eliminate almost all revenue risk. As expected, options positions protect against downside risk most effectively. However, measures of hedging effectiveness for both futures and options vary significantly across farms. Comparing the effectiveness of futures versus options hedges is difficult because the two instruments have different underlying purposes. The options are effective at setting a revenue floor, but have an up-front cost that must be paid. The futures markets are less effective at minimizing deviations from expected revenue and are not as effective at setting a revenue floor as the options are.

Hedge ratios estimated with county, state, or national data are not good estimates of hedge ratios at the farm level. Table 2 shows the range of farm level hedge ratios within Boone and Webster counties. Although the mean farm level hedge ratio is close to the hedge ratio determined with county level data, there is considerable variation from the mean. Differences in soil types, drainage, weather, and farming practices cause the optimum hedge ratio at the farm level to be highly variable across farms, even within a single county.

The optimum hedge ratio will also change as the growing season progresses and yield risk declines. The results in Table 3 shows that the optimum pre-harvest hedge ratio approaches the price risk minimizing hedge ratio as yield risk declines. Additional estimates of expected yield, at several points in the growing season, would further illustrate the effect of changing expected yield distributions on the optimum hedge ratio estimates. Plant growth models can provide some help in estimating expected yields between planting and harvest, but are best with site specific weather data. Experienced corn producers, however, should be able to estimate their expected yields with reasonable accuracy.

The analysis presented in this paper is contingent on the yield patterns that occurred during the 1980's. The unusual weather conditions of this time could have contributed to the wide range of optimum hedge ratios at the farm level. The rule of thumb suggesting pre-harvest futures hedges of 30% to 50% of expected production would have been a reasonable estimate of the optimum hedge ratio for many producers. Our results show 80% of the optimum futures hedge ratios fell between 0 and 80% of expected production. With options hedges, a larger position, possibly 50% to 120% of expected production, would have been needed to minimize risk for most producers in Iowa. At this time we are considering other alternative measures of hedging performance, and we are considering re-evaluating the optimum farm specific hedge position at different times within the growing season.

References

Grant, Dwight. Optimal Futures Positions for Corn and Soybean Growers Who Face Price and Yield Risk. TB-1751. U.S. Dept. Agri., Econ. Res. Serv. 1989.

Greenhall, L.J., L.W. Tauer, W.G. Tomek, "Optimal Hedging Levels for Corn Producers With Differing Objective Functions", in The Proceedings of the NCR-134 Conference on Applied Commodity Price Analysis and Forecasting held in St. Louis, Missouri 26-27 April 1984.

Karp, L.S. "Methods for Selecting the Optimal Dynamic Hedge When Production is Stochastic." Amer. J. Agr. Econ. 69(1987):647-657.

Myers, R.J. and R.T. Baillie. "Modeling Commodity Price Distributions and Estimating the Optimal Commodity Futures Hedge", Working Paper Series #CSFM-201, Columbia Center for the Study of Futures Markets, Columbia Business School, New York, New York, 1990.

Myers, R.J. and S.R. Thompson. "Generalized Optimal Hedge Ratio Estimation", American Journal of Agricultural Economics, 71, 858-868. 1989.

U.S. Department of Agriculture, National Agricultural Statistical Service, 1960-90. Agricultural Statistics. Selected issues.

Wisner, R.N., D.M. O'Brien and S.J. Monson, "Corn and Soybean Basis Patterns for North Central Iowa", Iowa Sate University Extension Publication M-1214, September 1990.

Witt, H.J., T.C. Schroeder, and M.L. Hayenga. "Comparison of Analytical Approaches for Estimating Hedge Ratios for Agricultural Commodities." Journal of Futures Markets 7(1987):135-146

Working, H. "Futures Trading and Hedging." Selected Writings of Holbrook Working, compiled by A.E. Peck. Chicago: Chicago Board of Trade, 1977. pp. 139-163.

TABLE 1.

