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Farmer Forward Pricing Behavior: Evidence from Marketing Clubs

Kevin McNew and Wesley N. Musser

Numerous studies have investigated how farmers should use forward pricing markets, but only limited research exists on how farmers actually use these markets. This study relies on data from a real-time forward pricing game employed by Maryland grain marketing clubs from 1994 through 1998. Hypotheses are tested regarding the consistency of farmer behavior with the research literature on hedging. Findings indicate that farmers do not achieve price enhancement, a result consistent with the efficient market hypothesis. However, pricing behavior does not conform to the implications of efficient market models in a number of respects, suggesting farmers may form different expectations than those conveyed by forward prices.

Key Words: grain marketing, hedging, risk management

Less government intervention in commodity markets has heightened farmers' exposure to price risk and has created a stronger desire among farmers to attempt to manage this risk by using forward pricing markets. Although numerous applied research studies have focused on risk management using futures and options markets, it would appear past research has failed to meet the needs of practitioners, and ultimately farmers.

For example, surveys of extension economists suggest they perceive that risk management research is of little relevance to real-world decisions such as forward pricing (Anderson and Mapp, 1996). Furthermore, extension and research marketing economists hold different opinions on what motivates farmers to use forward pricing markets (Parcell et al., 1998).

These differing views about forward pricing also are documented in the literature. Most research economists would endorse the "efficient market" view, as argued by Zulauf and Irwin (1998)—i.e., that futures markets yield the best expectation of a commodity's price in the future. This view has considerable empirical support, including analyses by Fama and French (1987), Just and Rausser (1981), and Rausser and Carter (1983), to name a few. Under the efficient market view of futures prices, farmers are unlikely to profit consistently from forward pricing strategies, so risk aversion becomes the primary motive for using forward markets.

A large body of research has derived optimal hedging rules under this assumption (Peck, 1975; Kahl, 1983; Myers and Thompson, 1989; Lapan, Moschini, and Hanson, 1991; Sakong, Hayes, and Hallam, 1993). The hedge ratio has drawn considerable empirical attention in the literature for two reasons. First, the hedge ratio is based on the ratio of the covariance between cash and futures prices to the variance of futures prices. As such, it is easily estimated from a simple regression where cash prices are regressed on futures prices.

Second, if prices are normally distributed and transactions costs are zero, an individual's optimal hedging decision is independent of his or her risk-aversion parameter. Lence (1996) recently generalized the assumptions for this independence. Thus, empirical estimates of the hedge ratio have the potential for widespread applicability. However, empirical complications, such as time-varying covariance and variances, can exist in most applications.

Farmers seldom follow the prescriptions offered by this research. Based on survey data from farmers, it appears they hedge significantly less than would

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be expected under the efficient market assumption (Patrick, Musser, and Eckman, 1998; Goodwin and Schroeder, 1994). Although production risk may be one explanation for lower hedging (Grant, 1985), in their survey of large-scale Midwestern grain producers, Patrick, Musser, and Eckman found that farmers considered yield risk to be a lesser issue than other factors such as credit constraints and margin calls. While not explicitly considered in Patrick, Musser, and Eckman's survey, diversification of wealth and hedging transactions costs could also limit the use of forward pricing (Lence, 1996).[1]

The price enhancement view is consistent with the second segment of the literature that suggests farmers can use forward markets to achieve higher prices. Based on their survey, Patrick, Musser, and Eckman (1998) found the majority of farmers believe forward markets present an opportunity to achieve higher prices, confirming the relevance of this view for farmers. If farmers have different expectations from those portrayed by forward prices, then their use of forward markets can be for the purpose of increasing profits as a result of those differing expectations, rather than managing risk.

A recent study by Kenyon (2001), based on a survey of farmers prior to planting, reported farmers as a group tended to underestimate the risk of a downside price movement between planting time and harvest, which would suggest they may not obtain adequate price protection. Other research investigating the price enhancement view has sought to identify profitable forward pricing strategies (e.g.,Wisner, Blue, and Baldwin, 1998).

Whether farmers use forward pricing strategies to enhance prices or to manage risk is a debate likely to continue. However, a common problem in the forward pricing literature is the lack of evidence on farmers' use of forward pricing markets. Some research has been conducted on tracking agricultural marketing advisory services as a proxy for farmer forward pricing decisions (e.g., Bertoli et al., 1999; Irwin et al., 2000), although Pennings et al. (2001) found that only 11% of the subscribers to market advisory services follow the recommendations "very closely." Before applied research in this area can be improved, analysts need to observe farmers' actions in these markets to better understand how farmers form price expectations and utilize forward pricing tools (Brorsen and Irwin, 1996).

This study examines farmer forward pricing decisions in a marketing game conducted over the period 1994 through 1998. Farmers in Maryland grain marketing clubs participated in a real-time marketing simulation allowing paper transactions in forward markets over the marketing season. Unlike other studies where survey data are utilized at one point in time (e.g., Patrick, Musser, and Eckman, 1998), these marketing simulation data enable us to study farmer behavior over several years and within marketing seasons. Thus we are able to assess whether farmers use forward markets to manage price risk or to enhance prices.

