Integrating Price Forecasting with Hedging to Reduce Risk and Improve Price to Producers

by

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In recent years, hog production has become an increasingly uncertain business. Profitable outcomes are rarely assured of at the time the production decision is made. Much of the uncertainty which hog producers have faced in recent years can be attributed to the increased variability of crop and livestock prices. Since 1966, when futures trading in live hogs was initiated, producers have had the opportunity to manage their price risks by hedging all or part of their production.[1]

Even though the marketing environment has become more risky, livestock producers have shown great reluctance to use futures markets. A recent survey revealed that during 1980 only 5.2 percent of the hogs marketed by large production units (5000 head or more annually) had been hedged and smaller production units used hedging even less extensively (Gonzalez, Rhodes, and Grimes).

One problem may be the lack of empirical evidence indicating the potential usefulness of producer hedging. This may be especially true for hog producers. A casual review of the literature turned up four studies which have examined hedging strategies for hog producers (Brandt and Bessler (1983); Campbell; Leuthold and Peterson (1980); McCoy, Price, and Solomon). Generally, the studies concluded that selective hedging by hog producers could significantly reduce risk (variance) but could not significantly increase mean net returns when compared with unhedged marketings. Brandt and Bessler (1983) incorporated hedging with price forecasting. Several of their forecasting

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approaches were capable of increasing mean returns relative to cash marketing, although no statistical test of significance was conducted. However, all of their hedging-forecasting approaches resulted in larger standard errors (risk) than did cash marketing. Leuthold and Peterson (1980) allowed the hedge to be liquidated after either one or two margin calls. By incorporating this rule, several strategies were found which were capable of reducing risks and increasing returns relative to cash marketing.

This study differs from most of those mentioned above in several important ways. First, hedging is conducted with what Leuthold and Peterson (1980, p. 10) call "a view to the market". That is, hedging only occurs when forecasted cash hog prices are below the current localized futures quote for a particular delivery period.

Second, we have adopted a view of risk similar to that of Peck. In an optimal hedging study for egg producers, Peck argued that if producers make decisions on the basis of price expectations, the important measure of risk becomes the remaining "unexplainable" variation in the price series. In light of this, a root mean squared error measure of risk is used.

Third, hedging is extended beyond the feedlot phase to include the entire breeding-to-farrow-to-finish process. Futures contracts are traded more than a year into the future, offering hedging opportunities to a hog producer as early as when the breeding decision is made.

Finally, hedging is viewed as a dynamic process. Previous hedging studies have been static in nature, not allowing producers to alter the established futures positions during the production process.[2] As new information becomes available though, a producer may choose to liquidate a current hedge or perhaps even to re-establish a new position. In this study, the producer will have three opportunities to alter his current position during the farrow-to-finish process.

This paper includes a theoretical framework which shows how a risk averse producer could use price forecasts combined with hedging to reduce price variability and enhance expected prices. Several short-term price forecasting models are integrated with a hedging strategy for a pork producer. The results of these forecasting models are evaluated on the basis of both their statistical and economic performance. The economic evaluation will consider the risk reduction and profitability resulting from the hedging activity.

Producer Behavior Under Uncertainty

The utility theory of individuals under uncertainty suggests that if a risk averse individual is faced with two alternative actions, both with the same expected income, the individual would choose the one with the lower variability (risk) to maximize expected utility. This behavior is consistent with diminishing marginal utility of income. Risk averse agricultural producers may actually take a guaranteed forward price (either hedging or forward cash contracting) that is lower than the expected cash price (Ikerd). The producer is assumed to have the expected utility function, $U = U(P)$, where P is the product price. Furthermore, for a risk averse individual the utility function will be concave and the degree of concavity reflects the degree of risk aversion. For convenience, the producer is assumed to have a discrete subjective probability distribution of expected price. If the producer assigns equal probabilities of 1/2 that either a or b will be observed as the final price when no forward pricing is considered, the expected price and utility of this distribution are $\overline{P}$ and U, respectively, which corresponds to the midpoint of line segment ab (Figure 1).

