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Believing Yourself: Perceived Risk Taking and Risk Management Decisions of Texas Cotton Farmers

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Abstract

Farmers have to assess the level of risk and choose the risk management tool(s) that sufficiently reduce the negative financial effects that result from risk, according to his or her risk preference. In these articles, we evaluate the subjective perception of risk held by Texas cotton farmers relative to a quantitative assessment of the risk they face and identify the variables that affect the risk perception. Our study shows that a farmer's willingness to accept risk is primarily influenced by the sources of information they use, their level education, and their non-farm income. There is heterogeneity in risk management decisions even within groups that share similar risk perceptions.

Keywords: Risk Perception, Willingness to Accept Risk, Cotton

JEL Codes: D83, G22, Q18, Q14

Believing Yourself: Perceived Risk Taking and Risk Management Decisions of Texas Cotton Farmers

In agriculture, risk stems from a multitude of sources, not all of which can be controlled, so risk management is an essential element of the farmer's decision making process. The challenge that a farmer faces when making risk management decisions is two-fold. First, the farmer must assess the level of risk he or she faces. This is done through both a subjective assessment by the farmer and through quantitative assessments provided by experts. Then, the farmer must choose the risk management tool(s) that sufficiently reduce the negative financial effects that result from risk, according to his or her risk preference. The linkage between the risk assessment, the risk preference of the farmer, and the risk management decision has been the focus of many studies; however, these studies tend to focus on the impact of the either the quantitative assessment of risk or the subjective assessment by the farmer but not both of these factors at the same time.

The literature on risk management decision making in agriculture can be summarized into three general areas. The first area focuses on analyzing the demand for crop insurance utilizing information about crop yield, price risk, and indemnity expectation (Goodwin, 1993; Coble, et al., 1996). The second area focuses on the assessment of risk preference and the associated risk management decisions (Moschini and Hennessy, 2001; Tomek, and Peterson, 2001.). The third area compares the risk management decision to the attributes of the insurance product and of the decision maker (Sherrick, et al., 2004; Luitel, Hudson, and Knight, 2015). To date there have been no studies that explicitly connect the farmer's subjective evaluation of risk to their risk management decision, but there have been studies that identify the factors that might impact subjective risk assessment.

First, an individual might evaluate risk according to his or her general perception of risk. Renn (2004) identifies 5 possible perception models through which an individual might view risk: risk as a fatal threat, as fate, as a test of strength, as a game of chance, and as an early warning indicator. Each of these different perceptions might lead a farmer to make different risk management decisions, regardless of how risky his or her situation is according to an objective assessment. The implication is that any effort to link risk assessment to decision making should consider the farmer's subjective assessment of risk along with quantitative assessments.

Second, how an individual assesses risk might depend on socio-demographic variables. The criteria used to assess risk are practically universal across peoples and cultures; however, the relative weight placed on each criterion and the risk tolerance of the individual can vary significantly (Renn and Rohrmann, 2000). Furthermore, while there is general agreement that farmers are risk averse, there are still mixed opinions on how exactly socio-demographic variables influence risk preference (Botterill and Mazur, 2004). Comparing a farmer's risk perception and risk management decisions to those of his or her neighbors may shed some light onto how socio-demographic variables impact the farmer's subjective risk assessment.

Finally, an individual's perception of risk, and the correlation between risk perception and risk management decisions, may be informed by context and past experience (Greiner, Patterson, and Miller, 2009). A farmer may be more inclined to make risk management decisions based on their previous experience with a risky situation or a risk management tool than on a quantitative assessment from an outside source. Again, if this is so then the farmer's subjective assessment of risk should be considered alongside quantitative risk assessments when studying risk management decisions.

Quantitative assessments of risk are an important part of effective risk management decision making; however, it is also clear that subjective assessments by the decision maker may also affect risk management decisions. It may also be the case that when the subjective risk assessment differs from the quantitative assessment that the risk management decision may differ from the decision suggested by models that consider the quantitative assessment only.

To better understand how subjective risk assessment is conducted and to understand how subjective assessments might change the risk management decision this study has two objectives. First, we evaluate the subjective perception of risk held by Texas cotton farmers relative to a quantitative assessment of the risk they face. Cotton production on Texas is a risky enterprise relative to other crops and locations in the US due to multiyear droughts and uncertainty surrounding the amount of water available for irrigation; therefore, farmers in Texas who chose to grow cotton must evaluate the risk they face and choose a set of tools to manage that risk.