Study Hypotheses

The efficient market view of hedging implies farmers forward price a proportion of their crop, known as the hedge ratio. Based on empirical studies on grains, the hedge ratio is in the range of 0.85 to 1.00 without yield uncertainty (Myers and Thompson, 1989); the ratio drops to a range of 0.55 to 0.90 with yield uncertainty (McNew, 1996), depending on the extent of yield variability and correlation between yield and price. Higher yield uncertainty increases the likelihood that production will not meet the contract requirement. In addition, negatively correlated price and yield provides a natural hedge on revenue, thereby reducing the hedge ratio.

Under the standard hedging model assumptions, forward pricing is purely risk reducing because farmers believe forward prices are unbiased. At a minimum, we would expect to see a high proportion of the crop forward priced if farmers followed this rule. Furthermore, hedging theory would argue that the amount forward priced does not change over time, unless the relevant correlations change over time. Earlier research by McNew and Fackler (1994) tested time variation in the hedge ratio from an estimated GARCH model, and did not find significant variation in the case of corn.

The above reasoning suggests several hypotheses for this analysis:

- Farmers should forward price a high proportion of their crop (approximately 85–100%) each year.
- The hedge ratio should not vary over years based on past price relationships or current price expectations.
- The hedge ratio should not vary over the growing season.

[1] Along with Lence (1996), alternative theoretical explanations for hedging behavior have also been investigated by Collins (1997) and Brorsen (1995). These studies determine that bankruptcy risk and the size of transactions costs can influence hedging levels.

The alternative view that forward pricing increases prices received and perhaps also decreases risk is more ad hoc than the above reasoning, and is therefore not as easy to summarize into hypotheses. However, the presumption is that farmers can identify pricing opportunities which increase prices. Consequently, we would expect the reverse of the above hypotheses—i.e., forward pricing should vary throughout the marketing season, and perhaps from one year to the next. If this is true, then an interesting question is: What information influences farmers' forward pricing decisions?

For example, under an adaptive expectations view, farmers' current price expectations should be strongly influenced by price levels in the previous year. If current prices are below these expectations, farmers will wait for better opportunities, which presumably will arise in the future. Thus, one would expect less hedging if prices are lower than in the previous year, and more hedging if prices are higher.

Data and Procedures

Marketing Club Data

A typical grain marketing club is comprised of a group of farmers and agribusiness personnel who discuss and explore marketing strategies and outlook. Clubs are usually associated with the Cooperative Extension Service, with agricultural marketing specialists and extension agents providing educational training on the marketing process. In Maryland, the educational component is enhanced through a practical marketing exercise called the Model Farm.

The Model Farm is a hypothetical 1,000-acre farm with 600 acres of corn, 200 acres of soybeans, and 200 acres of wheat. Crop yields are the same for every club and are assumed to be constant, so production risk does not influence pricing decisions. Club participants make joint marketing decisions for the Model Farm at their meetings, which usually occur once every two weeks.

The Model Farm serves as an exercise in promoting an understanding of how the tools will perform in actual market situations. Farmers make decisions about when to price, how much to price, and what tool (cash sale, forward contract, futures contract, or options contract) to use. These marketing activities are hypothetical, as no actual pricing is done with real grain. No monetary transactions costs are assumed for futures and options trades.

Table 1. Maryland Grain Marketing Clubs Participating in the Model Farm, 1994–1998

	Years Participating				
Club Name	1994	1995	1996	1997	1998
Carroll County	T	T	T		
Harford County	T	T	T		T
Kent County	T	T	T	T	T
Talbot County	T	T	T	T	T
Washington County	T	T	T	T	
Worcester County		T	T	T	

Indirect costs such as learning about forward pricing are also not accounted for, but club members reduce such costs by participating in the Model Farm exercise.

At the end of each year, marketing clubs turn in their trading records. These records describe the date, the size, and the types of transactions made throughout the marketing year.[2] Nine marketing clubs participated in the Model Farm trading exercise between 1994 and 1998. However, because three of the clubs only participated for one year, they are excluded from the analysis. After 1998, no clubs participated in the exercise. Table 1 identifies the six marketing clubs examined here and lists the specific years during 1994 and 1998 each club participated in the Model Farm exercise.

To simplify the analysis, we consider only corn transactions for the pre-harvest pricing window.[3] This time period is from January (prior to planting) until harvest time in November. Figure 1 shows the mid-month price for the December corn futures contract over the five marketing years included in the analysis.

As observed from figure 1, forward prices varied substantially not only in terms of their level from one year to the next, but also in terms of seasonal pattern. With this pattern, any routine hedging strategy would have led to significant variation in hedging profits. In 1994 and 1998, the forward price fell consistently and bottomed at harvest time. In 1995, the reverse trend occurred as the forward price rose throughout the season and reached a high at harvest.

[2] Certainly, decisions made in a game setting may not be consistent with actual behavior. However, applications of experimental economics have shown that participant behavior often mirrors expected actions from economic agents (Fackler and McNew, 1998). While there are inherent limitations in associating Model Farm trading behavior with actual trading behavior, the data are a reasonably good proxy for understanding expectations and forward pricing behavior.

[3] Examining only corn transactions does abstract from any portfolio effects which may be occurring when farmers make forward pricing decisions for soybeans and wheat.