SUMMARY STATISTICS ON 250 INDIVIDUAL
FARM HEDGE RATIO EVALUATIONS

OBJECTIVE 1) MINIMIZE SUM OF ALL SQUARED DEVIATIONS FROM EXPECTED REVENUE

	AVERAGE	RANGE
HEDGE RATIO:	-.39	+.90 TO -1.85
HEDGE EFFECTIVENESS:	27%	0 TO 87
CHANGE IN REVENUE:	3%	-6 TO 17

OBJECTIVE 2) MINIMIZE SUM OF ALL NEGATIVE SQUARED DEVIATIONS FROM EXPECTED REVENUE

	AVERAGE	RANGE
HEDGE RATIO:	-.49	+.90 TO -1.90
HEDGE EFFECTIVENESS:	36%	0 TO 100
CHANGE IN REVENUE:	4%	-6 TO +17

OPTIONS HEDGES

OBJECTIVE) MINIMIZE SUM OF ALL NEGATIVE SQUARED DEVIATIONS FROM MINIMUM REVENUE

	AVERAGE	RANGE
HEDGE RATIO:	-1.21	+.32 TO -2.90
HEDGE EFFECTIVENESS:	62%	0 TO 100
CHANGE IN REVENUE:	9%	-3 TO +29

1) Short futures positions and long put options positions are indicated by a negative sign preceding the hedge ratio, while long futures positions and short put options positions (puts written) are indicated by positive signs. The hedge ratio is expressed as the percent of *expected* quantity held in the futures or options markets. Hedge effectiveness, R^2 is defined as the percentage reduction in the sum of squared errors resulting from hedging at the specified optimum level.

TABLE 2.

SUMMARY STATISTICS ON COUNTY LEVEL
OPTIMUM PLANTING TIME HEDGE RATIOS

	FUTURES		OPTIONS
	OBJ #1	OBJ #2	
COUNTY	HEDGE RATIO	HEDGE RATIO	HEDGE RATIO
FAYETTE	-.39	-.41	-.84
CHEROKEE	-.53	-.63	-1.02
JEFFERSON	+.40	+.38	-.23
CASS	-.26	-.35	-.62
WARREN	+.15	+.09	-.09
WEBSTER	-.39	-.43	-.92
BOONE	-.39	-.36	-.82

COUNTY VERSUS INDIVIDUAL FARM
OPTIMUM HEDGE RATIO ESTIMATES

	FUTURES OBJ #1		OPTIONS	
	h*	RANGE	h*	RANGE
BOONE COUNTY	-.39		-.82	
50 BOONE COUNTY FARMS	-.34	+.60 TO -1.45	-1.19	+.09 TO -2.80
WEBSTER COUNTY	-.39		-.92	
50 WEBSTER COUNTY FARMS	-.50	+.18 TO -.79	-1.42	-.16 TO -2.90

TABLE 3.