Our second objective is to identify the variables that affect the risk perception for this group under two scenarios: one in which the subjective and quantitative risk profiles are consistent and one in which the subjective and quantitative profiles differ. We assume that from the farmer's perspective the risk assessment includes the riskiness of their crop yield, prices, and other variables. We also assume that the farmer's perception of risk is influenced by their peers'/neighbors' relative risk profiles and risk management decision.

Theoretical Concept and Estimation Procedure

In this study we are analyzing the factors that influence the farmer's subjective risk assessment and the relationship between this assessment and the farmer's risk management decision. When analyzing risk management decisions we normally assume that a farmer is a rational being with perfect information. These assumptions imply that the farmer evaluates all possible risk

management alternatives with the goal to achieve the largest possible payoff, and the farmer's decision can be described using expected utility theory. However, when the farmer faces imperfect information about a risky enterprise their risk management decision may be influenced by their overall perception of the risk involved rather than a rational thought process.

Miron (2007) describes an individual's perception of risk as a function of the individual's own knowledge about their situation, background knowledge provided by other sources, and the individual's expectations for the future. For a farmer making a risk management decision, own knowledge might include information about the size of the farm and the amount of non-farm income the farmer earns. The own knowledge also affects the farmer's expectations about the future, their subjective assessment of risk, and their risk management decision might be influenced by the farmer's level of education and the level of previous farming experience he or she possesses.

A farmer's background knowledge may come from the information provided in a quantitative assessment of risk; however, it may also come from the farmer observing the decisions of his or her neighbors. In other words, a farmer might analyze their neighbor's risk management decisions and the returns on those decisions to develop their own subjective assessment of risk. Furthermore, a farmer may choose what level of coverage to purchase by evaluating his or her level of risk aversion relative to their neighbors. In this decision making framework, if a farmer sees themselves as more risk averse than their neighbor it is likely that the farmer will choose to purchase a higher level of coverage than their neighbor, regardless of how risky their situation actually is. If a farmer believes that he or she is less risk averse than their neighbor then it is more likely the farmer will choose to purchase a lower level of coverage than their neighbor.

As we are in the preliminary stage of this study, we use an ordered logistic model to analyze the farmer's perception of risk. Using this model may not result in a consistent estimation of parameters due to the logistic distribution assumption (Greene, 2003); however, this model gives insight into the various factors influencing the farmer's risk perception. The estimated model has following function form:

$$\text{Prob (choice =j)} = \beta_0 + \beta_1 (\text{Source of information}) + \beta_2 (\text{Non-Farm income \%}) + \beta_3 (\text{Borrowed \%}) + \beta_4 (\text{Education}) + \beta_5 (\text{Years of Farming}) + \beta_6 (\text{Total Acres}) + \beta_7 (\text{CCIP 2014 Coverage Level}) + \beta_8 (\text{coefficient of Variance of Irrigated Cotton}) + \beta_9 (\text{coefficient of Variance of Non-Irrigated Cotton}) + \varepsilon.$$

Descriptive statistics for the variables used in the model can be found in Table 1. The choice parameter j represents a farmer's willingness to take on risk relative to their neighbor's. When surveyed about their perceived willingness to take on risk relative to their peers farmers gave their responses on a 1 to 5 scale where 1 is less willing to accept risk and 5 is more willing to take risk. However, in order to simply the interpretation, we transformed the 5 categories of risk perception into 3 category variables. That is, the risk perception variable is equal to 1 if the farmer's response was less than 3, equal to 2 if the farmer's response was exactly 3, and equal to 3 if the farmer's response was more than 3.

A farmer's ability to assess risk is determined in part by his or her level of education and experience with farming. Education is measured in the model on a scale with 3 levels where a response of 1 indicates the farmer has a high school level of education or less, a response of 2 indicates that the farmer has either some college level education or an undergraduate degree and a response of 3 indicates that the farmer has earned either a graduate or professional degree. Farming experience is measured using the number of years that the respondent has farmed.

To provide a quantitative assessment of risk we use the yield coefficient of variation for irrigated and non-irrigated cotton. The mean and variance for cotton yield were estimated using subjective yield distribution information elicited from farmers using the PERT method (Davidson, and Cooper 1976).

The farmer's choice of crop insurance product and coverage level is used as a proxy for the farmer's risk management decision. As the Agricultural Act of 2014 was not implemented in 2014 crop year, we use the farmer's Common Crop Insurance Policy (CCIP) coverage level of 2014.