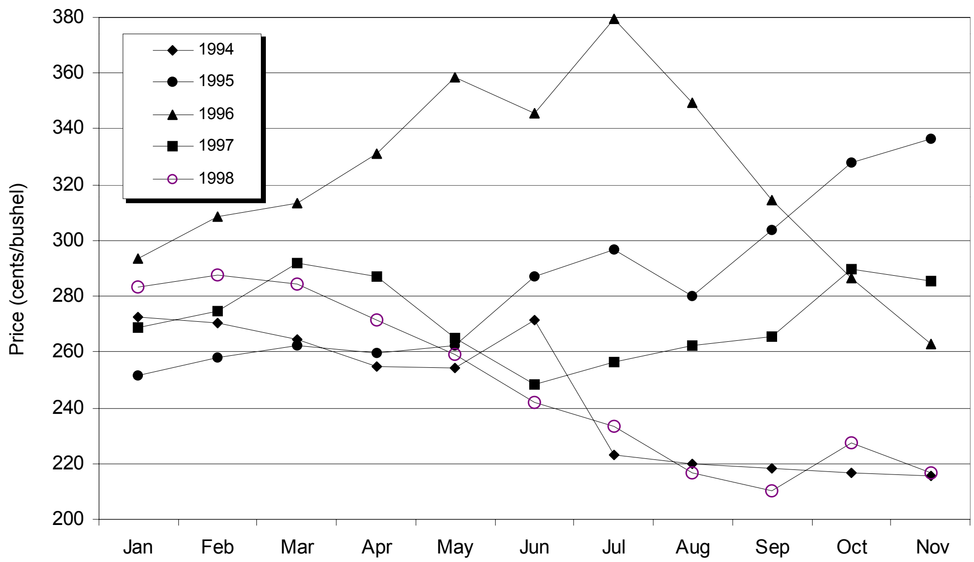

Figure 1. December corn futures price, Chicago Board of Trade, 1994–1998

In 1996 and 1997, high and low prices were posted, respectively, during the summer.

Each club has 60,000 bushels of corn that may be priced through forward contracts for 1,000 bushels or exchange-traded futures and options contracts for 5,000 bushels. Although the clubs use forward contracts for local markets, in this study all cash forward prices are based on the December futures price for the date when a contract is entered. This assumption means the basis is zero, allowing us to draw comparisons across clubs. In addition to forward contracts, clubs may use futures contracts, call options, or put options to forward price their corn, strategies which are also based on the December contract.[4]

Combining Futures and Option Positions

Use of options introduces a complication for analyzing how much has been hedged. For example, a $2.50 put option provides different price protection than a $2 put option. Similarly, pricing 5,000 bushels with a futures contract at $2.50 is different than pricing 5,000 bushels with a $2.50 put option.

We use the *delta* value of an option to determine how much price protection is offered through a certain option position. The option's delta measures the change in the option premium from a one-unit change in the underlying futures price.[5] For put options, the delta value is in the range of $[-1, 0]$, while for call options the range is $[0, 1]$. A short futures position has a delta value of -1. Because forward contracts are simply futures contracts that cannot be offset, they too have a delta of -1.

An option's delta value depends on two main factors. First, the strike price of the option relative to the underlying futures price is a key component. With declining futures prices, the delta for a put option will increase in absolute value, and the delta for a call option will decrease. Indeed, arbitrage guarantees that the delta of a call option and a put option with the same strike price will sum to 1 in absolute value.[6]

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[4] Some clubs utilize contract months other than the December month for purposes of storage or because of early harvest decisions. Therefore, we have taken the liberty of converting all non-December contracts into December contracts. For example, if a club takes a short futures position for September 1995 corn on March 31, 1995, we have instead changed the club's position to short a December 1995 contract on the same date. With options, if a club buys a March 270 put option when the March futures price is 280, we convert this transaction to a December put option that is 10¢ out-of-the-money. Less than 10% of all futures and options transactions were non-December contracts, so the impact of changing to a December contract is likely minimal.

[5] We assume futures prices are lognormal, and adopt the methodology outlined by Black (1976) to compute the implied standard deviation of the price distribution based on observed option prices. The delta measures the change in the option price based on a change in the futures price, and is computed numerically.

[6] A conceptual proof of this statement can be made by showing that a synthetic futures position can be created from a portfolio of a put and call option with the same strike price. For example, a synthetic long futures position is created from a long call option and short put option with the same strike price. Therefore, the delta of the portfolio is $\delta_c - \delta_p$, which equals the delta of the long futures position (+1).

The second factor influencing an option's delta is the length of time until expiration. In the extreme case when the option is at expiration, a call (put) option's delta will be either 0 or 1 (−1), depending on whether the option has intrinsic value. Prior to expiration, an option's delta will be somewhere in between these values, depending on the time until expiration and the relationship between the futures price and strike price.

Using the concept of an option's delta, it is straightforward to add positions in forward, futures, and options contracts. For each club throughout the five-year study period, we construct a delta-weighted hedge ratio, which is the quantity-weighted sum of each portfolio instrument. Bertoli et al. (1999) adopted the same approach in assessing the hedging portfolio of marketing advisors. Although the delta approach is a local measure, it does provide a useful way to measure the downside price protection from a portfolio consisting of different pricing instruments.[7]

Fundamental Price Forecasts

A fundamental price forecast is used in the analysis of club behavior. This forecast is for December futures price based on monthly U.S. Department of Agriculture (USDA) forecasts of corn supply and demand. If farmers adjust their forward pricing decisions based on this economic data, we would expect to see greater hedging when the futures price is high relative to the fundamental price forecast.

