What Drives *How Much* Crop Producers Sell in Spot, Forward, and Futures Markets?

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Abstract

Crop producers have numerous marketing and risk management tools available. Research relating producers' risk attitudes to their use of these tools has produced mixed results, and most studies focus on individual tools to the neglect of complementarities among them. Hence, little is known about the proportion in which these tools are used, e.g., the percentage of the crop that is forward sold as opposed to hedged. This study identifies some factors, including risk attitude, that impact the proportion of corn producers' sales through spot markets, futures and options, and forward and production contracts using complementary survey and accounting data.

Keywords: risk behavior, risk attitude, futures and options, forward contracts, production contracts.

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Crop producers have numerous marketing and risk management tools available. Research on producers' use of these tools has produced relevant but sometimes puzzling results. For instance, the role of risk aversion appears ambiguous, as some studies find a strong relationship between risk aversion and the use of risk management instruments while others do not (e.g., Pennings and Garcia 2001; Rabin and Thaler 2001). Most research has focused on relatively simple choices, such as whether to use futures and options contracts (Pennings and Leuthold 2000a) or crop insurance (Knight and Coble 1997), and few studies examine a broader array of marketing and risk management choices. While Pennings, et al. (2008) identify factors influencing the portfolio of marketing and risk management tools that producers adopt, less is known about how such factors influence the *proportion* in which these tools are used, e.g., the factors influencing the percentage of the crop that is forward sold as opposed to hedged. Other studies examine the *proportion* of crop sales made using a particular marketing method but offer little insight regarding how the use of one marketing tool influences the use of another (e.g., Shapiro and Brorsen 1988; Goodwin and Schroeder 1994; Musser, Patrick, and Eckman 1996; Sartwelle, O'Brien, Tierney, and Eggers 2000; Katchova and Miranda 2004).

This study identifies some factors, including risk attitude, that impact the *proportion* of corn and soybean producers' sales through spot markets, futures and options, forward contracts, and production contracts using complementary survey and accounting data. Secondary accounting data control for farm size and their financial state (e.g., debt structure), while primary survey data capture producers' age and risk attitude. We elicit risk attitude measures directly (Roe 1982), instead of computing indirect measures from observed behavior (e.g., Moscardi and de Janvery 1977; Antle 1987). Two main approaches to directly eliciting risk attitudes exist: measures derived from the expected utility framework and measures derived from responses to multi-item scales (c.f., Pennings and Garcia [2001] for a measure combining both approaches). We use the lower-cost multi-item scale approach and factor analysis (Hair et al. 1995) of producers' responses to limit measurement error of latent risk attitudes.

The remainder of the paper is organized as follows. The literature on crop producers' use of risk management and marketing tools is reviewed in the next section. Subsequently, sample representativeness and data collection are discussed in the research design section, followed by a description of the empirical methods. Next, empirical results are presented followed by a discussion of the findings and suggestions for future research.

Literature Review

The empirical literature pertaining to crop producers' use of marketing tools is reviewed in this section. Selected findings on the proportion of crops sold in studies discussed below are summarized in Table 1 to facilitate comparison with our own results as discussed later.

Shapiro and Brorsen (1988) used tobit models to examine the factors influencing 41 Indiana corn, soybean, and wheat producers' use of futures markets. Producers' perceptions of the ability of futures markets to increase and to stabilize income both had significantly positive effects, as did off-farm income, the debt-to-asset ratio, and farm acreage. Years of farming experience and formal education had significantly negative effects. The most important factors were perceptions regarding income stability, followed by the debt-to-asset ratio. Using similar data on 62 Indiana corn and soybean producers and tobit models, Musser, Patrick, and Eckman (1996) investigated the factors influencing the percentage of expected harvest that was forward priced using any type of marketing arrangement. The debt-to-asset ratio had a significantly positive impact on the maximum percentage of expected soybean production that producers would forward price, which is consistent with Shaprio and Brorsen's (1988) previous results. Age and education had significantly negative and positive effects, respectively, on the forward pricing of corn, as younger producers have more time to recover the costs of learning forward pricing methods and further education facilitates their use. Farm scale, as measured by gross income, had a significantly negative impact on the forward pricing of corn. Risk aversion toward losses had a significantly positive impact on the maximum percentage that producers would forward price for both corn and soybeans. Dummy variables for options/minimum-price contracts and for futures hedges generally had significantly positive impacts on forward pricing for both corn and soybeans, suggesting that joint portfolio effects may exist.

