RISK ATTITUDES AND FARM/PRODUCER ATTRIBUTES: A CASE STUDY OF TEXAS COASTAL BEND GRAIN SORGHUM PRODUCERS

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Abstract

An analysis of risk attitudes for a sample of grain sorghum producers in the Texas Coastal Bend is reported. Four alternative functional forms were estimated on data elicited by the direct elicitation of utility approach. The exponential functional form described most producers' utility preferences better than other utility forms. Relationships between exponential risk measures and both producer attributes and farm characteristics, including interactions among them, were identified as significant. Risk aversion was found to diminish with more experience in farming and to increase with more leasing of farm land. Risk aversion was also found to decline with larger farm size and to increase with higher dependency of farm operators on farm income.

Key words: direct elicitation, Bernoullian utility, risk aversion, grain sorghum.

Grain sorghum production in the Texas Coast Bend typically occurs under dryland conditions. Grain sorghum prices in the area are affected by the export market demand/ supply situation and the prospects of the United States corn crop. Consequently, Texas Coastal Bend producers of grain sorghum execute their production and marketing decisions in a risky environment. Development of decisionmaking aids requires an understanding of their risk attitudes.

The need for studying the risk attitudes of producers operating under uncertain conditions is further documented by the extensive literature in this area (Dillon; Anderson; Halter and Dean; Hazell). In this paper, alternative utility functional forms and their use in analyzing the risk attitudes of a sample of Texas Coastal Bend producers were investigated.

RISK ATTITUDES AND UTILITY FUNCTIONS

Much empirical work has been focused on measuring the risk attitudes of agricultural decisionmakers (Lin et al.; Halter and Mason). Depending on the research objectives, the approaches followed differ considerably (Robison et al.). In normative studies, it is generally assumed that decisionmakers have specific utility functions in income space, known as the Bernoullian utility functions. Curvatures of these utility functions imply differences in producers' risk attitudes (Friedman and Savage). A numerical measure of the degree of risk aversion was suggested by Pratt. The validity of Pratt's measures of risk aversion depends on the "accurate" representation of producers' Bernoullian utility functions.[1] In this context, selection of appropriate functional forms becomes an important area of study.

Several functional forms have been used by researchers over the years to represent

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[1] Following Pratt, the knowledge of the risk aversion coefficient alone can be considered sufficient for the analysis of decisions under risk (see King and Robison for an application).

producers' utility. In the 1950s and 1960s, different polynomial forms, especially the *quadratic* form, were widely used due to their convenience of estimation. The tractability of the quadratic expected utility form contributed to its general acceptance. Criticism of quadratic forms, however, began with Pratt's identification of the coefficient of ***absolute risk aversion:***

$$R_a(M) = -u''/u',$$

where u' refers to the first derivative of the utility function, u'' is the second derivative, and M is money income. It is argued that decisionmakers become more willing to accept a gamble with fixed probabilities and fixed small payoffs when their wealth increases, if the absolute risk aversion coefficient is a declining function of M. The coefficient $R_a(M)$ for quadratic utility functions, however, increases with M and thus is contrary to the general belief of declining absolute risk aversion. The quadratic functional form has been defended by Anderson et al., however, based on its superior empirical fit to data and convenience of estimation. It has also been used by several other researchers (Hanoch and Levy; Lin et al.).

Alternative forms which are more acceptable according to the hypothesis of decreasing absolute risk aversion include the *logarithmic* and *semi-logarithmic* forms. These forms have been used to some extent (Lin and Chang). In general, however, they have not been as popular as the quadratic form. One possible explanation for this lack of popularity is that no tractable solution procedure has been developed for the associated expected utility functions (Buccola, 1982a).

The *exponential* utility function (more accurately referred to as the *negative inverse exponential*) is another form which has been found suitable (Buccola and French), even though it has the implication of constant absolute risk aversion. This form has been used by a few researchers in recent years (Buccola, 1982b; Attanasi and Karlinger), but, as with the logarithmic function, it has not been widely used.