If forward pricing is used, the final price will be known with greater, but not complete, certainty and the probability distribution of expected price

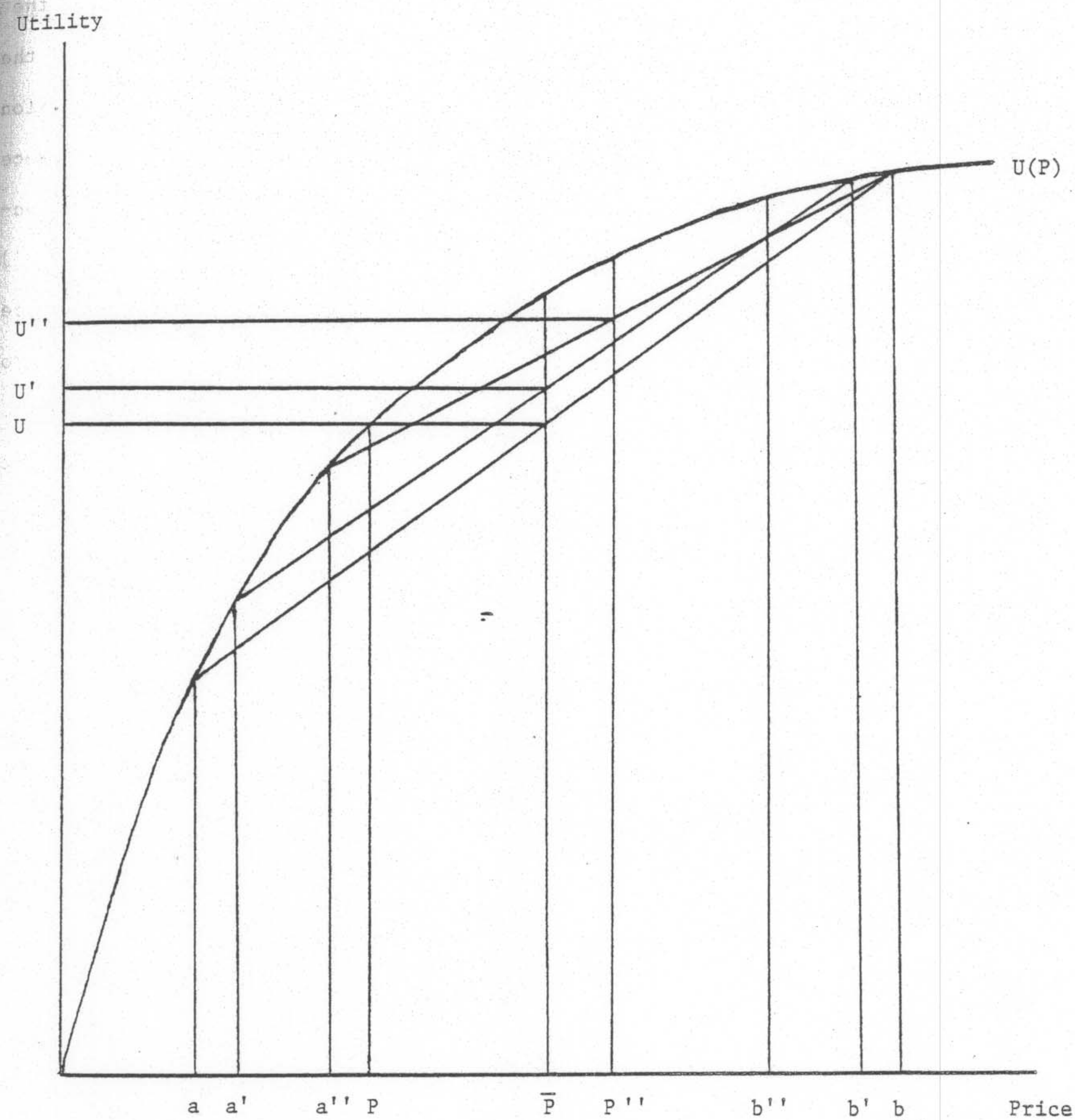

Figure 1. Expected Utility From Cash Sales, Forward Pricing, and a Selective Hedging Strategy for a Risk Averse Producer.

can now be represented by the endpoints a'b' in Figure 1. The forward pricing distribution (a'b') is associated with a slightly smaller distribution than is the cash sales distribution (ab).

The expected price from forward pricing is also $\overline{P}$, however, the expected utility from forward pricing is U', which is greater than the expected utility from cash sales (U). The greater the degree of risk aversion (i.e., the greater the concavity of U(P)), the greater will be the difference between U (cash sales) and U' (forward pricing). Also the greater the reduction in the variability of expected prices from forward pricing (range a'b') relative to cash marketing (range ab), the greater will be the difference between U' and U. A producer would prefer any guaranteed price above P to cash marketing, since this results in the same (or higher) expected utility. Thus, quite possibly a risk averse producer would accept a guaranteed price which is lower than the expected cash price.