Goodwin and Schroeder (1994) used probit and tobit models to investigate factors influencing whether 509 Kansas producers forward price their output using futures and/or forward contracts and how much of it they forward price. In general, experience had a significantly negative effect on use of forward pricing and the proportion of output forward priced, while farm size in acres, education, the debt-to-asset ratio, and risk aversion had significantly positive effects. These variables all had similar effects on producers' attendance of marketing or risk management seminars which also significantly increased the probability of forward pricing and the proportion of output forward sold.

Sartwelle, O'Brien, Tierney, and Eggers (2000) used tobit and multinomial logit models to examine the factors that influence 351 Kansas, Texas, and Iowa grain producers' use of cash sales, forward contracts, and futures and options. Cash sales decreased and forward contracting increased significantly with farm size (i.e., crop acreage) in tobit regressions. A survey item regarding farm size relative to others in their region also significantly decreased cash sales in the tobit analysis and increased use of forward contracts and futures and options relative to cash sales in multinomial logit regressions. Both tobit and logit models indicated that use of futures and options decreased with experience in agriculture. Diversifying into livestock production increased cash sales and decreased forward contracting significantly in both analyses. Crop insurance increased use of forward contracts and futures and options and decreased cash sales significantly in both analyses. Their measure of risk attitude was statistically insignificant in all regressions.

Katchova and Miranda (2004) raised doubt about much of this prior research by identifying that previous results may have confounded explanatory variables' contract adoption effects with their influence on the quantity contracted. Using USDA ARMS data on corn, soybean, and wheat producers, the authors demonstrated that results of Tobit models performed on samples with observations of zero contracting are strongly influenced by and almost identical to the adoption decision, i.e., binary probit results.[1] Hurdle models explaining the proportion of crop contracted, the frequency of contracting, and contract type (i.e., forward or specialty marketing contract) conditional on contract adoption revealed few consistent impacts across commodities for the conditional or truncated regressions. In some cases the signs of significant effects were the opposite of those for Tobit regressions in their own work and in previous studies. Unfortunately, the study was unable to provide any insights into the impacts of risk aversion due to unavailability of measures in the ARMS dataset.

Identifying that crop producers utilize numerous combinations of marketing and risk management tools, Pennings, et al. (2008) employed multinomial logit analysis and a choice bracketing framework to investigate the factors that influence the portfolio of tools adopted. The sample consisted of commercial producers that subscribe to agricultural market information and advisory services from a US firm via satellite. At a broad bracketing level, adoption of forward pricing tools and crop insurance in combination was significantly more likely for younger producers, larger farms, and farms that had not diversified into livestock production. These variables were also important at medium bracketing levels that included forward pricing categories of exchange, exchange-derived, and non-exchange-derived instruments (i.e., futures and options, hedge-to-arrive and basis contracts, and forward contracts, respectively) and insurance categories of catastrophic, yield insurance, and revenue insurance products. Though essentially unimportant at broader bracketing levels, risk aversion mattered at the narrowest bracketing level for choices of combined use of futures and options and for choices of combined use of hail and other yield insurance products. While the study provided interesting insights into combinations in which marketing and risk management tools are adopted, it did not consider the proportion in which each tool in the portfolio was utilized.

Discussion of the Data Sample

A unique dataset was assembled by surveying a sample of crop producers, for which annual accounting and production records are kept through the University of Illinois Farm Business Farm Management (FBFM) Extension program. FBFM is a cooperative educational-service available to all agricultural producers in the state for a fee (Lattz, Cagley, and Raab 2005). The program is designed to assist producers with management decisions by providing business analysis through computer-assisted processing of records for income tax management. The secondary production and accounting data are collected annually by 58 full time field staff specialists serving nine FBFM associations.

Four rounds of pre-tests – two with FBFM personnel and two with producers – were performed. In each case, survey items were modified, eliminated, and added based on comments. One hundred fifty producers were contacted and as encouragement for their participation were offered a chance at one of ten $100 lottery prizes. Personal interviews, averaging just over an hour, limited the sample size but enhanced the reliability of responses. In total, 48 producers participated in the interviews from December 2006 through April 2007.

Since producers' use of marketing arrangements may vary from year to year, producers were asked to select from pre-defined ranges to approximate the percentage of their expected production that they sold using various marketing arrangements in marketing year 2006. Averages of these ranges are used here to construct the dependent variables. Since the respective minimum and maximum available responses were zero percent and greater than 75%, the resulting dependent variables are truncated with a minimum of zero percent and a maximum of 88% (= (75%+100%)/2). The marketing arrangements included categories of futures and options, forward contracts including hedge-to-arrive contracts, production contracts for seed and non-genetically modified crop production for instance, and a category for any proportion sold on the spot with no form of price protection.