Different forms of Bernoullian utility functions imply different theoretical properties related to behavior under risk. One of the objectives of this study was to investigate the suitability of these functional forms for a sample of Texas Coastal Bend grain sorghum producers. Risk measures for producers derived from these functional forms were analyzed with respect to six selected producer attibutes and farm characteristics. In an earlier study, Halter and Mason found that farmers' age, education, and land tenure were significantly related to their measure of absolute risk aversion, either separately or jointly. The effects of several such socioeconomic variables were considered in this study.

SELECTING UTILITY FUNCTIONAL FORMS

As a result of the theoretical shortcomings of the quadratic utility function, alternative utility functions ranging from *log linear, semi-log, constant elasticity of substitution* (CES), and various exponential forms to generalized forms such as the *Box-Cox transformation* type have been suggested. Lin and Chang summarized these forms, their implied restrictions on parameters, and the nature of risk aversion coefficients associated with them. All functional forms can be fit to utility and money data obtained through elicitation techniques which will be discussed later.

The *quadratic* utility function is described in the form,

$$(1)\ U = a + bM + cM^2 \qquad b > 0, c < 0,$$

where U is utility measured in utils, M is levels of money income, and a, b, and c are parameters to be estimated. This function has an associated absolute risk aversion measure of:

$$R_a^Q(M) = -u''/u' = -2c/(b + 2cM),$$

which is an increasing function of M. The *log-linear* form of utility functions such that,

$$(2)\ \ln U = d + e \ln M \qquad 0 < e < 1,$$

results in a risk aversion measure of the form:

$$R_a^L(M) = -u''/u' = (1-e)/M.$$

This expression is a decreasing function of M and, so long as e < 1, produces a positive risk measure implying risk aversion. The *semi-log* form of the type:

$$(3)\ U = f + g \ln M \qquad g > 0$$

produces an absolute risk aversion measure which is a decreasing function of M, but which is also independent of g,

$$R_a^S(M) = -u''/u' = 1/M.$$

This particular semi-log form was reported to fit the data used by Lin and Chang very well, among the several semi-log forms evaluated.

The *exponential* function:

$$(4)\ U = K - Q \exp(-N M) \qquad K, Q, N, > 0$$

implies a constant absolute risk aversion measure,

$$R^c_a(M) = -u''/u' = N \text{ (constant)}.$$

A logarithmic transformation of equation (4), such as:

$$(4')\ \ln(-u + k) = \ln Q - N M,$$

was suggested as one possible estimation equation (Buccola and French). When the natural log of (–u + k) is regressed against money (M) using equation (4'), the negative of the observed coefficient of M will be the value of N, the constant absolute risk aversion measure. The anti-log of the constant intercept term will be the value of Q. The value of K, on the other hand, will be equivalent to an additive adjustment to the original utility scale and has to be determined *a priori*.

The estimation equation (4') is a non-linear, though monotonic, transformation of equation (4). The von Neumann and Morgenstern (VNM) properties of the Bernoullian utility function are unique only up to a linear transformation. Thus, the value of N providing the best fit to equation (4') is not necessarily the same as that giving the best fit to the original exponential function, equation (4). For overcoming this problems, a search procedure indicated by Buccola and French was adopted for this study. In accordance with this method, the value of N which minimized the sum of the squared deviations (SSE) between actual utils used in the study and those predicted by equation (4), when substituting the values of N and Q obtained from equation (4') for the different pre-determined values of K (namely, 101, 150, 200, and 250), was chosen as the "true" measure of producers' absolute risk aversion with the exponential function.

The relevant criteria for selecting the "best" utility functional form are related to economic or behavioral considerations regarding the risk measures, econometric/statistical fit of the data, and convenience of estimation. These considerations, however, are not necessarily listed in their order of importance. It is the individual researcher's judgment, given the circumstances, which must determine where the emphasis would be placed.