Ikerd (p. 4) has offered the following observation regarding producer hedging:

> The futures market may offer a wide range of potential forward prices during the period from beginning to completion of a production process. Thus, the producer may have an opportunity to forward contract at levels higher than the ultimate cash price. Whether or not a producer will be able to select one of these higher prices is a speculative question. Conceptually, a producer could gain from such a strategy in the long run only if he had a comparative advantage in bearing price risk rather than production risk.

Brandt noted that a "student of the market" who has regular access to market information, may well have a comparative advantage in dealing with price risks and that a risk averse producer could combine hedging with price forecasts to obtain even higher levels of expected utility and price.

The model can be extended to show how a producer could potentially reduce risk and increase expected utility by incorporating forecast information with a hedging approach. The hedging strategy calls for selling futures contracts when the price expectation (i.e., price forecast) is below the current futures quote for some deferred option.[3] Otherwise, if the forecasted price is above the current futures quote, the farmer remains unhedged in anticipation of receiving the higher cash price. In Figure 1, this would allow the producer to raise the lower end of his expected forward price range from a' to, say, a". This is accomplished by selling futures contracts when the localized futures price is above the expected cash price. At the same time, the producer maintains the flexibility to receive the maximum expected cash price (b) by remaining unhedged when the expected price is higher than the futures price.

This selective hedging strategy will result in higher expected utility over the entire possible range of outcomes (a"b) than will cash marketing (ab). That is, the line segment a"b completely dominates line segment ab in terms of expected utility. The selective hedging strategy will also result in higher expected utility than will routine forward pricing over the range a"b". By assigning equal probabilities (1/2) to the endpoints a"b, the new expected price resulting from selective hedging is P". From this, it is theoretically possible that both expected utility (U") and expected price (P") are greater from selective hedging than is true for either routine forward pricing ($U',\overline{P}$) or cash marketing ($U,\overline{P}$).

The preceding analysis depends heavily on the ability of some forecasting approach to predict future cash prices more accurately than the futures market. If this is not possible, then the gains in expected utility and risk reduction attributed to the selective hedging strategy would not be obtained. Several researchers have compared the predictive performance of econometric models to that of the futures market for live hogs (Just and Rausser; Leuthold and Hartmann). Others have examined the predictive ability of cash prices relative to the live-hog futures market (Holt, Brandt, and Erickson; Martin and Garcia). The general conclusion seems to be that the futures market for live hogs should not be relied upon to anticipate future cash prices accurately. Thus, it seems reasonable that forecasting models could be constructed which "outperform" the futures market for live hogs.

Alternative Forecasting Procedures

A variety of methods are currently used for generating agricultural price forecasts ranging in complexity from large scale econometric models (see Just and Rausser for a more detailed discussion of these types of models) which simultaneously forecast prices and quantities for a large number of agricultural commodities to single equation models designed to forecast the value of a single variable. Another forecasting method often used is the class of autoregressive integrated moving average (ARIMA) processes (Oliveria, O'Connor, and Smith; Spriggs). These models are based solely on the past behavior of the economic variable in question. Brandt and Bessler (1981) have examined the feasibility of creating composite forecasts generated as weighted averages of several individual forecasts and concluded that composite forecasting was generally preferred to individual forecasting methods.

In this analysis, several types of monthly forecasting models were constructed including single equation econometric models, an ARIMA model, a seasonal index, and several simple average composite forecasts. The goal was to construct parsimonious models which would not sacrifice forecasting accuracy. The estimation period for all models was from March 1965 (6503) through November 1976 (7611). With the exception of the seasonal index, all models were periodically re-estimated through 1982. The final estimates for each model are presented in Table 1. All models were designed to forecast hog prices over a nine-month horizon. The forecasts were updated quarterly following the release of each Hogs and Pigs report (HPR).

Two specifications of the econometric models were used: linear and curvilinear (double log) forms.[4] Both specifications included three equations in order to forecast over different monthly horizons. The first used weight categories from the HPR to forecast hog prices two through four months into the future.[5] The second used sow farrowings (second intentions) in place of weight categories to forecast prices five through seven months out. The third equation incorporated first sow farrowing intentions instead of second intentions to forecast prices eight through ten months out. The first equation in the linear model also used six slope shifters to allow for a differential impact of weight categories on hog prices by forecast month.

Other variables in the econometric models include the lagged hog-corn ratio, lagged income, and eleven monthly dummy variables. The lagged hog-corn ratio was used as a proxy measure of the profitability of raising hogs. Lagged income was included to trace movements in demand. The eleven-month lag was necessary for forecasting purposes. The dummy variables allow for seasonal variation in hog prices.