Producers were asked to respond to a series of survey items previously validated by Pennings and Garcia (2001) for the construction of factor analytic measures of latent risk attitudes. Items were scaled negative four to positive four, so that negative numbers indicate risk-seeking, positive numbers indicate risk-aversion, and zero indicates risk-neutral. Producers responded to these items separately for corn and soybeans, so that separate risk attitude measures could be computed to correspond specifically to respective corn and soybean marketing contexts.

Cronbach's (1951) alphas exceeding 0.70, specifically 0.80 for corn and 0.79 for soybeans, indicate that the resulting risk attitude measures are highly reliable.

Representativeness and Summary Statistics

Presently, about one out of five Illinois commercial farms with over 500 acres or over $100,000 total farm sales participate. "(T)he data from recordkeeping farms may be used with reasonable confidence, even though the recordkeeping farms as a group do not represent a cross section of all commercial farms in the state" (Lattz, Cagley, and Raab 2005, p. 1). Consistent with prior research on producers participating in farm management associations (e.g., Goodwin and Schroeder 1994) and subscribing to advisory services (e.g., Pennings, et al. 2008), surveyed FBFM farms are larger and more commercial than typical US farms (Table 2). Relative to 2007 USDA Census data, the distribution of FBFM farms by size is also more similar to the sample obtained by Pennings, et al. (2008). Producers in our sample range in age from 39 to 76 with a mean of 55 and a standard deviation of about 8 years. About 33% have completed four or more years of college, 38% have completed some college, and 29% have complete only high school. Mean education levels are about 14 years in Shapiro and Brorsen (1988) and in Goodwin and Schroeder (1994) and 15years in Musser, Patrick and Eckman (1996). The debt-to-asset ratio for producers in our sample ranges from one percent to 69% with a mean of 24% and a standard deviation of about 16%, which suggests degrees of leverage that are similar to Shapiro and Brorsen's (1988) and Musser, Patrick and Eckman's (1996) samples. As in prior research (e.g., Shapiro and Brorsen 1988; Pennings, et al. 2008), the majority of producers in our sample are risk-averse with respect to both corn (59%) and soybean (58%), and the average producers is moderately risk-averse.

Surveyed FBFM producers' use of contracts is also more representative of large commercial producers than it is of typical US producers (Table 3). In the USDA-ARMS dataset analyzed by Katchova and Miranda (2004), only 12% of corn producers, 8% of soybean producers, and 5% of wheat producers use *marketing* contracts including flat or fixed price, formula pricing, delayed price, minimum price, fixed basis, futures fixed, and other contracts. By comparison, of the 48 producers in our sample raising corn (soybeans), about 42% (40%) use futures and options, 88% (83%) use forward contracts, 33% (31%) use hedge-to-arrive contracts, 10% (25%) use production contracts. Similarly, in the sample studied by Pennings, et al. (2008), about 40% of producers use futures, 37% use options, 82% use forward contract, and 21% use hedge-to-arrive contracts. Though adoption rates are somewhat lower in Goodwin and Schroeder (1994), producers using contracts in their study market similar proportions of output using those contracts as in our sample. Specifically, producers using the respective contracts to market corn (soybeans) in our sample make 36% (32%) of sales using futures and options, 43% (40%) using forward contracts, and 29% (35%) using production contracts. Producers using the respective contracts to market corn (soybeans) in Goodwin and Schroeder (1994) make 34% (29%) of sales using futures, 29% (37%) using options, and 37% (33%) using forward contracts.

Empirical Methods

Several studies investigating determinants of the proportion of a crop contracted have employed Tobit procedures (e.g., Shapiro and Brorsen 1988; Goodwin and Schroeder 1994; Musser, Patrick and Eckman 1996). The log-likelihood for the Tobit model contains probabilities of nonuse of contracts from a Probit regression in the first term and a classical regression for positive amounts contracted in the second term:

$$\ln L = \sum_{\alpha_i=0} \ln \Phi\left(-\frac{\beta'_\alpha x_i}{\sigma}\right) + \sum_{\alpha_i>0} \ln\left[\frac{1}{\sigma}\phi\left(\frac{\alpha_i - \beta'_\alpha x_i}{\sigma}\right)\right], \tag{1}$$