The fundamental price forecast is estimated every month based on the USDA's projections for corn supply and demand in its *World Agricultural Supply and Demand Estimates* (*WASDE*) report. In this report, the USDA provides forecasts of supply, use, and ending stocks. The projections for ending stocks are perhaps the single most important statistics because they measure the surplus to be carried forward to the next crop year (Purcell and Koontz, 1999). A common way to develop a price forecast is to incorporate as an explanatory variable the ending stocks as a percentage of total use. Therefore, we construct an ex ante forecast of the December futures price in November of the same year based on the latest USDA estimate of the ending stocks-to-use ratio (*SUR*). The model is of the form:

$$(1)\quad F_t = a(SUR_t)^b,$$

where F_t is the December corn futures price in mid-November, and *SUR* is the stocks-to-use ratio from the November *WASDE* report for the current marketing year. This model captures the essence of a storable commodity market where prices increase proportionally more at low stocks than high stocks.

To develop estimates for a and b, a seven-year rolling sample is used to estimate the model of equation (1). The data consist of the previous seven-years' value for the *SUR* estimate in November and the corresponding December futures price in November. Based on the estimated model from (1), a forecasted December futures price is computed each month in the current marketing year derived from USDA's estimate of the SUR. At the start of a new marketing year, the model is reestimated using the most recent seven years of data.

The choice of seven years of data is based on the need to develop a simple predictive model that responds more rapidly to current conditions. For 1994 through 1998, the model fits relatively well, with the R^2 ranging from 0.74 to 0.98, and the parameter estimates are reasonably stable. For example, at a SUR value of 10%, the price projections range from a low of \$2.81 per bushel in 1995 to a high of \$2.91 per bushel in 1997.

Regression Models

To analyze the factors influencing hedging behavior, we begin by estimating a seasonal model of the form:

$$(2)\quad H_{kt} = \alpha_0 + \sum_i \beta_i M_i + \sum_j \alpha_j Y_j + e_{kt},$$

where H_{kt} is the proportion of the crop forward priced in month k of year t, M_i is a set of seasonal dummy variables, and Y_j is a set of yearly dummy variables.[8] Two seasonal dummy variables are used, one for the pre-planting period of January to April and the second during the critical growing season of May to July. The intercept accounts for the case of August to November 1996.

To investigate whether clubs are responding to information, we augmented equation (1) with variables that may influence expectations:

[7] The results reported in this study are not appreciably different if a simple sum of the positions is used (i.e., options are treated as −1 or +1).

[8] Whether farmers exhibit variation in their usage of puts/calls and forward/futures contracts would be of interest. Unfortunately, individual clubs show a tendency to use one pricing instrument over another. For example, Washington and Carroll County clubs were heavily slanted toward forward contracts and very seldom used options. Kent County was at the opposite extreme, using mostly options contracts. As such, this group of farmers seems to have a personal preference for certain instruments, although this may not be true in a larger sample of farmers.

$$(3)\quad H_{kt} = \alpha_0 + \sum_i \beta_i M_i + \sum_j \alpha_j Y_j + \delta_1 TP_{kt} + \delta_2 RP_{kt} + \delta_3 FP_{kt} + e_{kt},$$

where TP is a dummy variable that measures the price trend using a 20-day moving average of past prices. If the current price is above the moving average, then the trend is higher and the dummy variable takes a value of 1. If farmers use technical analysis to form the basis of their price expectations, then we would expect a higher trend to be associated with less hedging.

The variable RP in equation (3) represents the current price relative to the previous year's high price. This variable measures the extent to which the current year's price is relatively high or low compared to a reference price from last year. If farmers tend to make forward pricing decisions relative to last year's prices, we would expect this variable to be significant although the sign of the variable is unclear. For example, if farmers have adaptive expectations, then a high current price relative to last year would imply greater hedging. In contrast, if farmers use current prices as the basis for forming expectations, then high current prices relative to last year may signal higher prices in the future and less hedging.

The third variable from (3), FP, is the current futures price less the fundamental price based on a price forecast derived from the monthly USDA-*WASDE* supply and demand report (discussed above). A positive value for FP indicates the current price is above the fundamental price. This variable is similar to the approach of Wisner, Blue, and Baldwin (1998), where marketing years are classified as a short crop year if expected production is less than expected usage. Our approach differs in that FP changes monthly and measures the difference between a fundamental value and the observed futures price. If farmers make pricing decisions based on market fundamentals, we would expect them to forward price more if FP is positive.

Results

Although the perceived major benefit of hedging among agricultural economists is to reduce price risk, an empirically important question is whether farmers have the ability to consistently profit from their forward pricing decisions. Table 2 presents the average forward pricing profits by individual year and for the full sample from 1994–1998. Forward pricing profits for each year are the difference between the net price received for corn and the price at harvest. These profits account for all transactions through forward, futures, and options contracts.

