# PARTICIPATION BY FARMERS IN FORWARD CONTRACTING AND HEDGING

by

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Abstract

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Logit models of farmers' forward pricing practices are developed. Results indicate: (a) farm size significantly affects use of hedging and forward contracting; (b) farmers inclination to search for information is related to their forward pricing practices; and (c) forward pricing practices are complementary with other risk reduction methods.

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The demand for most U.S. agricultural products is inelastic, producing unstable farm gate prices. Due to weather related supply uncertainties, policy induced shifts in supply, and abrupt changes in the global demand for U.S. exports, price volatility has become common for many cash crops, especially grains and oilseeds. Clearly, agricultural producers have an incentive to seek some means of reducing the profit uncertainty caused by price instability. Forward contracting and hedging are among the tools available for this purpose. This study investigates farmers' use of forward contracting and hedging.

Much of the past research on farmers' use of hedging and forward contracting has emphasized their use in the context of risk reduction using portfolio concepts (Peck; Heifner, 1973; Heifner, 1978; Harwood and Tomek; Barry and Willmann; Miller; Zacharias et al.). Tomek states that empirical applications of the portfolio approach "suggest that the optimal futures position is often a large percent - say 75 to 100 - of the expected cash position." (Tomek, p. 7) Studies that incorporate yield risk into their analysis report optimal hedging proportions ranging from 20 to 60 percent for soybeans and 60 to 70 percent for corn (Alexander et al.; Grant).

Given these risk reduction advantages, widespread adoption of hedging and/or forward contracting would be expected. However, farmers consistently use these marketing tools less than portfolio studies suggest they should (Hill; Tierney; Helmuth; Leath). In spite of their apparent advantages in controlling a risky market environment and extensive educational efforts on the part of the cooperative extension service, commodity exchanges and academic researchers, their use remains limited.

The purpose of this study is to explain farmers' adoption of forward pricing by relating the characteristics of grain producers to their use of

hedging and forward contracting. The literature, reviewed in the next section, suggests three general sets of characteristics that may affect the use of forward contracting and hedging: (a) farm operator characteristics developed from the adoption and human capital literature, (b) financial leverage and farm size, and (c) farm operator use of alternative risk management strategies. After outlining these specific characteristics in the following section, this paper reports a logit analysis of the effect of these characteristics on farmers' participation in hedging and forward contracting. Implications of our findings are in the final section.

The data used in this study comes from a panel of 937 Ohio farm households (Stout et al.). The sample was drawn from the population of all Ohio farmers using random sampling from stratified sales classes. Comprehensive cross sectional data on financial, demographic, sociological, marketing, and production characteristics were collected from the panel in 1987, and farm production, finance, and marketing data are for the 1986 calender year. From this sample, grain farms were selected based on the criterion that at least 50 percent of the farms' gross cash receipts were from the sale of corn, soybeans, and wheat. The sample for this analysis totaled 353 farms.

## Factors Affecting the Use of Forward Contracting and Hedging

Young and Shortle emphasize the importance of operator characteristics in explaining the process of farm management decision making. These characteristics include human capital, the stock of skills and productive knowledge embodied in people (Rosen). Characteristics of operators also are the foundation of innovations diffusion theory (Rogers). This theory rests on the observation that an innovation, such as use of a marketing tool, will diffuse through society at a rate that is dependent on characteristics of both the innovator and the innovative practice.

## Farm Operator Characteristics, Farm Size, and Financial Condition

Characteristics of the innovator that encourage use of an innovative practice include operating large and specialized farms, high net income and net worth, amount of formal education, participation in local community organizations, and close association with information sources such as the cooperative extension service or innovation advocates. Characteristics of the innovative practice that increase its use are that its advantages are easily perceived, its use is compatible with existing customs and practices, it is relatively simple to use, it can be tried on a small scale, and it is relatively inexpensive. Both hedging and forward contracting suffer from inadequate perceptions of their advantages (Patrick). The use of hedging runs counter to existing customs and practices of grain farmers (Helmuth; Mintert; Patrick; and Paul et al.). In addition, hedging is not easy to understand or use, and may be difficult to try on a small scale because of contract specifications (Paul et al.). These characteristics may explain why hedging and forward contracting are used relatively infrequently and why forward contracting's use is more widespread than that of hedging.

Patrick et al. found that younger, better educated producers operating larger acreage utilized forward contracting significantly more than other producers. Factors significant in explaining farmers' use of hedging were age, size of farm, and financial condition, while education was not significant. Shapiro and Brorsen found significant factors related to hedging included years of management experience, education, debt, and farm size. Contrary to other studies' findings, education was inversely related to farmers' use of hedging.