where Φ(•) is the standard normal probability density function, $\mathbf{x}_i$ and β_α are vectors of independent variables and coefficients, σ is the standard deviation, and α_i denotes the proportion contracted.[2] Following Katchova and Miranda (2004), α_i is not constrained from above since a producer conceivably may contract more than his actual *ex post* production. Under the Tobit formulation, the independent variables and associated coefficients are constrained to be the same for the contract adoption and proportion contracted decisions. Cragg's (1971) less restrictive hurdle or two-step model does not require the variables and coefficients for both decisions to be the same. The log-likelihood is the sum of the log-likelihood of a Probit regression (the first two terms) and the log-likelihood of a truncated regression (the second two terms) and is given by

$$\ln L = \sum_{c_i=0} \ln \Phi(-\gamma' z_i) + \sum_{\alpha_i>0} \left\{ \ln \Phi(\gamma' z_i) + \ln\left[\frac{1}{\sigma}\phi\left(\frac{\alpha_i - \beta'_\alpha x_i}{\sigma}\right)\right] - \ln \Phi\left(\frac{\beta'_\alpha x_i}{\sigma}\right)\right\}, \tag{2}$$

where $\mathbf{z}_i$ and γ are vectors of independent variables and coefficients pertaining to contract adoption and, and as before, $\mathbf{x}_i$ and β_i are vectors of independent variables and coefficients pertaining to the proportion contracted. When $\mathbf{z}_i = \mathbf{x}_i$ and $\gamma = \beta_\alpha/\sigma$, these models are equivalent.

Empirical Results

Marginal effects for Tobit and hurdle models of spot market, futures and options, and forward contract, usage are reported in Tables 4 through 6. Corresponding model results are presented for production contracting of soybeans in Table 7. As only four production contracts for corn exist in our dataset, this aspect of corn marketing could not be modeled. Two-limit or double-censored Tobit regressions are useful when several observations exist at upper as well as lower limits of the dependent variable (Goodwin and Schroeder 1994; Sartwelle, O'Brien, Tierney, and Eggers 2000). Following Katchova and Miranda (2004), we compare the results of Tobit models censored only at zero and hurdle models, since we surveyed producers on the proportion of expected production that was contracted which conceivably may exceed the realized production. Particularly, in the case of futures and options, quantities contracted may exceed expected production due to speculative behavior (Musser, Patrick and Eckman 1996). Two-limit Tobit regressions yield results that are qualitatively similar to the Tobit regression results presented here and are available from the authors upon request.

Unlike Katchova and Miranda's (2004) analysis, where Tobit results appeared to be driven by the binary Probit results for contract adoption, the Tobit models presented here are mostly consistent with the truncated regression results for the proportion contracted in hurdle models. For forward contracting regressions, this consistency likely reflects that most producers use forward contracts, and hence, there are so few zero observations that Tobit models are unlikely to confound adoption effects with independent variables' effects on the proportion contracted (Table 6). In fact, binary Probit regressions are unable to detect significant effects for soybean forward contracting and are infeasible for corn forward contracting due to the limited number of zero observations. The potential value of the hurdle approach is apparent, though, as certain variables at times have opposite effects on the adoption and proportion decisions. No instance exists, however, in which the opposing effects are both statistically different from zero. The significantly positive marginal effect of education on the adoption of corn futures and options and the insignificantly negative marginal effect on the proportion of the crop for which they are used is an example (Table 5). For simplicity, the remainder of the discussion focuses on the hurdle model results unless otherwise indicated.

Spot regressions suggest that for each additional year of age, a producer will sell about one to two percent more soybeans in spot markets (Table 4). The marginal effect in the truncated regression for corn is of similar magnitude and nearly significant (*p-value* = 0.108). Age also decreases the adoption of futures and options significantly for soybeans and nearly significantly for corn (*p-value* = 0.106) and significantly decreases the proportion of soybeans sold using forward and production contracts (Tables 5, 6, and 7). The results for futures and options adoption are consistent with the findings of Musser, Patrick, and Eckman (1996), who argued that older producers have less time before retirement to recover the learning and adjustment costs associated with risk management instruments, and hence, are less likely to adopt them. Shapiro and Brorsen (1988) and Goodwin and Schroeder (1994) find similar negative effects for experience on the proportion forward priced and the proportion hedged, respectively.