Table 2. Average Forward Pricing Profits for All Clubs

Year	Average Profits (¢/bushel)	Number of Clubs	Change in December Futures (¢/bushel)[a]
1994	21.0	5	38.5
1995	−26.2	6	−74.0
1996	27.9	6	95.3
1997	−0.6	4	−20.0
1998	30.3	3	42.5
1994–98	10.5		16.5

[a] Defined as the December corn futures price in May (planting) less the December corn futures price in November (harvest).

For comparison, the last column of table 2 shows the change in the December futures price between May and November. A positive number indicates the forward price was higher at planting in May than at harvest in November. Stated another way, a farmer who routinely hedged his or her entire production in May would have averaged a 16.5¢ higher price per bushel than by selling corn at harvest between 1994 and 1998.

As a group, the clubs made positive profits in 1994, 1996, and 1998 (table 2), which were years when prices were lower at harvest than earlier in the season, making any pre-harvest pricing strategies profitable.

In contrast, 1995 was a year when prices rose consistently throughout the marketing year and were highest at harvest with a 90¢ difference between the harvest price and the seasonal low. Not surprisingly, the clubs earned negative profits, which were statistically different from zero that year.

In 1997, the harvest-time price was roughly the same as the price in the early spring, after bottoming in the summer, and the clubs on average experienced a small loss. In general, the profitability of a club's annual trading is highly correlated to the direction of price change. For all clubs, the correlation between club profits and the futures price change between May and November is 0.84.

For the entire 1994–1998 time period, forward pricing profits for all clubs averaged 10.5¢ (table 2). However, the t-statistic was 0.98, indicating the clubs were not able to achieve statistically significant profits for this particular sample.

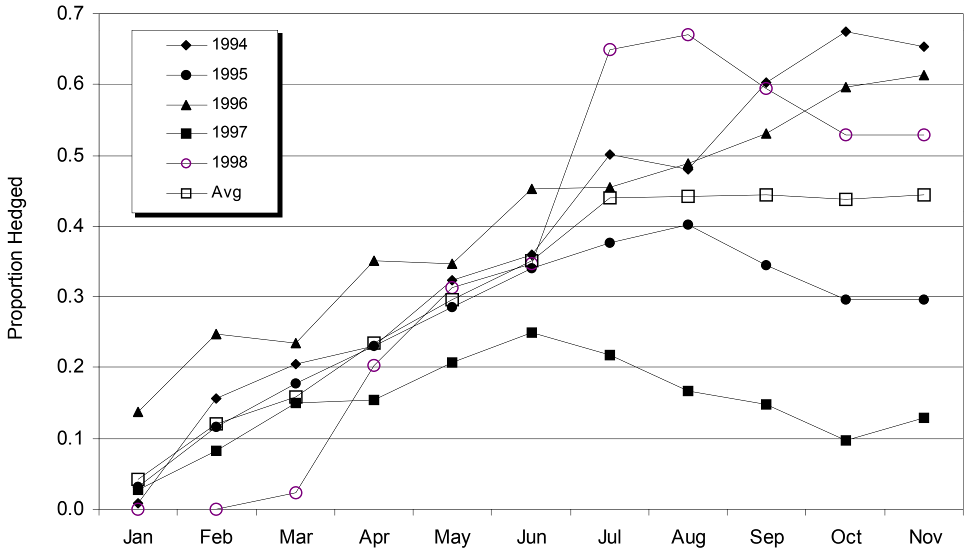

Figure 2. Average proportion forward priced by marketing clubs, 1994–1998

The results reveal the marketing clubs participating in this study did not consistently beat the market or earn statistically significant profits from forward pricing over the five-year sample period. Thus, the findings support the efficient market hypothesis of hedging. However, it is important to note that the sample size and zero transactions costs limit the generality of this conclusion. Although there are numerous marketing clubs on which to base the test, only five marketing years were available. With more marketing years, the results may differ.

Figure 2 depicts the delta-weighted hedge ratios. This graph illustrates the all-club average by year and for the average of all years from 1994–1998. From figure 2 it is apparent that clubs have a strong seasonal tendency to hedge less in the spring and more in the summer. Also, the amount hedged is significantly less than what is prescribed by hedging theory. At its peak, the all-club average was 0.67 in August 1998, but the average in each year suggests a normal level of about 0.45. When all years are averaged, the proportion priced increases from the start of the year until July where it reaches 0.45, and is constant for the remainder of the year.[9]

[9] If club participants were making pricing decisions on the basis of yield risk, one would anticipate that yield risk would be nearly eliminated by September when the crop has reached maturity. Because clubs on average price only 45% of their crop after September, farmers' pricing motives are not likely tied to yield uncertainty.

Clubs exhibited considerable variation in hedging from year to year, especially from July until harvest. The amount hedged at harvest (October) ranged from a low of 0.1 in 1997 to a high of 0.68 in 1994. Comparison of these results to those from Bertoli et al.'s (1999) survey of marketing advisory services reveals remarkable similarity. For example, in August of 1995, the average marketing advisory service had priced 35% of the corn crop, while the average marketing club had priced 40% of the crop at the same time.

Overall, these characteristics suggest club participants may be using forward pricing for reasons other than pure risk reduction. Hedging levels are well below 0.9 for all years, and are observed to vary from year to year as well as seasonally. Given that hedging behavior appears to be dynamic, and not myopic or static, we now consider whether these decisions are influenced by observable factors.