Obtaining risk aversion measures for producers that can be compared across functional forms and relating them to producer attributes and farm characteristics was the main focus of this study. Therefore, it is not proposed here to judge the merits of the hypothesis of decreasing absolute risk aversion or its implications with respect to decision responses under uncertainty. Rather, emphasis is directed towards meeting adequate statistical fit criteria with respect to the estimated utility functions. Measures such as the coefficient of determination adjusted for degrees of freedom ($\bar{R}^2$), student's t-values, and sum of squared errors (SSE) were used as the basis for determining individual producers' Bernoullian utility for money.

DATA

Interviews with 26 producers were conducted during June 1983, in a three county area (i.e., Nueces, San Patricio, and Bee counties) of the Texas Coastal Bend. A stratified sampling procedure was used in preference to a random sampling approach. Loss of representativeness often associated with sparse random samples was avoided by sequentially selecting producers to included producers from all three counties with diverse farm characteristics and personal attributes. Local agricultural extension service personnel were helpful in selection of the sample.

The Coastal Bend region of South Texas is situated around the Corpus Christi area. Its importance as one of the major areas of grain sorghum production in Texas has increased during recent years. The area accounted for approximately 14.5 percent of Texas grain sorghum production in 1981, up from approximately 6.5 percent of production in 1971 (Texas Field Crop Statistics). Several characteristics of farms included in the sample and selected attributes of the grain sorghum producers interviewed are presented in Table 1. This information, along with the risk aversion coefficients on each producer, provides the background for this study.

The farm and decisionmaker characteristics reported in Table 1 are hypothesized to be the more important variables related to risk attitudes. The human and monetary capital requirements associated with studies directed at measuring producers' risk attitudes have limited prior theoretical and applied empirical work in this area (Buccola and

TABLE 1. SELECTED FARM AND PERSONAL CHARACTERISTICS OF TEXAS COASTAL BEND GRAIN SORGHUM PRODUCERS, 1983

Item	Summary measures: Mean	Std. dev.	Range: Min.	Max.
Farm Characteristics:				
Acreage[a]	2,897.8	3,877.3	100	19,000
Percent acreage leased (tenure)[b]	73.9	36.7	0	100
1982 average yields—lbs./acre (productivity)[c]	4,226.1	602.4	3,000	5,300
Personal Attributes:				
Age—years	43.3	10.5	30	65
Experience—years[d]	19.1	11.3	2	40
Percent income from farming (dependency)[e]	72.1	31.9	10	100

[a] This value is the total of all acreage farmed by the respective producers; i.e., it includes both grain sorghum acreage and cotton acreage (the most predominant alternative crop) as well as any other cultivated acreage (e.g., wheat).

[b] Land ownership and tenure were captured in this variable. Among all producers, only four leased land on a cash basis and the acreages was less than 20 percent of their operation acreage. The remaining producers leased land on a share basis.

[c] Average yield of grain sorghum in the crop year 1982 was considered to represent prevailing farm productivity.

[d] This value represents the number of years the respective producers have been engaged in commercial farming.

[e] This measure was used as an indication of farmer dependency on income from farming, given the availability of other sources of income.

French; Dillon and Scandizzo; Halter and Mason; Lin et al.; Love; Moscardi and de Janvry; Officer and Halter; Wilson and Eidman). As a result of sample sizes ranging from 6 to 47 producers in earlier United States studies, meaningful relationships have to be suggested and verified by regression methods. It would be desirable if producer differences in risk attitudes, as estimated through utility measurement methods, could be easily distinguished through more readily observable producer attributes[2] such as age, experience, farm income dependency (for disposable income), and farm characteristics such as farm size, tenure, and productivity.

The producers interviewed ranged from beginning farmers of age 25-35 up through farmers of age 60-65 who were approaching retirement. Farm size varied from very small to extremely large acreage in the case of a Foundation operation. A majority of the respondents leased land on a share basis and their primary source of income tended to be from farming. Although several producers' yields were below the regional average, the sample mean was slightly above the regional mean.