A farmer's source of information about crop insurance options is an important variable in the risk management decision making process. Farmers were surveyed about their use of many such sources of information (FSA office, Insurance Agent, Extension office or farm agency, Private Contacts, None, Others (Specify)), but most farmers seemed to use their crop insurance agent as their primary source of information. For this reason, the Source of Information variable was transformed into a dummy variable for insurance agent when the model was estimated.

Other variables of interest in the model include the size of the farm, the amount that the farmer has borrowed in loans, and the farmer's nonfarm income. The level of debt and the level of nonfarm income are measured as a percentage (i.e. between 0 and 1) of total investment and total household income, respectively. The size of the farm is measured using the farmer's total acres of cropland transformed to a logarithmic scale.

Data Description and Results

The data for this study was collected through a survey mailed to 4,000 randomly selected Texas subscribers to the magazine *Cotton Grower*. Subscribers to this magazine do not necessarily currently farm cotton. We received 270 total responses representing 69 Texas counties, which is

about 44% of the counties farming cotton in Texas according to the USDA's Risk Management Agency (RMA). Among these responses 163 indicated that the farmer was involved in irrigated cotton production and 255 indicated that the farmer was involved in non-irrigated production. Because some surveys were returned with omitted responses to other questions we received 212 usable responses.

Table 1. Descriptive statistics

Variable	Mean	Std Dev	Minimum	Maximum
Risk perception (1=less risk averse 2=risk averse, 3= high risk averse)	2.17	0.69	1	3
Source of Information 1=insurance agent, 0= others	0.90	0.30	0	1
Education (1= high school 2=college, 3= graduate)	2.04	0.72	1	3
CCIP 2014 Coverage level	66.12	5.75	50	75
Non-farm income Percent	0.22	0.26	0	1
Borrowed percent	0.54	0.38	0	1
Years of Farming	32.93	12.94	3	65
Log of total acres	7.53	0.80	5.30	9.31
Coefficient of variance of irrigated cotton	0.26	0.08	0.09	0.59
Coefficient of variance of non-irrigated cotton	0.39	0.12	0	0.80

Most (97%) of the survey respondents were male. About 23% of all respondents had a high school level of education or less, 50% had completed some college or had finished an undergraduate degree, and 26% had completed a graduate or professional degree. The level of nonfarm income reported by respondents was heterogeneous with the average nonfarm income making up about 21% of total household income with a standard deviation of 26%.

The majority of the farmers surveyed chose to purchase revenue protection crop insurance in 2014. Since there is very little variation in the choice of crop insurance we use the level of coverage chosen by the farmer as a proxy for their risk management decision. About 42% of the respondents selected a coverage level of 65% in 2014, about 19% of respondents

selected a coverage level lower than 65%, and about 39% selected a coverage level higher than 65%.

About 57% of the farmers who responded to the survey made risk management decisions that were consistent with their perceived risk preference. In other words, if the farmers reported themselves as moderately risk averse they chose the average coverage level of 65%, if they reported themselves as highly risk averse they chose a coverage level greater than 65%, and if they reported themselves as having low risk aversion they chose a coverage level less than 65%. The other 43% of respondents could not be identified as having higher or lower than average risk aversion because their willingness to accept risk and their CCIP coverage level choice were not consistent.

Descriptive statistics for farmers with low, moderate, and high risk aversion are reported in Tables 2 and 3. The level of coverage was similar across all three groups. In general, a higher level of education, a larger farm size, and a lower level of nonfarm income are associated with a higher willingness to accept risk. Respondents who indicated a higher willing to accept risk also appear to use more sources of information than respondents with a lower willingness to accept risk. Neither the farmer's experience, the amount the farmer has borrowed, nor the risk associated with farming show a clear association with the farmer's risk preference.

The coefficients for the estimated model are presented in Table 4. Each coefficient represents the effect that a change in the independent variable has on the probability that a farmer will have a lower or higher willingness to accept risk with the highest level of risk aversion acting as the base scenario. The results show that all of the explanatory variables except borrowed percentage and years of farming years are significant at least at the 17% level of significance. The source of information and log of total acres are significant at 5% level.