To test for variation in hedging behavior, equation (2) was estimated for each club using ordinary least squares. Parameter estimates from equation (2) are given in table 3. Preliminary tests indicated first-order serial correlation in the residuals for the Carroll and Talbot clubs, so the regression models for these clubs were corrected for autocorrelation.

If clubs are purely minimizing risk, one would expect all the seasonal and year coefficients to be zero, implying no difference in hedging behavior across years or within the marketing season. *F*-statistics reported at the bottom of table 3 indicate

Table 3. Parameter Estimates: Seasonal Model for Proportion Forward Priced by Marketing Clubs

	Marketing Club					
Variable	Carroll	Hartford	Kent	Talbot	Washington	Worcester
Intercept	0.498	0.368	0.397	0.531	0.837	0.229
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Jan-Apr Dummy	!0.294	!0.326	!0.229	!0.362	!0.128	!0.141
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.005)
May-Jul Dummy	!0.114	!0.068	!0.075	!0.179	!0.007	0.006
	(0.168)	(0.222)	(0.192)	(0.026)	(0.828)	(0.897)
1994 Dummy	0.147	0.172	0.362	0.023	!0.565	—
	(0.293)	(0.036)	(0.001)	(0.868)	(0.001)	
1995 Dummy	!0.362	!0.126	0.163	0.115	!0.648	0.173
	(0.005)	(0.035)	(0.042)	(0.376)	(0.001)	(0.003)
1997 Dummy	—	—	!0.092	!0.247	!0.636	0.098
			(0.246)	(0.060)	(0.001)	(0.069)
1998 Dummy	—	0.298	!0.130	0.071	—	—
		(0.001)	(0.065)	(0.611)		
Seasonal Dummies = 0 [a]	5.86	15.11	9.45	10.83	11.09	6.49
	(0.009)	(0.001)	(0.001)	(0.001)	(0.001)	(0.005)
Yearly Dummies = 0 [a]	10.83	11.41	12.68	2.27	137.46	5.59
	(0.001)	(0.001)	(0.001)	(0.075)	(0.001)	(0.009)
All Dummies = 0 [a]	9.01	13.04	11.87	5.11	86.98	6.14
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R^2	0.59	0.73	0.61	0.54	0.91	0.53
No. of Observations	30	36	55	55	44	33

Note: *p*-values are reported in parentheses.

[a] *F*-tests are used to determine the significance of the seasonal dummies, the yearly dummies, and both sets of dummies (combined seasonal and yearly).

a rejection of the constant hedging hypothesis within a season as well as across marketing years for all clubs. The annual dummy variables confirm the above finding that the clubs systematically changed their pricing behavior from one year to the next. As compared to the base of 1996, two clubs hedged significantly more in 1994, while one club hedged significantly less. In 1995, three clubs hedged significantly less and two clubs hedged significantly more compared to 1996. Likewise, three clubs in 1997 and two in 1998 had significantly different hedging compared to 1996.

The seasonal coefficients reported in table 3 confirm the seasonal relationships seen in figure 2, discussed above. All clubs demonstrated significantly lower levels of hedging in the pre-planting period of January to April as compared to hedging levels in August through November. However, from May to July, only one of the six clubs showed a systematic tendency to hedge less during this period as compared to August through November. These results do not imply that clubs do not change their forward pricing position after May, but rather, the clubs do not change their hedging in a systematic fashion after May. One explanation for the different levels across years and within a year is that clubs change their forward pricing behavior based on expectations, which is explored in equation (3).

Estimates for equation (3) are presented in table 4. Preliminary tests again found first-order serial correlation for Carroll and Talbot counties, and the models for these clubs were corrected for autocorrelation. *F*-statistics for the significance of the seasonal variables, the year variables, and the price trend variables (*TP*, *RP*, and *FP*) are also reported at the bottom of table 4. As discussed above, all clubs show some tendency to hedge less when the price trend is positive, as denoted by the negative coefficients on the trend dummy variable (*TP*). However, only two clubs have a statistically significant coefficient at the 5% level. Based on the parameter estimate for *TP*, clubs tend to hedge 1% to 10% less of their entire crop during a higher trending market.

Table 4. Parameter Estimates: Model for Proportion Forward Priced by Marketing Clubs Based on Relative Prices