Among the several approaches available for studying risk attitudes, the Direct Elicitation of Utility method (DEU) was chosen in this study to elicit the Bernoullian utility function. This involved offering producers a series of hypothetical choices involving monetary gains and losses. Unlike the Von Neumann-Morgenstern (VNM) method which requires the decisionmaker to identify the probability for a favorable outcome that would yield indifference between the risky alternative and a "sure thing", a modified Ramsey method, known as the equally likely risky outcome (ELRO) method, was used in this study.

This procedure was previously used with a sample of large farms in California (Lin et al.) and was reported to be suitable. Individual decisionmakers were requested to "play" a series of nine games against nature and/or market forces, where two action choices such as A and B were available. Producers (subjects) were told that each of the choices can lead to a "favorable" or an "unfavorable" outcome, both occurring with equal likelihood (i.e., probabilities of one-half each), depending on the states of nature and/or market conditions. The pre-assigned payoffs were a, b, and x (a>b>x), and were associated with actions A and B as follows.

Probabilities	Outcomes	Action choices: A	B
½	"Favorable"	a	b
½	"Unfavorable"	y=?	x

Each farmer was asked in the first game to specify the monetary (net income) value for the outcome y which results in a state of "indifference" between choosing actions A

[2] An "important" producer attribute, level of education (Halter and Mason), was not obtained due to the apparent sensitivity of producers to such an inquiry.

and B when a, b, and x were assigned net income values of \$150,000, \$125,000, and −\$50,000, respectively. The objective was to provide the subjects with "realistic" monetary gain and loss situations (extreme cases) under the alternative states of nature. In the subsequent game situations, the pre-assigned outcome x and the producer suggested value of y in the first game were maintained throughout. The value of outcome a, however, was replaced with the value of b and a new value of "b" which provided indifference to the subjects between the two action choices was sought. This procedure was continued until eight more "games" were posed to the producers and their responses were obtained.

These DEU methods have been criticized as being subject to bias arising from different interviewers, negative preferences toward gambling, absence of realism in game setting, and lack of time and experience of the participants to become familiar with the hypothetical choices (Roumasset; Binswanger; Robison). These criticisms are often misdirected because few other approaches to studying the risk behavior of individual decisionmakers offer as rich an empirical setting. Some of these criticisms are probably valid in certain situations. The other methods, such as the interval measures of risk aversion (King and Robison), the experimental methods with significant outcomes (Binswanger), and the observed economic behavior (Moscardi and de Janvry), are either relatively new and, thus, are not adequately tested or are too expensive to implement.

RESULTS

A summary of the risk aversion measures suggested by the different functional forms considered is presented in Table 2. The semi-log and exponential functions resulted in positive risk measures in the case of all producers; i.e., they were all risk averse to some degree based on these functional forms. The log-linear form suggested risk preferring behavior for 7 of 17 producers with non-negative income responses. The quadratic form resulted in a single risk preferring producer and several near risk neutral farmers. On the whole,[3] the semi-log form suggested more risk averse behavior at the mean (0.0000159) with the exponential measure coming next (0.0000083). The quadratic and log linear functions resulted in apparently "near" risk neutral risk measures on average.

Risk measures for the estimated exponential function had the lowest standard deviation while those from the log-linear form had the highest. The standard deviation of risk measures from semi-log and quadratic functions were also rather high and equal, Table 2. This implies that the exponential form tends to suggest fewer differences in producers' risk attitudes while the log forms and the quadratic form likely lead one to believe there is substantial variation in risk attitudes. It is, therefore, not surprising that studies which employed only the polynomial (e.g.; quadratic) forms concluded there were equal numbers of risk averse, risk neutral, and risk preferring producers (e.g.; Halter and Mason).