Both the linear and curvilinear equations did a good job of explaining cash hog prices over the fit period and all of the economic variables had the correct theoretical signs. In most instances, the estimated coefficients were large relative to their standard errors. However, the coefficients on sow farrowing intentions and the hog-corn ratio were not statistically significant in several cases. Initial OLS estimates resulted in Durbin-Watson statistics which were quite low. Consequently, the final models shown in Table 1 were re-estimated using the Cochrane-Orcutt iterative procedure.[6]

Table 1 Alternative Forecasting Approaches for Monthly Hog Prices.[a]

1. Linear Econometric

(1)
$$PH^*_t = 35.015 - \underset{(-1.38)^b}{.000334}\, WT1_{t-1} - \underset{(-2.55)}{.000742}\, WT1_{t-2} - \underset{(-2.79)}{.000795}\, WT1_{t-3}$$
$$- \underset{(-.995)}{.000585}\, WT2_{t-1} - \underset{(-.542)}{.000319}\, WT2_{t-2} - \underset{(-.492)}{.000241}\, WT2_{t-3}$$
$$- \underset{(-2.53)}{.373}\, HC_{t-24} + \underset{(4.06)}{.0178}\, I_{t-11} - 2.337 DV_2 + \ldots - .945\, DV_{12} \quad (-.731 \text{ to } -.306)$$

$R^2 = .96$ D.W.[c] = 1.47 S.E.[d] = 2.43 rho[e] = .94

(2)
$$PH^*_t = 22.911 - \underset{(-1.09)}{.00142}\, SF2_{t-6} - \underset{(-2.11)}{.314}\, HC_{t-24} + \underset{(3.34)}{.0174}\, I_{t-11}$$
$$+ 1.206\, DV_2 + \ldots - .939\, DV_{12} \quad (2.02 \text{ to } -1.57)$$

$R^2 = .96$ D.W. = 1.45 S.E. = 2.48 rho = .95

(3)
$$PH^*_t = 24.403 - \underset{(-.619)}{.000775}\, SF1_{t-9} - \underset{(-1.85)}{.279}\, HC_{t-24} + \underset{(2.44)}{.0141}\, I_{t-11}$$
$$+ 1.231\, DV_2 + \ldots - .957\, DV_{12} \quad (2.06 \text{ to } -1.61)$$

$R^2 = .96$ D.W. = 1.48 S.E. = 2.48 rho = .95

2. Curvilinear Econometric[f]

(1)
$$\ln PH^*_t = 2.586 - \underset{(-1.83)}{.159}\, \ln WT1_{t-3} - \underset{(-1.91)}{.199}\, \ln WT2_{t-3} - \underset{(-1.66)}{.113}\, \ln HC_{t-24}$$
$$+ \underset{(4.11)}{.659}\, \ln I_{t-11} + .0316\, DV_2 + \ldots - .0295\, DV_{12} \quad (1.97 \text{ to } -1.88)$$

$R^2 = .97$ D.W. = 1.47 S.E. = .0648 rho = .94

(2)
$$\ln PH^*_t = -.326 - \underset{(-1.22)}{.105}\, \ln SF2_{t-6} - \underset{(-1.23)}{.0853}\, HC_{t-24} + \underset{(3.45)}{.696}\, \ln I_{t-11}$$
$$+ .0356\, DV_2 + \ldots - .0294\, DV_{12} \quad (2.24 \text{ to } -1.85)$$

$R^2 = .97$ D.W. = 1.41 S.E. = .0661 rho = .95

Table 1 (continued)

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(3) $$\ln PH^*_t = -.338 - \underset{(-.512)}{.0409} \ln SF1_{t-9} - \underset{(-.903)}{.0643} \ln HC_{t-24} + \underset{(2.79)}{.617} \ln I_{t-11}$$

$$+ .0362\, DV_2 + \ldots - .0296\, DV_{12}$$
$$(2.26 \text{ to } -1.85)$$

$R^2 = .97$ D.W. = 1.43 S.E. = .0664 rho = .96

3. Autoregressive Integrated Moving Average

$$(1-B)(1-B^{12})PH^*_t = (1 + \underset{(3.85)}{.271B} + \underset{(2.55)}{.186B^{11}})(1 - \underset{(-22.78)}{.8801B^{12}})a_t$$