	Marketing Club					
Variable	Carroll	Hartford	Kent	Talbot	Washington	Worcester
Intercept	0.355	0.212	0.251	0.250	0.906	0.229
	(0.105)	(0.111)	(0.017)	(0.126)	(0.001)	(0.009)
Jan-Apr Dummy	!0.310	!0.311	!0.205	!0.456	!0.113	!0.131
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.031)
May-Jul Dummy	!0.117	!0.014	!0.043	!0.244	0.009	0.041
	(0.204)	(0.759)	(0.421)	(0.004)	(0.740)	(0.395)
1994 Dummy	0.233	0.237	0.427	0.210	!0.585	—
	(0.204)	(0.028)	(0.001)	(0.164)	(0.001)	
1995 Dummy	!0.159	0.067	0.332	0.527	!0.667	0.261
	(0.470)	(0.588)	(0.003)	(0.004)	(0.001)	(0.005)
1997 Dummy	—	—	!0.387	!0.662	!0.501	0.023
			(0.002)	(0.001)	(0.001)	(0.838)
1998 Dummy	—	0.233	!0.181	0.108	—	—
		(0.002)	(0.016)	(0.371)		
TP	!0.044	!0.031	!0.007	!0.059	!0.091	!0.091
	(0.507)	(0.530)	(0.883)	(0.310)	(0.001)	(0.040)
RP	!0.003	!0.004	!0.004	!0.006	0.001	!0.001
	(0.024)	(0.034)	(0.011)	(0.012)	(0.046)	(0.436)
FP	0.004	0.003	0.002	0.008	!0.001	0.001
	(0.057)	(0.045)	(0.024)	(0.017)	(0.975)	(0.840)
Seasonal Dummies = 0 [a]	6.08	23.07	9.17	16.68	13.55	7.95
	(0.008)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Yearly Dummies = 0 [a]	5.19	6.01	16.91	4.31	168.20	9.43
	(0.015)	(0.003)	(0.001)	(0.005)	(0.001)	(0.001)
TP = *RP* = *FP* = 0 [a]	4.68	5.57	4.85	3.15	6.31	4.19
	(0.023)	(0.004)	(0.005)	(0.034)	(0.002)	(0.016)
All Dummies = 0 [a]	5.25	19.71	14.68	6.55	114.80	8.50
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R^2	0.60	0.73	0.72	0.63	0.94	0.675

Note: *p*-values are reported in parentheses.

[a] *F*-tests are used to determine the significance of the seasonal dummies, the yearly dummies, both sets of dummies (combined seasonal and yearly), and the relationship of hedging behavior to current price conditions (*TP* = *RP* = *FP* = 0).

Four of the six clubs have a statistically significant negative coefficient for *RP*, the relative price variable (table 4). These clubs tend to hedge less when the current price is high relative to the previous year's price. Only one club had a statistically positive sign, suggesting this club hedged more when prices were higher in the current year relative to the previous year. Finally, the positive signs on the fundamental price measure (*FP*) for five clubs, four of which are statistically significant, reveal the tendency by these clubs to hedge more when current prices are high relative to the fundamental price.

The test statistics at the bottom of table 4 provide further insight about hedging behavior. In particular, the three tests of interest concern seasonality in hedging behavior (denoted as Seasonal Dummies = 0 in table 4), variation from year to year (Yearly Dummies = 0), and the relationship of hedging behavior to current price conditions (*TP* = *RP* = *FP* = 0). The test statistics for all coefficients for every club are significant, indicating a rejection of the corresponding null hypothesis.

These results suggest several unique features of farmer hedging behavior. First, this group of farmers exhibits systematic seasonal hedging patterns, tending to hedge less in the spring and more in the summer. While this behavior could partly be explained by yield uncertainty, it may also be due to farmers' unwillingness to commit to a forward position early in the season without information about market-level crop conditions. Based on the test statistic for price condition variables, it seems clear that farmers do adjust their hedging behavior as price conditions change. However, the significant yearly dummy variables in conjunction with the significance of the price condition variables suggest hedging behavior may be influenced by other factors we have not measured.[10]

According to our findings, farmers change their forward pricing behavior as market conditions change. In terms of expectations, farmers as a group seem to apply no universal strategy in forming their price outlook. However, the clubs do tend to hedge more when prices are relatively low, either in comparison to the previous year or in reference to a fundamental value. For example, if *FP* and *RP* are both ! 10¢ per bushel (implying the current price is 10¢ below the fundamental value and the high from last year), then four of the six clubs hedge more, although the amount hedged increases only by 1% to 4%.

Because the majority of farmers in this study tend to hedge more during low-price periods, these farmers likely use current prices as a gauge for the market outlook. Simply stated, farmers may interpret low prices as a signal that prices will continue to move lower, and thus forward pricing is warranted. Likewise, during periods of high prices, farmers tend to hedge less, possibly in anticipation of better prices to come.

Conclusions

The analysis in this study provides support for both the research and extension marketing views in the current debate on marketing strategies employed by farmers. Farmers participating in the marketing clubs examined here did not consistently profit from their forward pricing decisions—just as the efficient market hypothesis and standard hedging theory would suggest.

However, findings also show farmers' hedging activity was not consistent with the implications of standard hedging theory in a number of respects. First, farmers tend to forward price significantly less than what would be dictated by purely risk-minimizing behavior. Furthermore, the amount hedged varies considerably in different marketing years, indicating farmers may be attempting to time the market even though their ability to do so appears limited.

Our findings reveal the majority of the marketing clubs examined in this analysis use relative prices as a signal of future price direction. In addition, fundamental information, as measured by this study, appears to have some minor influence on pricing decisions. However, the large annual residual variation identified here indicates that farmers use other decision-making information for the purposes of pricing. Consequently, future research on additional measures used by farmers in their hedging strategies would be helpful in understanding hedging behavior.

[10] Given the similarity between farmers' hedging behavior illustrated here and marketing advisory services reported in Bertoli et al.'s (1999) survey, it may be that farmers base their pricing decisions in part on the advice of these services.

References

Anderson, K. B., and H. P. Mapp. (1996). "Risk Management Programs in Extension." *Journal of Agricultural and Resource Economics* 21, 31–38.

