THE TEMPORAL NATURE AND "INTERDEPENDENCE" OF AGRICULTURAL PRODUCERS' RISK ATTITUDES AND SUBJECTIVE BELIEFS: A TEXAS EXAMPLE

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Introduction

Most treatments of decision-making under risk (Savage, 1954) assume that agents form their subjective probabilities independent of their utilities. Further, utilities are usually assumed to be invariant over small intervals of time. More explicitly, utilities are treated as basic, while probabilities are dependent upon the particular decision environment. This research study tests the independence of utilities, subjective probabilities, and time for a set of twenty-seven grain sorghum producers in South Texas.

The plan of the paper is as follows. First, a brief summary of results on expected utility theory and literature relevant to utility and probability assessment is provided. Next, a description of the study (currently still active) on grain sorghum farmers' behavior under risk in South Texas is presented. This is followed by the results of tests of independence of elicited subjective probabilities and elicited risk attitudes along with tests of changes in the risk attitudes over time. The final section of this paper discusses the implications this study has on future work in the area of agricultural decisionmaking under risk.

Expected Utility Theory

The expected utility hypothesis gives a set of conditions which are sufficient for an agent's preference ordering of actions with uncertain outcomes to be equivalent to ranking according to expected utility. The conditions (axioms) are well-known and are subject of much concern in the

professional literature (see, for example, Ellsberg (1961), Fishburn (1974), and others). This paper focuses on the independence condition of subjective probabilities and utilities. Following the treatment given in Marschak and Radner (1972, p. 23), the condition of interest is stated as follows:

> '.....a further characteristic of the consistent man (is) his judgments about comparative probabilities of events should not depend on what rewards or punishments they entail.

An additional condition, which most researchers impose, but one not required by the expected utility hypothesis, is that utilities (risk attitudes) remain constant over short intervals of time. This assumption is useful to economists and others involved in making recommendations on individual or aggregate farm policy, etc.

From a methodological view, the work presented in this paper appears to involve testing assumptions of basic theory and thus might be viewed as unnecessary from an instrumental or positive economics perspective (see Friedman, 1952). The motivation for this research does not, however, derive from such lofty heights. This research is not an attempt to test the expected utility theory with an empirical study. Rather, the theory is taken as basic and an effort is made to shed light on the reasonableness of the elicitation experiment. That is, if the independence condition is rejected, or if it is found that risk preferences change (significantly) over time, then other elicitation procedures will be turned to.

Binswanger (1980), for example, found much discrepancy in utility elicitations performed in hypothetical situations. His work has been used by other researchers to recommend elicitation procedures based on actual monetary payments (Bessler, 1979). Such a recommendation will generally be viewed cautiously by project administrators, as it will involve large data acquisition costs. If it can be shown that risk preferences are stable over

time and that they do not change with the particular environment then there is at least partial justification (although not complete) for using hypothetical payoffs.

Objectives of the Paper

There are several objectives of the research discussed in this paper:

(i) Examine the temporal behavior of agricultural producers'

(a) subjective probability distributions of expected product prices, and

(b) level of risk aversion over short periods of time (4-6 months).

(ii) Test the hypothesis that producers' subjective beliefs of prices and yields are independent of their risk attitudes.

Data

Individual interviews with a sample of 27 producers in the Texas Coastal Bend were carried out during 1983 and provided the primary data which is the basis for this study. A purposive sampling procedure was utilized in preference to a random sampling approach. The local Extension Service personnel were helpful in the selection of the sample. The Coastal Bend region of South Texas is situated in and around the Corpus Christi area and is characterized by an uncertain production and marketing environment dictated by the nature of local weather and market conditions.

Producers' subjective probability distributions of grain sorghum prices at the local public port elevator in January and July of 1984 were initially obtained during the summer (June) of 1983 and subsequently re-elicited from the same producers during the fall (October) of 1983.[1] Conditional

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[1] A Non-motivating elicitation procedure, with hypothetical payoffs, was adopted in obtaining the probability weights for the relevant price intervals, since monetary payments were not feasible.

probability distributions of per acre yields for the 1984 grain sorghum crop, conditional upon the level of nitrogen fertilizer use, were also elicited from these producers in June, 1983. Hence, the distribution of yields given by the producers took into account the various possible weather scenarios.

Data required for the construction of Bernoullian utility of producers for net (money) income was also obtained using a modified Ramsey method which is also known as the Equally Likely Certainty Equivalent (ELCE) method. Producers' risk attitudes were evaluated using the numerical measure of the degree of absolute risk aversion suggested by Pratt (1964) and several utility functional forms were investigated (Sri Ramaratnam *et al.*, 1984). Initial interviews with the producers were conducted in June of 1983. A second survey of the same group of producers' risk attitudes was conducted in October of 1983. Producers' projected net income from the 1984 cropping season was used as the starting value in the hypothetical choice situations for the ELCE method during the second elicitation of their Bernoullian utility (risk attitudes). An arbitrary fixed value of net income considered suitable for the group as a whole was used as the initial starting value during the first (June 1983) visit. Each interview took approximately 1.0 to 1.5 hours.