$R^2 = .95$ $Q_{(17)} = 27.35$g S.E. = 2.54

4. Seasonal Index

Jan.: .958, Feb.: .990, Mar.: .943, Apr.: .912, May: .960, June: 1.023,

July: 1.105, Aug.: 1.115, Sep.: 1.043, Oct.: .999, Nov.: .954, Dec.: .997

Notation: PH* - forecast of monthly price of barrows and gilts at seven markets (\$/cwt.); WT1 - market hogs in the under 60 pound category, quarterly, ten states (thousand head); WT2 - market hogs in the 60-119 pound category, quarterly, ten states (thousand head); SF2 - sow farrowings, second intentions, quarterly, ten states (thousand head); SF1 - sow farrowings, first intentions, quarterly, ten states (thousand head); HC - hog-corn ratio, Omaha; I - consumer personal income, (billion dollars); $DV_2 \ldots DV_{12}$ - eleven monthly dummy variables, February through December; ln - natural logarithm; B - lag operator; a - disturbance term.

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[a] The original fit period for all models was from January 1965 (6501) through November 1976 (7611). The econometric models (linear and curvilinear) were re-estimated quarterly prior to the release of the Hogs and Pigs report through August 1982 (8201) for equation (1), May 1982 (8201) for equation (2), and February 1982 for equation (3). The ARIMA model was re-estimated annually through November 1981 (8111). The seasonal index was not re-estimated. The results of the final estimates are presented above.

[b] t-statistics are in parentheses below the estimated coefficients.

[c] Durbin-Watson statistic.

[d] Standard error of the regression.

[e] The value of rho is from the Cochran-Orcutt procedure to correct for autocorrelation.

[f] All variables, with the exception of dummy variables, are estimated in natural log form.

[g] The chi-squared statistic for 17 degrees of freedom at the 95 percent confidence level is 27.59.

An ARIMA process for the monthly hog price series was identified, estimated, and checked. Regular and seasonal first differences of the series were performed. The estimated autocorrelations were more than twice their standard errors at lags one and twelve. In addition, the partial autocorrelation function had spikes at lags twelve and twenty-four. This indicated that a 1st order regular and 12th order seasonal moving average process might fit these data. Examination of the estimated autocorrelations of the residuals revealed that lag eleven had an autocorrelation more than twice its standard error. Consequently, the final specification included an 11th order regular moving average parameter in addition to the two parameters mentioned above.

The final estimates of the ARIMA model (6501-8111) is also listed in Table 1. All coefficients are significant at the 95 percent level. The high R^2 suggests the ARIMA model explained most of the variation in hog prices over the fit period. The Ljung-Box Q-statistic is below the critical chi-squared value, supporting the hypothesis that the residuals are white noise. Additional investigation of the residual series might be useful, however.

In addition to the previous models, a simple monthly index of hog prices was constructed and used for forecasting (Table 1). According to the index, hog prices are seasonally higher during the summer months and lower in the spring (March and April) and fall (November). To generate a forecast with the index, the three most recent monthly cash prices are averaged together and then seasonally adjusted. This adjusted average is then multiplied by the appropriate index value.

The final forecasting procedure involves the simple-average composite of several individual forecast series. Two separate composite forecasts were constructed by averaging the linear econometric forecasts with the ARIMA forecasts and curvilinear econometric forecasts with the ARIMA forecasts.[7]

Statistical Evaluation of Forecast Results

Monthly cash price forecasts were generated over the 24-quarter period beginning with December 1976 through September 1982. After release of the HPR, out-of-sample forecasts were generated over a two-to-ten month horizon.[8] Table 2 shows the root mean squared errors (RMSE) of the forecasts from each model. (For a complete presentation and evaluation of the forecasts used in this study, see Holt.) The curvilinear econometric model tended to forecast more accurately (lower RMSE) than any of the other individual forecasting approaches (linear econometric, ARIMA, and seasonal index). The ARIMA model had the highest RMSE for seven of the nine forecast months while the seasonal index performed only slightly better than the ARIMA model.

The two composite forecasts clearly performed the best as measured by the RMSE criterion. Table 2 shows that among all approaches, the ARIMA-curvilinear econometric composite resulted in the lowest RMSE for all nine periods in the forecast horizon. Furthermore, the ARIMA-curvilinear econometric composite had lower RMSE than either of its individual components during eight of the forecast periods. The ARIMA-linear econometric composite generated lower RMSE than either the ARIMA or linear econometric forecasts for all nine periods.

The results here are supportive of the earlier studies by Bates and Granger, and Brandt and Bessler (1981). Combining two forecast series -- each based on a different set of information -- into a composite tends to result in predictions which are superior (lower RMSE) to either individual method. This is true even when the composite method is no more sophisticated than simple averaging.