Bertoli, R., C. R. Zuluaf, S. H. Irwin, T. E. Jackson, and D. L. Good. (1999, August). "The Marketing Style of Advisory Services for Corn and Soybeans in 1995." AgMAS Project Research Report No. 1999-02, University of Illinois, Urbana-Champaign.

Black, F. (1976). "The Pricing of Commodity Contracts." *Journal of Financial Economics* 3, 167–179.

Brorsen, B. W. (1995). "Optimal Hedge Ratios with Risk-Neutral Producers and Nonlinear Borrowing Costs." *American Journal of Agricultural Economics* 77, 174–181.

Brorsen, B. W., and S. H. Irwin. (1996). "Improving the Relevance of Research on Price Forecasting and Marketing Strategies." *Agricultural and Resource Economics Review* 25, 68–75.

Collins, R. A. (1997). "Toward a Positive Economic Theory of Hedging." *American Journal of Agricultural Economics* 79, 488–499.

Fackler, P. L., and K. McNew. (1998). "Experimental Markets Using the Electronic Market Place (EMP)." *Journal of Agricultural and Applied Economics* 30, 151–162.

Fama, E., and K. French. (1987). "Commodity Futures Prices: Some Evidence on Forecast Power, Premiums, and the Theory of Storage." *Journal of Business* 60, 55–73.

Goodwin, B. K., and T. C. Schroeder. (1994). "Human Capital, Producer Education Programs, and the Adoption of Forward-Pricing Methods." *American Journal of Agricultural Economics* 76, 936–947.

Grant, D. (1985). "Theory of the Firm with Joint Price and Output Risk and a Forward Market." *American Journal of Agricultural Economics* 67, 630–635.

Irwin, S. H., D. L. Good, J. Martines-Filho, and T. E. Jackson. (2000, November). "Do Agricultural Market Advisory Services Beat the Market? Evidence from the Corn and Soybean Markets over 1995–1998." AgMAS Project Research Report No. 2000-03, University of Illinois, Urbana-Champaign.

Just, R. E., and G. C. Rausser. (1981). "Commodity Price Forecasting with Large-Scale Econometric Models and the Futures Market." *American Journal of Agricultural Economics* 63, 197–208.

Kahl, K. H. (1983). "Determination of the Recommended Hedging Ratio." *American Journal of Agricultural Economics* 65, 603–605.

Kenyon, D. E. (2001). "Producer Ability to Forecast Harvest Corn and Soybean Prices." *Review of Agricultural Economics* 23, 151–162.

Lapan, H. E., G. Moschini, and S. D. Hanson. (1991). "Production, Hedging, and Speculative Decisions with Options and Futures Markets." *American Journal of Agricultural Economics* 73, 66–74.

Lence, S. H. (1996). "Relaxing the Assumptions of Minimum-Variance Hedging." *Journal of Agricultural and Resource Economics* 21, 39–55.

McNew, K. (1996). "Testing the Success of the Iowa Corn Yield Contract." In *Chicago Board of Trade Spring Research Seminar Proceedings* (pp. 12–24). Chicago: CBOT.

McNew, K., and P. L. Fackler. (1994). "Non-constant Optimal Hedge Ratio Estimation and Nested Hypotheses Tests." *Journal of Futures Markets* 14, 619–635.

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

Parcell, J., T. Schroeder, T. Kastens, and K. Dhuyvetter. (1998, April 20–21). "Perceptions of Marketing Efficiency and Strategies: Extension vs. Research Marketing Economists." Paper presented at the annual NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management, Chicago, IL.

Patrick, G. F., W. N. Musser, and D. T. Eckman. (1998). "Forward Marketing Practices and Attitudes of Large-Scale Midwestern Grain Producers." *Review of Agricultural Economics* 20, 38–53.

Peck, A. E. (1975). "Hedging and Income Stability: Concepts, Implications, and an Example." *American Journal of Agricultural Economics* 57, 410–419.

Pennings, J., D. L. Good, S. H. Irwin, and J. K. Gomez. (2001, March). "The Role of Market Advisory Services in Crop Marketing and Risk Management: A Preliminary Report of Survey Results." AgMAS Project Research Report No. 2001-02, University of Illinois, Urbana-Champaign.

Purcell, W. D., and S. R. Koontz. (1999). *Agricultural Futures and Options*, 2nd edition. Upper Saddle River, NJ: Prentice-Hall.

Rausser, G. C., and C. Carter. (1983). "Futures Market Efficiency in the Soybean Complex." *Review of Economics and Statistics* 65, 469–478.

Sakong, Y., D. J. Hayes, and A. Hallam. (1993). "Hedging Production Risk with Options." *American Journal of Agricultural Economics* 75, 408–415.

U.S. Department of Agriculture. (1994–1998). *World Agricultural Supply and Demand Estimates* (*WASDE*). Monthly report, USDA/World Agricultural Outlook Board, Washington, DC. Various monthly issues.

Wisner, R. N., E. N. Blue, and E. D. Baldwin. (1998). "Preharvest Marketing Strategies Increase Net Returns for Corn and Soybean Growers." *Review of Agricultural Economics* 20, 288–307.

Zulauf, C. R., and S. H. Irwin. (1998). "Marketing Efficiency and Marketing to Enhance Income of Crop Producers." *Review of Agricultural Economics* 20, 308–331.