Results and Discussion

Subjective Probabilities of Prices Over Time.

Changes in producers' subjective beliefs of grain sorghum prices over time are summarized in table 1. Their probabilistic forecasts of January and July 1984 prices at the local public elevator, made in the summer (June 1983) and fall (October 1983) of 1983, provide the background for this

evaluation.

In June 1983, producers' expectations were that prices in January and July of 1984 would be similar (means of 5.478 and 5.416). In the aggregate, however, they were more confident of the January 1984 prices being around $5.50 than was the case with their July 1984 price expectations (Coefficient of Variation of 0.0686 vs. 0.0793).

In October 1983, (following the reduced expectations of the Midwest corn crop associated with the summer drought), producers on the average believed January 1984 prices would be higher (5.941)[2] than their earlier expectations and the July 1984 prices would be relatively lower (5.396). Here again, they expressed more confidence in regard to the near term (January 1984) prices than the distant (July 1984) prices. (Coefficient of Variation of 0.0699 vs. 0.0873).

Nevertheless, considering the forecasts of January 1984 prices made in June and October of 1983, respectively, there appears to be no strengthening or increase in confidence of price expectations as producers get closer to the actual occurrence of the event. In fact, they appear to become slightly less confident. (Coefficient of Variation of 0.0699 in October vs. 0.0686 in June). Our sample of 27 farmers do not appear to form their subjective beliefs according to optimal Univariate forecasting rules (see Box and Jenkins, 1970, chap. 5). That is, as one approaches the forecast date with a univariate forecasting rule, his or her spread (Coefficient of Variation) will collapse around the actual value.

Risk Attitudes Over Time.

The temporal behavior of agricultural producers' risk attitudes (Pratt's

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[2] The price of Grain Sorghum at the local public elevator on January 11, 1984, the date for which the price distributions were elicited, turned out to be $ 5.90 per cwt.

Absolute risk aversion measures) is examined in table 2. Summary measures of the estimated risk measures of individual producers elicited in June and October of 1983, their ordinal ranking from the most risk averse to the least risk averse, and the correlation and regression analysis provide the necessary information for this phase of the analysis.

October elicitations appear to suggest that producers were more risk averse (0.0000155) at the mean, based upon Pratt's Absolute Risk Aversion Measures, than they were at the June elicitations (0.0000091). There was also indication that there is more producer differences in risk attitudes on the basis of October (0.0000106) measurements than the June (0.0000036) elicitations. These types of deductions, based upon actual rather than the relative values of the risk aversion coefficients, however, are not possible since they are based on cardinal rather than ordinal ranking of producers. But only an ordinal ordering of producers is relevant in expected utility analysis using their Bernoullian utility functions and the respective risk aversion measures.

Nevertheless, there was strong evidence that both the June and October measurements of producers' risk attitudes were fairly highly correlated (0.623); the correlation was significant at the .05 confidence level. This suggests that those producers who were found to be more risk averse in October were also observed to be relatively more risk averse in June and vice versa (table 2).

There was further evidence of the above conclusion based upon a regression analysis as per the values of the t, F statistics and the adjusted R^2 values (table 2; section 3). The F statistic (8.884) was significant at the .05 confidence level and so was the t-statistic (2.981) associated with the regression coefficient of June risk measure which turned

out to be significantly different from zero. Of more interest, however, is the test of the hypothesis that this regression coefficient is significantly different from one. The standard error of the parameter estimate was 0.613 (i.e., 1.828/2.981) and the t-statistic for this test was 1.35 (i.e., [1.828-1.0]/0.613). Thus, the coefficient relating the October and June risk measures was not significantly different from one. There is much variation in the October risk measures however, which is not explained by the June risk measures alone (R^2 = 0.345).

Interdependence of Subjective Probabilities and Risk Attitudes

An attempt has been made to test the (less common) hypothesis of interdependence between producers' subjective beliefs and their risk attitudes (table 3). Simple regression analysis between the mean and the coefficient of variation[3] of the respective producers' subjective probability distributions of prices (elicited in June and October of 1983), yields (conditional upon the level of N fertilizer use), and producers' (Pratt's) absolute risk aversion measures allow for the testing of this hypothesis.

Based upon the t-values reported in table 3, there appears to be no significant relationship or interdependence between the subjective beliefs (Mean and Coefficient of Variation of the probability distributions) and the risk attitudes of agricultural producers in the Texas Coastal Bend.[4]

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[3] Coefficient of Variation is used as a proxy for Variability, since it takes account of the changes in mean values.