Table 2. Root Mean Squared Errors of Forecast and Hedged Price Series (7702-8301).

Forecast Approach	Forecast Horizon[a] 2	3	4	5	6	7	8	9	10
	$/cwt								
Linear Econometric									
Forecast Prices	6.11	6.29	7.27	8.41	7.98	8.25	8.52	8.44	9.43
Hedged Prices	5.73	5.93	6.57	7.73	7.31	7.82	8.10	8.33	9.34
Curvilinear Econometric									
Forecast Prices	6.03	5.96	6.59	7.95	7.59	8.12	8.32	8.17	9.28
Hedged Prices	5.89	5.65	5.86	7.26	7.53	8.00	8.03	8.20	9.24
ARIMA									
Forecast Prices	5.87	6.69	7.83	8.52	8.08	8.20	8.81	8.94	9.92
Hedged Prices	4.25	4.98	6.33	6.47	6.62	7.14	7.64	8.25	9.02
Seasonal Index									
Forecast Prices	6.85	6.65	7.58	8.38	7.82	8.07	8.57	8.57	9.51
Hedged Prices	4.76	4.90	6.13	6.62	6.38	7.12	7.46	6.95	7.86
ARIMA-Linear Econometric Composite									
Forecast Prices	5.61	6.15	7.21	8.13	7.65	7.82	8.27	8.25	9.26
Hedged Prices	4.88	4.94	5.96	6.60	6.33	7.22	7.41	7.73	8.85
ARIMA-Curvilinear Econometric Composite									
Forecast Prices	5.43	5.85	6.79	7.75	7.30	7.62	8.01	7.97	9.04
Hedged Prices	4.81	4.83	5.65	6.79	6.56	7.29	7.52	7.65	8.79

[a] The forecast horizon represents the number of months following the release of the <u>Hogs and Pigs</u> report.

The Dynamic Hedging Model

The hedging model is based on a hypothetical farrow-to-finish operation where 550 market hogs are sold every month (6600 per year).[9] At a market weight of 220 pounds, approximately 1200 cwt. of hogs will be sold monthly which is equivalent to four live-hog contracts on the CME. With a sow gestation period of 114 days and a feeding period of six to seven months for a hog to reach market weight, this means there is about ten months between the time sows are bred and fat hogs are marketed.

The hedging strategy used in this study is similar to the one used by Brandt and Brandt and Bessler (1983). The producer sells futures contracts when the cash price forecast for some forward month, t+i, is below the current adjusted futures quote for month t+i. Logically, the producer would expect the subsequent actual cash price for month t+i, as predicted by some forecasting approach, to be less than what he could obtain by hedging. If the price forecast is higher than the current futures quote, the producer remains unhedged in anticipation of receiving the higher cash price.

An important feature of this analysis was the dynamic process by which a producer could adjust market positions. The producer was allowed to engage in a hedging activity at three different times during the ten-month production process. The first opportunity occurs when the sows are bred; the second at farrowing time: and the final chance occurs during the growing phase. In all cases, the hedges can be held until the hogs are marketed, as in previous hedging studies. However, the producer who hedges in period one (breeding) may decide to liquidate the contracts in period two (farrowing) or period three (growing). Similarly, the producer who hedges in period two may liquidate the position in period three rather than waiting until marketing (period four).

With this arrangement, it is possible for a producer to complete two round-turn transactions during the production process. This is accomplished by placing a hedge at breeding, lifting it at farrowing, placing a new hedge during the growing stage, and liquidating it when the market hogs are sold. In the above manner, marketing decisions for each group of hogs can be made or altered at various stages of the production process.

In order to make the futures prices directly comparable with the cash price forecasts, the futures prices must be localized to the seven-market average price by generating an expected basis at the time of marketing. Several methods for predicting the basis exist including structural and time series analysis (Leuthold (1979); Leuthold and Peterson (1983); Garcia and Good). Since basis patterns are fairly repetitive and have strong seasonal tendencies, the expected basis used in this study was calculated by using a simple average of the actual basis during the same period for the most recent three years.[10]

Following the release of the $\overline{\text{H}}$PR, there may be several days of erratic movement in futures prices. For this reason, all futures prices used to compare with the price forecasts are the average closing prices for the first five trading days following the report. All hedging activity will be based on this five-day average price. Contracts which are carried to maturity (period four) are liquidated at the average closing price for the first five trading days of that month. This was done to avoid unusual price fluctuations which may occur during the latter part of the delivery period. Actual delivery on the futures contracts was not considered as an alternative.