Producers possessing Bachelor of Science degrees sell about 19% and 21% less corn and soybeans in spot markets (Table 4) and about 19% and 36% more corn and soybeans using forward contracts (Table 6) than those that had not completed a four-year degree. Education also has a significantly positive influence on the proportion of soybeans sold on production contracts (Table 7). The results are consistent with prior findings for education's impact on the proportion forward priced using various types of contracts (e.g., Goodwin and Schroeder 1994; Musser, Patrick, and Eckman 1996). Shapiro and Brorsen (1988) find that education has a significantly negative effect, however, in the specific context of the proportion hedged with futures.

Intuitively, as risk aversion increases, spot sales of soybeans decrease and forward contracting of corn and soybeans increases significantly (Tables 4 and 6). Risk aversion also significantly increases the proportion of soybeans sold on production contracts (Table 7). Unexpectedly, risk attitude has a statistically insignificant effect on the use of futures and options

(Table 5). The result may reflect that motivations for hedging other than risk aversion may exist, as identified by Pennings and Leuthold (2000b). Consistent with Shapiro and Brorsen (1988) and Musser, Patrick, and Eckman (1996), higher debt-to-asset ratios significantly increase the proportional use of futures and options, as relatively more leveraged producers likely use these tools to ensure stable cash flows to repay debt. The same logic should apply to forward contract use but does not show up statistically.

Complementarity and substitutability of risk management and marketing tools are relatively under-examined aspects of crop marketing. By including alternative contracting mechanisms as explanatory variables in regressions, we are able to ascertain such effects. The results suggest that producers may substitute forward contracts for futures and options and that forward contracts complement production contracts better than futures and options. Specifically, forward contracting corn significantly decreases the proportional use of futures and options (Table 5), and forward contracting and futures and options use, respectively increase and decrease the proportion of soybeans sold on production contracts significantly (Table 7). Discussions with surveyed producers provide insight on these results. Production contracts often specify a premium over the cash price for carrying out some special activity (e.g., raising seed or non-genetically modified crops or identity preservation), and give the buyer the right to call for quantities of grain, often stored on-farm, as needed. This uncertainty regarding the timing of delivery is not conducive to the use of futures and options, and hence, some production contracts offer the opportunity to forward price a portion of the secured grain based on current futures market prices.

Discussion and Conclusions

Most research on crop marketing and risk management either focus on one aspect of the process such as hedging (e.g., Shapiro and Brorsen 1988) or analyze aggregate contracting variables (e.g., proportion forward priced) that cannot distinguish differential effects of producer characteristics on different contracts or capture potential complementarities among them (e.g., Goodwin and Schroeder 1994; Musser, Patrick, and Eckman 1996; Katchova and Miranda 2004). Pennings, et al. (2008) identify factors influencing the portfolio of marketing and risk management tools that producers adopt but do not address how such factors influence the proportion in which these tools are used.

This study investigates the factors influencing Illinois corn and soybean producers' proportional use of futures and options, forward contracts including hedge-to-arrive contracts, production contracts, and spot sales without price protection. Like in several earlier studies, these producers participate in a university extension farm management program and are representative of large commercial producers. Following Katchova and Miranda (2004), we employ Cragg's (1971) hurdle model, which may be more appropriate than commonly used Tobit procedures if producers' marketing practices reflect separate decision processes of adopting a marketing method first and choosing the quantity marketed under that method second.

Interestingly, our results are largely consistent with prior research. Consistent with earlier findings for producers' age (Musser, Patrick, and Eckman 1996) and experience (Shapiro and Brorsen1988; Goodwin and Schroeder 1994), older producers are less likely to adopt futures and options and sell relatively less using forward and production contracts and more using spot markets. Consistent with Goodwin and Schroeder (1994) and Musser, Patrick, and Eckman (1996), higher education significantly increases the proportion of the crop forward contracted.

Shapiro and Brorsen (1988) and Musser, Patrick, and Eckman (1996) respectively find that the proportion of the crop hedged and the proportion forward priced increase with the debt-to-asset ratio, which may reflect needs for steady cash flows to repay debt. This variable significantly increases the proportion sold using futures and options but not forward contracts in our results. Alternatively, the positive relationship may reflect increasing debt to maintain margins in futures accounts. Intuitively, increasing risk aversion decreases spot sales and increases the proportion sold using forward and production contracts but has no impact on futures and options usage which may reflect that motivations for hedging other than risk aversion may exist (Pennings and Leuthold 2000b). The results are also consistent with complementarity among forward and production contracting and may reflect some degree of substitutability between forward contracts and futures and options.