The findings of these studies are mixed in terms of the relationship between farm operator financial condition and the use of forward contracting and hedging. Several studies report a positive relationship between the amount

of debt and forward contracting and hedging (Patrick; Shapiro and Brorsen; Paul et al.). However, Patrick et al. found debt to be positively related to hedging while insignificant in relation to farmers' use of forward contracting. One reason why leverage and the use of forward pricing tools may be positively correlated is that a farm lender may ask that the crop be forward priced to lower the uncertainly of the value of the crop held as collateral (Harris and Baker; Barry and Williams). On the other hand, a farm operator's use of debt and leverage may indicate that he has little aversion to risk, which would be consistent with lack of desire to reduce risk through forward pricing. Thus, leverage and the use of forward pricing tools may be negatively correlated.

Borrowing from human capital theory and diffusion of innovation theory, there may be a positive relationship between a farmer's use of computer services and consultants. Feder and Slade found that farmers who seek greater amounts of information from numerous sources are more likely to adopt innovations such as forward pricing techniques.

**Alternative Risk Reduction Methods**

Using forward pricing tools is only one method for a farm operator to reduce risk. Alternative methods include diversifying farm enterprises, obtaining income from off farm sources, participating in government commodity programs, purchasing crop insurance, and using share rental agreements.

Farm operators who are relatively risk averse might be expected to use both diversification and forward pricing tools. Setia and Williams conclude that risk averse farm operators are more likely to diversify farm enterprises, and several studies have found the more risk averse a producer is, the more likely he is to use forward pricing tools (Harwood and Tomek; Zacharias et al.). However, a farmer's propensity to hedge may be inversely related to diversification for operators of smaller farms. For these operators, hedging

has some characteristics that the adoption literature suggests might lead to slow adoption. For example, lumpiness of contracts may limit the ability of the operator on small, diversified farms to use futures contracts.

Off farm work activities by farm family members can be a response to income/price variability. The use of hedging and off farm work may be positively correlated if both are used as strategies to lessen variability.

Participation in government grain programs is another technique grain producers can use to lower their exposure to risk. Heifner and Sporleder argue that existing farm programs give farmers a relatively easy alternative method of limiting risk and lessen incentives to learn about and use forward pricing.

Crop insurance and crop share rental arrangements are two additional risk reducing tools that can be utilized by grain producers (Sonka and Patrick). These tools may offer alternatives to forward contracting for reducing risk.

In summary, the literature suggests the following factors that may affect a farm operator's use of forward pricing: (1) characteristics of the farm operator and the farm: operator age, experience, education, participation in farm organizations, use of computers and consultants, financial condition, and farm size; and (2) operator use of risk reduction techniques: diversification of farm enterprises, participation in government commodity programs, and use of crop insurance and share rental arrangements.

## Analytical Model

To analyze factors related to whether farmers use forward pricing, a qualitative choice model is required. Probit and logit models are two types of models commonly used to model binary choice behavior (Amemiya; Capps and Kramer; Dennedy; Lines and Morehart; Pindyck and Rubinfeld). The probit model relies on the standard normal distribution function while the logit model is based on the logistic distribution function. Since the logistic function

closely resembles the t-distribution with seven degrees of freedom, the probit and logit models are quite alike (Capps and Kramer). Empirical tests comparing the performance of probit and logit models have shown that they yield very similar results (Capps and Kramer). In this study, the logit model is used because available software easily can handle the complexities of a large data set and maximum-likelihood estimation.

The logit model used in this analysis is given by:

$$P_i = F(Z_i) = \frac{e^{Z_i}}{1 + e^{Z_i}} \qquad (1)$$

where $Z_i = \alpha_i + \beta x_{ij}$, and $P_i$ is the probability that the ith decision maker uses forward pricing, and $x_{ij}$ is the value of the jth independent variable for the ith decision maker. The maximum likelihood procedure finds estimates of $\beta$ that maximize the likelihood of observing the pattern of choice in the sample. That is, the estimated coefficients result in the greatest probability of giving the observed pattern of use (or non use) of forward pricing.

Two models of farmers' forward pricing behavior are constructed. In the first model, the 0 - 1 dependent variable measures whether or not the farm operator used forward pricing as a marketing strategy in 1986. The dependent variable for the second model indicates whether or not the operator traded futures contracts for hedging purposes. In each case, use of the forward pricing tool is measured by assigning a value of 1 for the dependent variable.

For each model, the initial independent variables includes the following: age of farm operator; years operator experience; years operator education; gross farm receipts; number of farm enterprises, with each contributing at least five percent of gross farm receipts; debt/asset ratio; government commodity program payments as a proportion of gross farm receipts; total off farm income of operator and family members; total insurance expenses;

attendance at farm organization meetings as a 0 - 1 dummy variable; and use of computers or consultants as a 0 - 1 dummy variable.