All trades were executed at a roundturn commission cost of $60 per contract. Interest was charged on an initial $600 margin requirement (per contract) at an annual rate of 12 percent. Margin calls were not considered.

One might assume that, on average, occasional margin deficits may be offset by occasional margin surpluses.

Hedging Results

Table 3 shows the results of the dynamic hedging strategy combined with the six forecasting approaches over the period February 1977 to January 1983. For comparison, a routine hedging strategy which automatically hedged each group of hogs was included. Of the six selective hedging approaches, the linear econometric model had the largest net trading loss, as well as the fewest number of trades. The curvilinear econometric model also resulted in a net trading loss. The seasonal index generated the largest net trading profit and the largest number of trades. The ARIMA model generated the second highest number of trades and the third largest net trading profit. Both composites resulted in net trading profits; however, the ARIMA-linear econometric composite made substantially more money than the other composite. It is gratifying in the sense of confirming results found by others that the simple sell-and-hold strategy (routine hedging) resulted in the largest net trading loss among all alternatives.

A statistical test, similar to the test suggested by Peterson and Leuthold, was conducted to compare trading returns relative to strictly cash marketing. The null hypothesis is that mean net returns from a hedging strategy (e.g., mean of net hedging returns plus cash returns) are equal to the mean cash returns. The results of this test show that only the linear econometric selective hedging strategy and the routine hedging strategy had mean net returns which were significantly different from (both below) mean cash returns.

Table 3. Number of Transactions, Costs, Returns and Risk Reduction from Futures Trading with the Six Forecasting Alternatives (7702-8301).

Forecast Approach	Number of Contracts[a]	Total Commissions[b]	Total Interest on Margin[c]	Net Trading Results	Percent Risk Reduction[e] (Range)
1. Linear Econometric	104	$6240	$2064	-$31,032*(6)[d]	1.0 to 9.6
2. Curvilinear Econometric	116	6960	2304	-15,744 (5)	-.003 to 11.1
3. ARIMA	180	10,800	5496	11,328 (3)	7.7 to 27.6
4. Seasonal Index	260	15,600	6696	28,800 (1)	11.8 to 30.4
5. ARIMA-Linear Econometric Composite	128	7680	3936	16,920 (2)	4.4 to 19.7
6. ARIMA-Curvilinear Econometric Composite	156	9360	3720	300 (4)	4.0 to 17.4
7. Routine Hedge	288	17,280	13,176	-257,736*(7)	---

[a] Every hedging activity involves four contracts.
[b] Based on $60 commission charge per contract.
[c] Based on 12 percent annual interest rate and $600 initial margin requirement per contract.
[d] Numbers in parentheses represent ranking; * represents significant difference from mean returns for cash marketing at the .90 percent confidence level.
[e] Represents reduction in unexplainable price variation (RMSE) from hedging over the forecast horizon.

In addition to evaluating mean returns, risk reduction is also an important consideration in any hedging program. If producers react according to price expectations, then risk should be associated with the predictive accuracy of the expectations (RMSE) and not the variation in prices. If hedging occurs, the only remaining uncertainty about the price received is associated with the basis forecast error. Thus when a hedge is placed (or maintained), the price forecast error is replaced with the basis forecast error for computation of a new RMSE series.

In the above manner, forecasting and hedging RMSEs were calculated for each hedging-forecasting approach (Table 2). With only one exception, hedging reduced the amount of unexplainable price variation. Greater risk reduction also tended to be associated with the more profitable trading combinations (e.g., the ARIMA and seasonal index models) since these models generated the most hedging activity.

Table 4 lists the dynamic results for the various hedging approaches. The seasonal index made the most use of the dynamic capabilities of the selective hedging model by placing and lifting more contracts during period two (farrowing) and period three (growing) than any other approach. The more profitable hedging-forecasting combinations tended to establish the majority of positions early (breeding) and hold them until marketing. This was true for the ARIMA, seasonal index, and ARIMA-linear econometric composite forecasting techniques. At the same time, there was a tendency for the less profitable methods (the linear and curvilinear econometric models) to establish the largest share of their positions late in the production period. Many of the positions which were taken early by the less profitable trading-forecasting combinations were offset within one period. The implication is that the less profitable approaches tended to "whipsaw" in and out of the market on a frequent basis. While the dynamic aspects of the model are important, the success of a hedging program apparently depends even more on the ability of the forecasting model to identify and take advantage of market trends at an early stage.