Using a unique combination of survey and accounting data, this study detects significant effects despite a limited sample size. A larger sample size would permit a multinomial Logit analysis of producers' portfolios of marketing and risk management tools, like in Pennings, et al. (2008), that would greatly complement the analysis presented here. While the categories of marketing methods considered in this study are more disaggregated than in prior research, further disaggregation could be informative. The futures and options category could be broken apart into separate futures and options categories or into categories for hedging and speculation. The forward contracting category could also be split into cash forward sales and hedge-to-arrive contract categories. Each of these points appears to be fruitful avenues for future research.

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[1] Subsequently, Katchova and Miranda (2004) performed three hurdle models per commodity to explain the proportion contracted, the frequency of contracting, and the contract type (i.e., forward or specialty marketing contract), where the models estimated respectively truncated tobit, truncated count (i.e., poisson), and binomial logit regressions conditional on a binary contract adoption choice (i.e., probit).

[2] The proportion contracted α_i equals the latent variable α_i^* for $\alpha_i^* = \beta_\alpha' X_i + \varepsilon_{\alpha i} > 0$ and equals zero otherwise, where $\varepsilon_{\alpha i}$ are independently and normally distributed residuals with mean zero and variance σ^2.

Table 1. Selected Results for the Proportion of Crops Sold in Previous Studies.

	Shapiro and Brorsen (1988)	Goodwin and Schroeder (1994)	Musser, Patrick, and Eckman (1996)	Sartwelle, O'Brien, Tierney, and Eggers (2000)			Katchova and Miranda (2004)
Dependent Variable	Percent hedged using futures	Percent forward and futures	Percent forward priced	Percent cash sales	Percent forward contracted	Percent futures and options	Percent sold with *marketing contracts*[a]
Age	–	–	< 0, C	–	–	–	0
Experience	< 0	0	–	0	0	< 0	–
Education	< 0	> 0, C, S	> 0, C	–	–	–	0
Risk Aversion	0	0	> 0, C, S	0	0	0	–
Debt/Asset	> 0	0	> 0, S	–	–	–	0
Acres	> 0	> 0, C, S	–	< 0	> 0	0	–
Gross Income (size)	–	–	< 0, C	–	–	–	> 0, C
Futures Hedging	–	–	> 0, C, S	–	–	–	< 0, S
Forward Contracting	0	–	–	–	–	–	–
Crop Insurance	0	0	–	< 0	> 0	> 0	0
R^2	0.84	–	–	0.17	0.16	0.19	–
N	41	171, C, 238, S	43 & 53, C 45& 54, S [b]	351	351	351	503, C, 335, S

Note: C denotes corn and S denotes soybeans. > 0 denotes statistically positive effects, < 0 denotes statistically negative effects, and 0 denotes effects that are not statistically different from zero. – indicates that the variable was not included in the analysis. N denotes sample size.

[a] In this study, *marketing contracts* is an aggregate variable including categories of forward contracts that either set a price or tie it to futures markets and other specialty marketing contracts (e.g., seed, non-GM, identity-preserved).

[b] Sample sizes correspond to Musser, Patrick, and Eckman's (1996) analyses of the percentage of expected production forward priced by July 15, 1993 and the maximum percentage of expected production forward priced by August 1 for corn and soybeans respectively.

Table 2. Representativeness of Sample in terms of Size, Returns, and Operator Age.

	2006 FBFM	2007 Census		Pennings et al. (2008)	
Distribution of Farms by Size	Surveyed Producers	Farms with Harvested Cropland		Corn	Soybeans
Over 2,000 acres	8.33%	4.98%		4.50%	2.90%
1,000 to 1,999 acres	35.42%	5.94%		58.60%	45.10%
500 to 999 acres	35.42%	9.12%		7.90%	14.40%
Under 499 acres	20.83%	79.96%		9.80%	14.50%
Mean Statistics		Corn	Soybeans		
Size (acres)	1,044	745	731	1,500 to 1,999 range	
Producer Age	55	55	56	40 to 44 range	
Market Value of Products Sold	$417,260[a]	$335,767	$322,157	–	–
Crop Returns Per Acre[b]	$488.94	$467.61	$254.84	–	–

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2007 Census of Agriculture, available at http://www.agcensus.usda.gov/Publications/2007/Full_Report/usv1.pdf

[a] Total crop returns for FBFM producers.