[4] There is some indication however, that more risk averse producers tended to possess lower mean price expectations both in January and July of 1984 and also expressed higher mean yields from 40 lbs. nitrogen fertilizer than 80 lbs., although these relationships were not significant (table 3).

Summary and Conclusions

This paper reports the results on the tests of interdependence between risk attitudes, subjective probabilities, and time for a sample of South Texas grain sorghum producers. The usual assumption of independence of producers' subjective beliefs and their risk attitudes found in Expected Utility analysis was not rejected. Producers' risk attitudes did change over time; however, their ordinal rankings (from most to least risk averse) did not change drastically over time. Heretofore, research workers have suggested the use of actual monetary payoffs to motivate careful consideration in subjective utility and probability elicitations. In this study, hypothetical rewards were found to give results which are consistent with prior beliefs. Thus, there does not exist strong evidence to reject results based upon hypothetical answers. Yet, the results reported here do not diffuse the issue of actual versus hypothetical payoffs. Perhaps the next step is to consider a study which explicitly tests this question, using two groups under experimentally controlled conditions.

Table 1. Temporal Changes in Producers' Subjective Probabilities of Product Prices.

	January 1984 Prices Forecasted in		July 1984 Prices Forecasted in	
	June 1983	October 1983	June 1983	October 1983
	($/cwt.)			
A) Probability Weighted Mean Prices				
(i) Mean:	5.478	5.941	5.416	5.396
(ii) Std. Dev:	0.329	0.275	0.361	0.383
(iii) Range -				
Min:	4.750	5.400	4.750	4.500
Max:	6.100	6.425	6.025	6.025
B) Coefficient of Variation of Probabilistic Forecasts				
(i) Mean:	0.0686	0.0699	0.0793	0.0873
(ii) Std. Dev.:	0.0221	0.0160	0.0197	0.0191
(iii) Range -				
Min:	0.0000	0.0400	0.0444	0.0513
Max:	0.1090	0.1009	0.1154	0.1216

Table 2. Agricultural Producers' Risk Attitudes[a]: Temporal Behavior[b]

		June Elicitation	October Elicitation
1)	a. Mean:	0.0000094	0.0000159
	b. Std. Dev:	0.0000036	0.0000106
	c. Range -		
	Min:	0.0000036	0.0000020
	Max:	0.0000167	0.0000358

2) Correlation (between the two elicitations): + 0.623*

3) Regression results:

October Risk Measure = -0.00000104 + 1.828*June Risk Measure
(-0.173) (2.981*)

$\bar{R}^2 = 0.345$ F = 8.884*

4)Comparision of the Ordinal Ranking of Producers: (Most Risk Averse = Rank 1)

October		June	
Rank	Risk Measure	Rank	Risk Measure
1	0.0000358	1	0.0000167
2	0.0000309	4	0.0000106
3	0.0000284	5	0.0000095
4	0.0000281	3	0.0000135
5	0.0000221	2	0.0000146
6	0.0000155	7	0.0000087
7	0.0000141	11	0.0000072
8	0.0000118	9	0.0000082
9	0.0000105	12	0.0000067
10	0.0000087	6	0.0000093
11	0.0000070	14	0.0000036
12	0.0000065	10	0.0000080
13	0.0000021	13	0.0000067
14	0.0000020	8	0.0000085

[a] $R_a(M) = -U''/U'$: Pratt's Absolute Risk Aversion Measures.

[b] Of the 27 producers in the sample, only 14 producers' risk measures were well represented by the exponential utility function (see Sri Ramaratnam, et. al., 1984 for discussion related to the utility functional forms).

*All these statistics are significant at the 0.05 confidence level.

Table 3. Relationship between Producers' Subjective Beliefs and Risk Measures.[a]

	Risk Aversion Measure Elicitation of	
	June 1983	October 1983
	(t-statistics)	
I) Summary Measures of Probabilistic Price Forecasts		
a) January 1984 prices		
(i) Mean	-0.126	-0.739
(ii) Coefficient of Variation	-0.955	-1.237
b) July 1984 Prices		
(i) Mean	-0.668	-0.173
(ii) Coefficient of Variation	-0.707	-0.787
II) Summary Measures of Conditional Yield Expectations		
a) Mean - Level of Nitrogen		
40 lbs.	0.183	b
80 lbs.	-0.893	b
b) Coefficient of Variation - Level of Nitrogen		
40 lbs.	0.573	b
80 lbs.	-0.971	b

[a] This relationship was tested based on the results of all 27 producers in the sample.

[b] Producers' conditional yield expectations were not elicited during October.

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