Summary and Conclusions

The primary objective of this study was to determine if price predictions generated by monthly forecasting models could be combined effectively with a dynamic hedging strategy to reduce risk and increase price for a farrow-to-finish producer. Six alternative forecasting procedures were developed. Of these, four were capable of producing positive net trading profits when combined with hedging. However, only the linear econometric forecasting-hedging alternative had total returns which were significantly different from cash returns. The trading results suggest no strong case for or against composite forecasting. This is somewhat contradictory to the statistical results of the forecast evaluation. However, both composites outperformed their weakest components (in this case, the econometric models) in terms of both trading profit and risk reduction. This suggests that without additional information, composite forecasting would still be preferred to relying arbitrarily on any individual method.

A unique feature of this study was the dynamic aspect of othe hedging model. A producer had the opportunity to adjust a futures position three times during the breeding-to-slaughter process. While the dynamic feature of the model is intuitively appealing, the trading results indicate that the profitable hedging-forecasting combinations tended to take positions early and hold them until marketing. It should not be concluded though that the dynamic feature of the hedging model is without merit. All of the hedging-forecasting

Table 4. Summary of Dynamic Hedging Activities by Alternative Forecasting Approaches (7702-8301).

Forecast Approach	Period When Hedge Was Placed or Lifted[a]									Double Roundturns
	1 (Breeding)	2 (Farrowing)		3 (Growing)			4 (Marketing)			
	Placed	Placed	Lifted (1)[b]	Placed	Lifted (1)	Lifted (2)	Lifted (1)	Lifted (2)	Lifted (3)	
1. Linear Econometric	12	2	7	12	3	2	2	0	12	2
2. Curvilinear Econometric	9	7	5	13	3	4	1	3	13	0
3. ARIMA	25	8	2	12	5	7	18	1	12	0
4. Seasonal Index	32	11	10	22	6	6	16	5	22	7
5. ARIMA-Linear Econometric Composite	20	5	4	7	4	4	12	1	7	0
6. ARIMA-Curvilinear Econometric Composite	19	6	8	14	3	4	8	2	14	4
7. Routine Hedging[c]	70	1	0	1	0	0	70	1	1	0

[a] Each hedging activity involves four contracts.
[b] Numbers in parentheses represent the period when the hedge was placed.
[c] During the initial period, one hedge was placed for those hogs just farrowed and also one hedge for those hogs in the growing phase. Thereafter all hedges were placed at the time of breeding.

combinations used the dynamic capability to some degree. Furthermore, even the less desirable selective hedging approaches were much more profitable than the routine hedging strategy. Also, the analysis here is both forecasting model and time period specific. Different forecasting models and/or a different sample period could influence the results.

Footnotes

[1] Hedging is defined here as holding a position in the futures market equal and opposite to the current cash position. Forward cash contracting is another forward pricing option which has been available for some time.

[2] As mentioned earlier, an exception to this is the study by Leuthold and Peterson (1980). However, once a position was liquidated, no attempt was made to allow the producer to hedge again if market conditions changed.

[3] Actually this strategy involves two separate forecasts: a cash price forecast and a basis forecast. A futures price can only be compared directly to a cash price forecast if it is localized by adjusting for the expected basis.

[4] The econometric models are similar in structure and variable choice to the cobweb model used by Leuthold and Hartmann; the main difference being the models used here were specified and estimated in single equation reduced form.

[5] Forecasts were not made for the first month following the release of the HPR because of delivery constraints imposed by the hedging model.

[6] All forecasts generated by the econometric models incorporated the known information about the serial relationship in the error term. For a discussion and example of this procedure, see Pindyck and Rubinfeld (pp. 215-221).

[7] When composites are formed on the basis of simple averages, identical weights are given to each forecast. In this case, each forecast is weighted by 1/2.

[8] For example after the December HPR, monthly forecasts were generated for February through October of the following year.

[9] There was no simulation of the actual costs, returns, and profitability of the hypothetical production unit. While this could be desirable information, it was felt the more general approach used here would result in a hedging-risk management framework with potential application for many types of hog producers.

[10] The expected basis (BAS_{t+i}) was calculated in the following manner:

$$BAS_{t+i} = (BAS_{t+i-12} + BAS_{t+i-24} + BAS_{t+i-36})/3$$

[11] During the ninth period in the horizon, the curvilinear econometric model signaled hedging three times. On two of these occasions the basis forecast errors were greater than the price forecast errors they replaced, resulting in a hedging RMSE larger than the forecast RMSE.

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