[b] http://www.ers.usda.gov/Data/CostsAndReturns/testpick.htm

Table 3. Representativeness of Sample in terms of Contract Use.

	Our FBFM Sample (2006)			Pennings et al. (2008)	Goodwin & Schroeder (1994)	
	Corn	Soybean		Crop[a]	Corn	Soybeans
Portion of Producers Adopting						
Futures & Options	41.67%	39.58%	Futures:	40.4%	10.73%	5.22%
			Options:	37.0%	9.6%	4.42%
Forward Contracts	87.50%	83.33%		82.20%	34.46%	30.92%
Hedge-to-Arrive	33.33%	31.25%		20.60%	–	–
Production Contracts	10.42%	25.00%		–	–	–
Portion of Crop Contracted by Contracting Producers						
Futures & Options	36.25%	31.68%	Futures:	–	33.84%	28.65%
			Options:	–	29.24%	36.59%
Forward Contracts	43.11%	39.82%		–	37.18%	33.27%
Production Contracts	29.00%	34.67%		–	–	–

Pennings, J.M.E., O. Isengildina-Massa, S.H. Irwin, P. Garcia, and D.L. Good. 2008. "Producers' Complex Risk Management Choices." *Agribusiness: An International Journal* 24,(1):31-54.

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(November):936-947

Table 4. Marginal Effects for Spot Regressions.

	Corn			Soybeans		
		Hurdle Model			Hurdle Model	
		Binary	Truncated		Binary	Truncated
	Tobit	Probit	OLS	Tobit	Probit	OLS
AGE	0.0071	-0.0021	0.0108	0.0085*	-0.0037	0.0154***
	(0.0050)	(0.0046)	(0.0067)	(0.0051)	(0.0049)	(0.0054)
EDUCATION	-0.1272	-0.0135	-0.1870*	-0.1629**	-0.0185	-0.2127***
	(0.0798)	(0.0823)	(0.1108)	(0.0822)	(0.0826)	(0.0820)
ACRES	3.28×10^{-5}	0.0001	-0.0001	0.0000	3.98×10^{-5}	0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
DEBT/ASSET	-0.0036	-0.0036	-0.0013	-0.0042	-0.0053*	0.0025
	(0.0027)	(0.0024)	(0.0040)	(0.0029)	(0.0031)	(0.0033)
RISK ATTITUDE	-0.0608	-0.0287	-0.0649	-0.0988***	-0.0341	-0.0768**
	(0.0371)	(0.0352)	(0.0512)	(0.0384)	(0.0361)	(0.0393)
Sigma	0.3796	–	0.2691	0.2572	–	0.2262
	(0.0663)		(0.0445)	(0.0285)		(0.0301)
Observations	48	48	44	48	48	43
Censored	4 at 0%	–	–	5 at 0%	–	–
Log Likelihood	-5.9327	-11.2983	7.7303	-8.0250	-10.7690	7.6800

Asterisk (*), double asterisk (**), and triple asterisk (***) denote significance at 10%, 5%, and 1%, respectively.

Table 5. Marginal Effects for Futures and Options Regressions.

	Corn			Soybeans		
		Hurdle Model			Hurdle Model	
		Binary	Truncated		Binary	Truncated
	Tobit	Probit	OLS	Tobit	Probit	OLS
AGE	-0.0189*	-0.0188	-0.0110	-0.0183*	-0.0216*	-0.0071
	(0.0111)	(0.0116)	(0.0102)	(0.0109)	(0.0115)	(0.0130)
EDUCATION	0.1591	0.3014*	-0.1551	0.1804	0.2795	0.0196
	(0.1699)	(0.1746)	(0.1471)	(0.1599)	(0.1793)	(0.1853)
ACRES	3.10×10^{-5}	3.05×10^{-5}	-0.0001	-0.0001	2.14×10^{-5}	-0.0002
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)
DEBT/ASSET	0.0096*	0.0064	0.0104**	0.0110**	0.0041	0.0205***
	(0.0053)	(0.0055)	(0.0045)	(0.0048)	(0.0051)	(0.0058)
RISK ATTITUDE	-0.0316	-0.0287	-0.0149	-0.0212	0.0171	-0.0624
	(0.0801)	(0.0850)	(0.0700)	(0.0757)	(0.0815)	(0.0863)
FORWARDCONRACT	-0.4605	-0.2637	-0.6821**	-0.3794	-0.3411	-0.3782
	(0.3453)	(0.3578)	(0.3470)	(0.3073)	(0.3361)	(0.3614)
PRODCONTRACT	–	–	–	-1.3953	-1.3413	-0.0422
				(1.1673)	(1.0293)	(1.7423)
Sigma	0.4104	–	0.2115	0.3624	–	0.2141
	(0.0727)		(0.0472)	(0.0648)		(0.0553)
Observations	48	48	20	48	48	19
Censored	28 at 0%	–	–	29 at 0%	–	–
Log Likelihood	-25.3969	-27.9637	8.7183	-20.9676	-26.0669	10.4305

Asterisk (*), double asterisk (**), and triple asterisk (***) denote significance at 10%, 5%, and 1%, respectively.