A variable to represent the use of share leases is not included due to insufficient information in the data set. Several variables thought to be important in explaining forward contracting and hedging are omitted from the final logit models (Table 1). Years of farming experience is nearly perfectly correlated with farm operator age and is deleted from the list of independent variables. Finally, years of operator education, insurance expense, and off-farm income also are omitted due to their lack of statistical significance in early attempts at estimating the logit models.

## Forward Contracting Logit Model Results

Of the 353 operators in the sample, 42 percent forward contracted some of their crop in 1986 (Table 1). Independent variables in the forward contracting logit model include operator age, operator attendance at farm organization meetings, operator use of computer or consultant services, farm size (gross receipts), financial leverage, diversity (number) of farm enterprises, and government commodity program payments. All show a relatively high degree of statistical significance (Table 2). Most significant are size of farm operation (DGROSS), operator age (OPERAGE), and financial leverage (LEVRATIO). Operators of larger farms, younger farmers, and those with less financial leverage tend to be users of forward contracting. Users of information (i.e. those purchasing computer of consultant services) also participate in forward contracting significantly more than other farmers. Although lacking a high level of statistical significance, operators of diversified farms and those receiving higher amounts of government commodity program payments are also more likely to use forward contracting.

Results generally confirm findings from previous research and are consistent with theory. From the diffusion of innovation theory, adopters of innovations are expected to be younger, operate larger farms, participants in farm organizations, and users of information.

The effects of financial leverage, enterprise diversification, and government program participation are consistent with risk averse behavior on the part of farm operators. That is, risk averse operators would be expected to reduce price risk by forward contracting and also use less financial leverage, use more enterprise diversification, and participate more in government commodity programs. Results confirm these expectations.

Other studies cite several reasons why leverage and the use of forward contracting should be positively related. Two arguments presented are that lenders encourage highly leveraged farmers to reduce risk by forward contracting (Harris and Baker; Barry and Willman) and that highly leveraged producers will seek to avoid downside price risk (Paul et al.). Our results run counter to these arguments and to results from previous studies (Patrick; Shapiro and Brorsen; Paul et al.). Similarly, our results fail to confirm Heifner and Sporleder's proposition that commodity programs reduce incentives to use forward pricing.

## Hedging Logit Model Results

Only seven percent of the sample hedged some of their crop in 1986. Partly because few farmers use hedging, the logit model's independent variables are less successful in explaining farmers' use of hedging than for forward contracting. Only farm size, operator's use of information, and participation in government commodity programs are statistically significant.

Operators of larger farms are significantly more likely to use hedging. Because of the lumpiness of futures contracts and the inability of producers to

try hedging on a small scale, hedging may tend to be confined to operators of large farms. Other studies report similar results (Patrick et al.; Shapiro and Brorsen; Patrick). Farmers who seek information, as indicated by the purchase of consultant or computer services, also are significantly more inclined to use hedging. This behavior is consistent with our forward contracting model results and with the diffusion of innovation literature (Rogers). Finally, farmers who participate in government programs are more likely to hedge. These results are similar to those from our forward contracting model, and are consistent with risk averse behavior. Other variables, such as operator age, attendance at farm organization meetings, financial leverage, and enterprise diversity, are not significantly related to the use of hedging.

Measures of goodness-of-fit are found in the classification table, which depicts the relationship between actual use (dependent variable equals 1) and predicted use (predicted dependent variable is greater than 50 percent). Sensitivity is the proportion of actual users who are predicted to be users. Specificity is the proportion of actual non-users who are predicted to be non-users. Summing sensitivity and specificity yields the correct prediction ratio. Both models have relatively high goodness-of-fit.

## Conclusions and Implications

From the results of our forward contacting and hedging logit models, some conclusions may be drawn concerning farmers' use of forward pricing tools. First, there may be economies of size in the use of marketing tools in cash grain operations. There may be a minimum gross sales level that has to exist to justify the additional managerial time, effort, and expense that is incurred when forward contracting, and to an even greater degree, when hedging.

Second, there is an interaction between search for information and use of forward pricing tools. Paul et al. notes that hedging, and to a lesser degree

forward contracting, cannot be successful without an intense commitment of information collection and use. The strong significance of the use of computer and consultant services for both forward contracting and hedging users may be a manifestation of such activity. The greater frequency of participation in general farm organizations may also reflect more searching for information.

Third, full-time operators of large grain farms appear to use complementary risk reduction strategies in managing their farms in an unstable production and economic environment. Those who forward price also tend to use less financial leverage and to participate in government commodity programs.