In Table 3, the risk aversion measures suggested by the different functional forms are related to some of the socio-economic variables hypothesized to be important. All of the reported results are based upon linear relationships between the dependent variable (risk aversion measures) and the independent socio-economic variables.[4] As can be readily verified, none of these linear equations were impressive on the basis of the adjusted R^2 values and, therefore, did not adequately explain the variation in risk attitudes among producers. The equation with the exponential measure, however, was better than the other equations in relation to adjusted R^2 (0.47) and F-value (4.88), which was significant as the 5 percent level. All of the linear equations had associated F-values which were significant at the 10 percent or higher level when the variables associated with the highly "insignificant" coefficients were dropped from the respective equations.

As a result of "weak" linear relationships between risk measures and independent socio-economic variables, it was considered appropriate to investigate the non-linear relationships. Evidence of such relationships

[3] The correlation between the risk measures from the semi-log and log-linear forms was, not surprisingly, very strong. Semi-log measures were positively correlated with the measures from the exponential and quadratic forms as well. There was, however, weak negative correlation of the exponential measures with measures from the log and quadratic forms.

[4] Age and experience were, as could be anticipated, very highly correlated (0.935) and thus were not used together in any of the estimated equations.

TABLE 2. RISK AVERSION MEASURES FOR DIFFERENT UTILITY FUNCTIONAL FORMS ESTIMATED FROM INFORMATION PROVIDED BY TEXAS COASTAL BEND GRAIN SORGHUM PRODUCERS, 1983

Summary measures	Quadratic		Log-linear		Semi-log		Exponential	
	$\bar{R}^2$ [a]	$R_a(M)$ [b]	$\bar{R}^2$ [a]	$R_a(M)$ [b]	$\bar{R}^2$ [a]	$R_a(M)$ [b]	$\bar{R}^2$ [a]	$R_a(M)$ [b]
Mean	0.937	0.0000057	0.950	0.0000068	0.958	0.0000159	0.978	0.0000083
Std. dev.		0.0000041		0.0000100		0.0000041		0.0000026
Range: Min.	0.868	−0.0000460	0.843	−0.0000082	0.889	0.0000102	0.799	0.0000025
Max.	0.999	0.0000105	0.994	0.0000241	0.997	0.0000247	0.998	0.0000135
N[c]	23		17		17		23	

[a] $\bar{R}^2$ is the coefficient of determination adjusted for degrees of freedom, when each functional form was used to fit individual producer's utility functions.

[b] $R_a(M)$ is Pratt's absolute risk aversion measure at the producers' mean income response, when employing the different functional forms.

[c] N is the number of producers' utility functions estimated using the respective functional forms. Only 23 of the 26 respondents responded to the entire sequence of choices. Only 17 of those producers had non-negative income responses throughout, enabling log transformations.

TABLE 3. RISK AVERSION MEASURES OF TEXAS COASTAL BEND GRAIN SORGHUM PRODUCERS LINEARLY RELATED TO SOME SELECTED SOCIO-ECONOMIC CHARACTERISTICS, 1983

	Statistics				Producer attributes			Farm characteristics		
Functional forms	N[a]	$\bar{R}^2$	F[b]	Intercept	Age	Experience	Dependency	Acreage	Tenure	Productivity
					Parameters (t-values)					
Quadratic	23	0.17	2.52[c]	-2.106 (2.15)	0.0363 (2.62)			0.000058 (1.52)	0.00676 (1.81)[c]	
Log-linear	17	0.23	2.58[c]	-0.98 E-05 (-2.31)[d]	—	2.729 (2.17)[d]		6.00 E-10 (2.08)[c]	6.729 E-08 (2.14)[d]	—
Semi-log	17	0.24	4.55[d]	0.91 E-05 (3.80)[d]	—	1.781 E-07 (2.56)[d]	—	—	4.586 E-08 (2.14)[d]	—
Exponential	14	0.47	4.88[d]	1.96 E-05 (4.53)[d]	—	-1.473 E-07 (3.07)[d]	4.366 E-08 (2.09)[c]	—	—	-2.795 E-09 (-2.51)[d]

[a] The sample size differs for the different functional forms. Log and semi-log forms could be used only for 17 respondents whose entire sequence of choice (eight) of money income values in hypothetical gambles were non-negative. The exponential form described well the utility of only 14 producers on the basis of the minimum values of SSE's, which were reasonably low when the search procedure was used.