Table 6. Marginal Effects for Forward Contract Regressions.

	Corn			Soybeans		
		Hurdle Model			Hurdle Model	
		Binary	Truncated		Binary	Truncated
	Tobit	Probit	OLS	Tobit	Probit	OLS
AGE	-0.0053	–	-0.0071	-0.0100**	3.39×10^{-5}	-0.0205**
	(0.0041)		(0.0052)	(0.0044)	(0.0002)	(0.0081)
EDUCATION	0.1731***	–	0.1918**	0.2205***	0.0002	0.3640***
	(0.0662)		(0.0825)	(0.0719)	(0.0015)	(0.1149)
ACRES	0.0001	–	0.0001*	0.0001*	8.53×10^{-7}	0.0001
	(0.0001)		(0.0001)	(0.0001)	(1.00×10^{-5})	(0.0001)
DEBT/ASSET	-0.0010	–	-0.0017	0.0011	0.0001	0.0000
	(0.0023)		(0.0027)	(0.0026)	(0.0004)	(0.0033)
RISK ATTITUDE	0.0869***	–	0.0906**	0.0840**	0.0003	0.1289**
	(0.0309)		(0.0397)	(0.0344)	(0.0021)	(0.0523)
FUTURES&OPTIONS	-0.1912	–	-0.2752	-0.0789	-0.0017	-0.1225
	(0.1363)		(0.1758)	(0.1586)	(0.0102)	(0.2147)
PRODCONTRACT	-0.2837	–	-0.3838	0.3123**	–	0.3733**
	(0.2931)		(0.3657)	(0.1529)		(0.1868)
Sigma	0.2053	–	0.227	0.2196	–	0.2413
	(0.0213)		(0.0296)	(0.0237)		(0.0363)
Observations	48	48	47	48	48	44
Censored	1at 0%	–	–	4 at 0%	–	–
Log Likelihood	6.6345	–	11.3290	0.8267	-6.9045	13.5075

Asterisk (*), double asterisk (**), and triple asterisk (***) denote significance at 10%, 5%, and 1%, respectively.

Table 7. Marginal Effects for Production Contract Regressions.

	Corn			Soybeans		
		Hurdle Model			Hurdle Model	
		Binary	Truncated		Binary	Truncated
	Tobit	Probit	OLS	Tobit	Probit	OLS
AGE	-0.0088	–	–	0.0037	-0.0017	-0.0178***
	(0.0192)			(0.0151)	(0.0084)	(0.0035)
EDUCATION	-0.1027	–	–	0.1276	0.0294	0.4185***
	(0.3070)			(0.2722)	(0.1498)	(0.0561)
ACRES	0.0003	–	–	0.0002	0.0001	0.0001***
	(0.0002)			(0.0002)	(0.0001)	(0.0000)
DEBT/ASSET	-0.0021	–	–	-0.0034	0.0002	-0.0218***
	(0.0097)			(0.0086)	(0.0046)	(0.0025)
RISK ATTITUDE	0.0877	–	–	0.1448	0.0915	0.2009***
	(0.1429)			(0.1280)	(0.0677)	(0.0237)
FORWARDCONRACT	–	–	–	0.2714	-0.1361	0.7492***
				(0.4787)	(0.2740)	(0.0821)
FUTURES&OPTIONS	–	–	–	-1.2908	-0.7447*	-0.5881***
				(1.0112)	(0.4436)	(0.2211)
Sigma	0.5136	–	–	0.5236	–	0.0415
	(0.2000)			(0.1247)		(0.0087)
Observations	48	48	5	48	48	12
Censored	43 at 0%	–	–	36 at 0%	–	–
Log Likelihood	-13.1180	–	–	-22.5920	-23.0915	22.3076

Asterisk (*), double asterisk (**), and triple asterisk (***) denote significance at 10%, 5%, and 1%, respectively.