Implications for grain marketing firms are that characteristics of farm operators are useful predictors of their likely participation in forward contracting and hedging. Elevators may want to promote the use of forward pricing among particular segments of the farm population: operators of larger farms, younger operators, those active in seeking information, and those operators who tend to be cautious about financial leverage. Similarly, brokers and commodity exchanges can characterize those who hedge as larger farm operators, as active information seekers, and as farmers seeking to reduce risk through hedging and other strategies.

Another implication concerns the direction of Federal farm programs. Several proposed policy changes call for alternatives to direct government payments, including greater use of forward pricing tools to lower the variation in producers' incomes. This study indicates that operators of smaller farms and those with financial leverage tend not to use forward pricing tools; however, these groups of farmers have been the target of benefits for past farm programs. Replacing present government commodity programs with the use of forward pricing tools would likely make producers' incomes more unstable for smaller and more financially leveraged farmers.

Table 1. Summary Statistics for Variables in Forward Pricing Logit Models.

| Variable Description | Variable Name | Mean | Standard Deviation |
|---|---|---|---|
| **Variables Used in Models** | | | |
| Use of forward contracting (0 = use; 1 = non use) | FORCONT | 0.416 | 0.492 |
| Use of hedging (0 = use; 1 = non use) | FUTHEDGE | 0.071 | 0.026 |
| Operator age | OPERAGE | 50.84 | 13.30 |
| Attend general farm organization meetings (0 = no; 1 = yes) | GFOMEET | 0.385 | 0.486 |
| Use computers or consultants | USEINFO | 0.173 | 0.379 |
| Gross farm receipts ($1000) | DGROSS | 77.97 | 115.4 |
| Leverage Ratio (Debt/Assets)* 100 | LEVRATIO | 27.73 | 49.39 |
| Number of farm enterprises | TOTALENT | 2.76 | 0.87 |
| Government commodity program payments (program payments/gross farm receipts)*100 | GOVTPMTS | 9.82 | 10.17 |
| **Variables Omitted from Models** | **Reason for omission** | | |
| Years of farming experience | Experience is highly correlated with operator age. | | |
| Years of operator education | Statistically insignificant in explaining use of forward pricing | | |
| Insurance expense | Statistically insignificant in explaining use of forward pricing | | |
| Off farm income | Statistically insignificant in explaining use of forward pricing | | |
| Use of share lease | Inadequate data | | |

Table 2. Estimated Logit Models.

Forward Contracting Model

| Variable | Beta | Standard Error | Chi-Square | Significance Level |
|---|---|---|---|---|
| INTERCEPT | 0.138 | 0.801 | 0.03 | 0.8631 |
| OPERAGE | -0.041 | 0.011 | 13.97 | 0.0002 |
| GFOMEET | 0.786 | 0.260 | 9.12 | 0.0025 |
| USEINFO | 0.776 | 0.357 | 4.71 | 0.0300 |
| DGROSS | 0.007 | 0.001 | 20.93 | 0.0000 |
| LEVRATIO | -0.011 | 0.004 | 6.77 | 0.0092 |
| TOTALENT | 0.234 | 0.152 | 2.37 | 0.1235 |
| GOVTPMTS | 0.020 | 0.012 | 2.65 | 0.1037 |

Model Chi-Square = 94.46 with 7 degrees of freedom
Significance Level = 0.00001
Correct Prediction Ratio = 73.9%
Sensitivity = 56.8%
Specificity = 85.9%
False Positive Rate = 25.9%
False Negative Rate = 26.2%

Hedging Model

| Variable | Beta | Standard Error | Chi-Square | Significance Level |
|---|---|---|---|---|
| INTERCEPT | -4.443 | 1.647 | 7.27 | 0.0070 |
| OPERAGE | 0.001 | 0.020 | 0.00 | 0.9515 |
| GFOMEET | 0.371 | 0.473 | 0.61 | 0.4333 |
| USEINFO | 0.953 | 0.501 | 3.61 | 0.0573 |
| DGROSS | 0.006 | 0.001 | 17.51 | 0.0000 |
| LEVRATIO | -0.007 | 0.008 | 0.84 | 0.3598 |
| TOTALENT | 0.119 | 0.291 | 0.17 | 0.0760 |
| GOVTPMTS | 0.039 | 0.022 | 3.15 | 0.0760 |

Model Chi-Square = 35.31 with 7 degrees of freedom
Significance Level = 0.00001
Correct Prediction Ratio = 92.3%
Sensitivity = 8.0%
Specificity = 98.8%
False Positive Rate = 66.7%
False Negative Rate = 6.6%

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