[b] The F value is reported to indicate the relative statistical fit of the different forms, since the $\bar{R}^2$values were rather low for all of the above linear fits. Critical F values for the four respective estimated functional forms are 2.40 (10 percent significance level with 3 and 19 degrees of freedom), 2.56 (10 percent significance level with 3 and 13 degrees of freedom), 3.49 (5 percent significance level with 2 and 14 degrees of freedom), and 3.71 (5 percent level with 3 and 10 degrees of freedom).

[c] Significant at the 10 percent level.

[d] Significant at the 5 percent level.

has been previously reported (Halter and Mason) and was also observed in a visual inspection of plotted data associated with the current study. Due to the relatively better performance of the exponential measures while estimating linear relationships, the non-linear relationship was studied using the exponential risk measures of 14 producers, Table 4.

A stepwise regression with back-step analysis resulted in the "best" non-linear equation, Table 4. It included all of the linear terms plus some interaction terms.[5] None of the quadratic (squared) terms were significant and neither were some of the interaction terms. All of the linear terms and the 5 reported interaction terms were significant at the 1 percent level. The overall fit of this equation was superior to all of the linear equations (Table 3) as well as to the other non-linear equations. The relationships indicated by the linear equations, sometimes contradictory among different functional forms, were verified using this non-linear equation in Table 4.

Partial derivatives were evaluated at the respective mean values of the socio-economic variables reported in Table 1. The

Table 5. Partial Derivatives Calculated at Means Levels for the Respective Socioeconomic Variables, Texas Coastal Bend Grain Sorghum Producers, 1983

Item	Partial Derivatives[a]
∂ Risk/∂ EXPERIENCE	−4.140E−07
∂ Risk/∂ DEPENDENCY	−1.475E−07
∂ Risk/∂ ACREAGE	−2.146E−09
∂ Risk/∂ TENURE	9.220E−08
∂ Risk/∂ PRODUCTIVITY	8.752E−09

[a] The calculated numeric values indicated are the respective risk values for the mean levels of the respective independent variables as identified in Table 1.

relationship of farmers' experience to risk aversion measures was negative; i.e., the more experienced the farmers, the smaller their risk aversion measures, Table 5. This inverse relationship was also true with respect to both size of the operation (Acreage) and the percentage of income earned from farming (Dependency). Those farmers with control over more land tended to be less risk averse than those with smaller farms. The more income earned from farming (probably due to the large operation size), the less risk averse the producers.[6]

The variables "Tenure" and "Productivity" appeared to exhibit positive relationships with the risk measures, Table 5. Producers

Table 4. Non-Linear Relationships between (Exponential) Risk Measures of Texas Coastal Bend Grain Sorghum Producers and Socio-economic Variables, 1983[a]

Variables	Parameter estimates	Standard errors	t-values
Intercept	−3.430 E−05	2.300 E−06	−14.91
Experience	1.691 E−06	6.331 E−08	26.70
Dependency	−1.782 E−07	8.799 E−09	−20.26
Acreage	−2.189 E−08	1.579 E−09	−13.86
Tenure	5.948 E−07	3.439 E−08	17.29
Productivity	1.404 E−08	6.360 E−10	22.08
Experience x productivity	−4.981 E−10	1.657 E−11	−33.06
Dependency x acreage	−7.503 E−11	4.488 E−12	−16.72
Dependency x tenure	3.357 E−09	1.515 E−10	22.15
Acreage x productivity	5.952 E−12	4.311 E−13	13.81
Tenure x productivity	−1.762 E−10	9.343 E−12	−18.86
Statistical fit:[b]			
$\bar{R}^2$	0.995		
Calculated F value[b]	306.		