Table 2. Descriptive statistics of three different risk preference variables across other variables

	Risk Perception level 1(accept lowest risk)		Risk Perception level 2(accept moderate risk)		Risk Perception level 3(accept highest risk)	
Variable	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Non- Farm Income%	0.31	0.39	0.22	0.26	0.18	0.23
Borrowed %	0.5015	0.40	0.56	0.36	0.52	0.40
Education	1.75	0.72	2.03	0.69	2.17	
Years of Farming	36.25	12.37	31.27	13.10	33.73	12.88
Total Acres	2,223.45	2,158.11	2,216.32	1,730.2	2,936.07	1,841.79
CCIP Coverage Level 2014	64.25	6.74	66.67	5.87	66.23	4.97
Coefficient of Variance of Irrigated Cotton	0.26	0.09	0.26	0.08	0.25	0.07
Coefficient of Variance of Non-Irrigated Cotton	0.41	0.13	0.37	0.12	0.43	0.12

Table 3. Percentage of education level for three different risk perception levels

	High school	College	Graduate	Source of Information (Insurance agent=1)
Risk Perception Level 1	40	45	15	100
Risk Perception Level 2	21.67	53.33	25	93.33
Risk Perception Level 3	17.07	48.78	34.15	80.49

In the estimated model a farmer's willingness to accept risk shares a direct relationship with the level of nonfarm income and the farmer's primary source of information. In other words, farmers who either have a large nonfarm income or who receive their insurance information primarily from an insurance agent are likely to be more risk averse.

A farmer's willingness to accept risk is indirectly related to their education level, total acreage, CCIP coverage level, and the coefficient of variation for non-irrigated cotton. As the

values for these variables increase farmers are less likely to evaluate themselves as highly risk averse. The sign on the coefficient of variation for non-irrigated cotton also indicates that non-irrigated cotton farmers are more likely to accept risk than irrigated cotton farmers; however, this coefficient is not statistically significant in the model.

Table 4. Estimated results of ordered logistic model

Variables	DF	Estimate	Standard Error
Intercept 1	1	4.31***	3.10
Intercept 2	1	6.96*	3.15
Source of Information (Insurance Agent=1)	1	1.42*	0.69
Non-farm income%	1	1.17**	0.74
Borrowed %	1	-0.07	0.54
Education	1	-0.48**	0.27
Years of Farming	1	-0.005	0.02
Log of Total acres	1	-0.46*	0.24
CCIP 2014 Coverage Level	1	-0.04***	0.03
Coefficient of variance of irrigated cotton	1	2.96	2.68
Coefficient of variance of non-irrigated cotton	1	-2.26***	1.59

*, **, and *** indicates statistical significance at the 5, 10, and 17% levels, respectively.

The overall ability of the model to predict a farmer's level of risk aversion can be assessed using the likelihood ratio test, the score test, and the Wald test. The Likelihood ratio test was significant at 0.006, Score test was at 0.0126, and Wald test was at 0.174. The model's prediction of the dependent variable, which is the ordered response of a farmer's willingness to accept risk, is another measure of goodness of fit. Among farmers with the lowest willingness to accept risk (risk perception level 1) the model correctly predicted the level of risk aversion 10% of the time. Among farmers with a moderate willingness to accept risk (risk perception level 2) the model was correct 83% of the time. Finally, among farmers with a high willingness to accept risk (risk perception level 3) the model was correct 31% of the time. Based on these results, the model has high predictive power for individuals with an average willingness to accept risk but is

not as reliable when making predictions about individuals whose risk preference is either extremely high or extremely low.

Conclusion

When farmers make risk management decisions they must first assess the level of risk they face and then must decide on an appropriate set of risk management tools to reduce the negative effects that result from risk. While most previous studies on this topic have focused on the impact of a quantitative assessment of risk on the risk management decision our field survey of Texas cotton farmers indicates that the farmer's personal perception of the risk they face can differ from a quantitative assessment of risk. Understanding how farmers subjectively assess risk, along with their level of risk aversion, may be important to consider when studying risk management decisions in agriculture.

Our study shows that a farmer's willingness to accept risk is primarily influenced by the sources of information they use, their level education, and their non-farm income. Other factors such as coefficient of variance for irrigated cotton, the CCIP coverage level, and total acres may also be factors that influence a farmer's willingness to accept risk.

Our results indicate that farmers incorporate the crop insurance decisions of their neighbors and their perceived risk aversion relative to that of their neighbors into their decision making process. There is, however, heterogeneity in risk management decisions even within groups that share similar risk perceptions.

This study will stimulate the discussion on incorporating the behavioral aspect of risk assessment and awareness into the current methods used to understand risk management decisions. In addition, this study is likely to suggest a gap in the literature related to how the farmer's perception of risk affects risk management in agriculture.

This study does suffer from some limitations that may affect how generalizable the results are. Our sample includes only cotton farmers in Texas so our results may not be representative of crop producers in other regions of the nation. Studies similar to this one across other locations will help to generalize our findings.

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