PLANTING VERSUS AUGUST HEDGE PLACEMENT

FUTURES HEDGES - OBJECTIVE #1

PLACED	IOWA	U.S.	PRICE RISK MINIMIZING
MAY	-.27	-.34	-.96
AUGUST	-.88	-.68	-.92

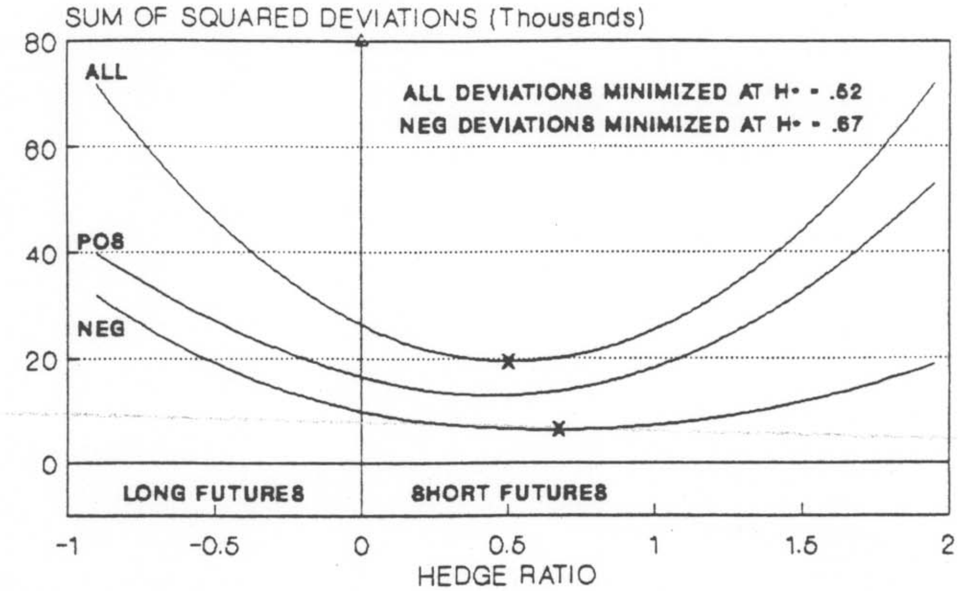
FUTURES HEDGES - OBJECTIVE #2

PLACED	IOWA	U.S.	PRICE RISK MINIMIZING
MAY	-.33	-.47	-1.13
AUGUST	-1.01	-.84	-1.15

OPTIONS HEDGES

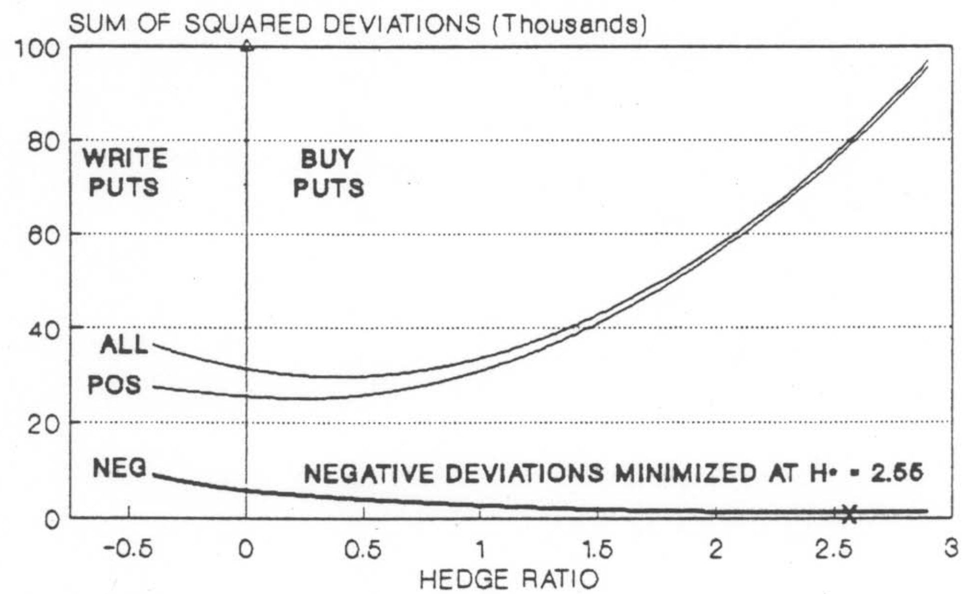
PLACED	IOWA	U.S.	PRICE RISK MINIMIZING
MAY	-.69	-.91	-1.85
AUGUST	-.97	-.83	-1.21

FIGURE 1. FUTURES HEDGE RESULTS PLACED AT PLANTING, LIFTED AT HARVEST



DECEMBER CORN FUTURES
FARM #19

FIGURE 2. OPTION HEDGE RESULTS PLACED AT PLANTING, LIFTED AT HARVEST



DECEMBER CORN PUT OPTIONS
FARM #19

FIGURE 3. DISTRIBUTION OF HEDGE RATIOS
FARM LEVEL FUTURES HEDGES
(MIN SUM OF SQUARED DEVIATIONS)

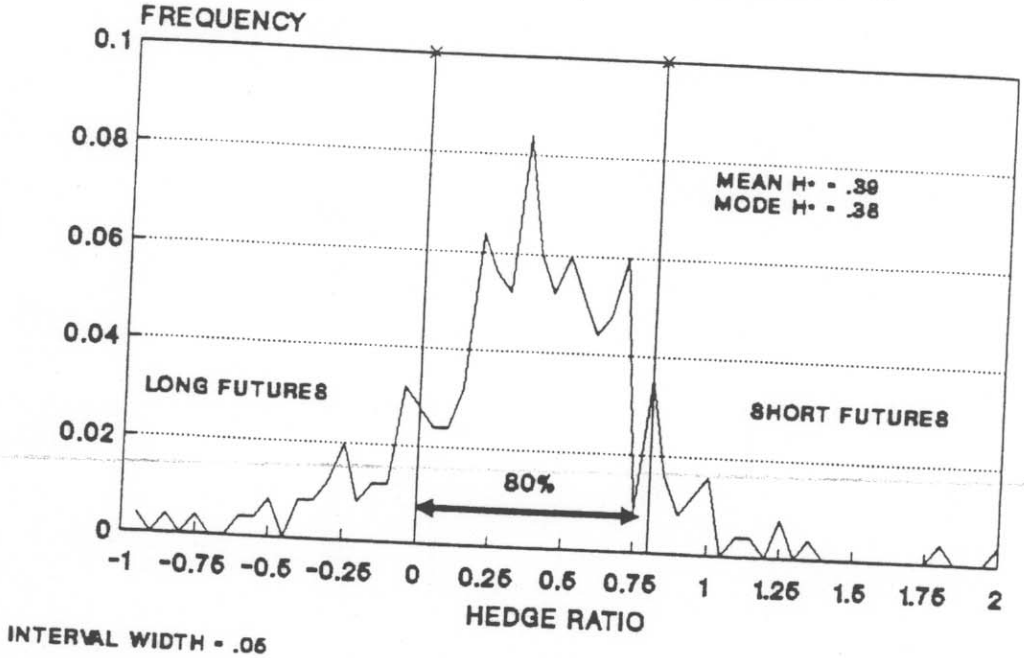


FIGURE 4. DISTRIBUTION OF OPTIMUM HEDGE RATIOS
FARM LEVEL OPTIONS HEDGES
(MINIMUM NEG SQUARED DEVIATIONS)