[a] All of the coefficients for the linear and interaction terms were significant at the 1 percent level of significance. The coefficients for squared terms were found to be not significant and also resulted in very inferior fits when they were used in the equation.

[b] The estimated function had 3 degrees of freedom. The critical F value at the 1 percent level of significance is 27.2.

[5] All of the variables except age was included in the non-linear analysis since experience (rather than age) was found to better explain variations in risk attitudes.

[6] The variables "Dependency" and "Acreage", however, were weakly negatively correlated. "Dependency" and "Tenure" were fairly positively correlated, although not significantly.

who lease a larger portion of their land, especially on a share basis, appeared to be more risk averse than those who own most of their land. The results also suggested that on farms with high prevailing productivity (on a per acre harvested yield basis) producers were more risk averse than on those farms with lower average farm productivity. Although the linear terms associated with tenure and productivity were both positive, the interaction term between them had a negative sign. That is, those producers who leased land tended to become less risk averse with increasing productivity on their leased land, even though farmers' risk aversion in general increased with less ownership and greater productivity on their farms separately.

Texas Coastal Bend farmers with more experience in farming were less risk averse than those with fewer years of farming experience. This is particularly true when the experienced farmers also operated farms which were relatively more productive. A similar result was reported by Halter and Mason when they found older farmers with high school education to be less risk averse than those who were younger. They also found risk aversion to diminish with age, at all levels of land ownership. They reported greater risk aversion, however, among the farmers who owned 90 percent of their land than those who owned only 10 percent. On the contrary, Texas Coastal Bend producers who leased more land (i.e., those who owned less land) were more risk averse than those who owned more land.

Some other interesting results were related to the relationship of farm size, percent of income from farming, and average farm productivity to the risk measures. At each level of farm dependency, farmers with larger operations were less risk averse than those with smaller farms. Among the farmers with similar farm size, however, those producers who realized relatively higher production levels were more risk averse than the farmers with relatively less productivity. Further, at each level of percent of income from farming (Dependency), farmers appeared to become more risk averse when more of this income was derived from leased land.

SUMMARY AND CONCLUSIONS

Empirical results using a reasonable number of producers with a wide range of farm and personal characteristics and several functional forms suggest no single functional form can be expected to adequately describe the Bernoullian utility of all producers. The exponential form, however, best describes the money utility of at least 14 of the 26 producers included in the analysis. The use of semi-log and log-linear forms were limited to only 17 producers since the other farmers had negative net income responses. Semi-log and log forms may be preferred over the exponential form by some researchers due to their adherence to the hypothesis of decreasing absolute risk aversion. Their use, however, will be restricted when the producers' Bernoullian utility is desired both over monetary gains as well as monetary losses, as was the case in this study.

The quadratic form was found to describe most producers' utility "well," on the basis of adjusted R^2 values and t-statistics. Risk measures derived from the quadratic function, however, related very poorly with socio-economic variables and were also inferior to all other forms in this respect. The lack of relationship of the quadratic risk measures with the farm and farmer attributes is probably due to the increasing absolute risk aversion associated with the quadratic form or is an additional objection to the use of quadratic utility functions.

In order to avoid the bias arising from choosing a functional form *a priori*, some researchers have suggested more generalized functional forms. The use of the Box-Cox transformation in the estimation of Bernoullian utility functions has been suggested so the appropriate degree of nonlinearity of the utility function can be determined by applying the maximum likelihood method (Lin and Chang). These Box-Cox transformations, however, have been demonstrated to not satisfy the VNM properties of a valid Bernoullian utility function (Buccola, 1982a). In this context, "flexible" functional forms, such as the Fourier unbiased form (Gallant) adapted in the utility framework and/or non-parametric estimation methods (Wecker and Ansley) offer some promise.

This study strongly supports the findings of Halter and Mason, at least with respect to the existence of non-linear relationships between risk measures and socio-economic variables. They, however, used the risk measures obtained from linear and polynomial utility functions, while in this study, the risk measures used were derived from an exponential function of the kind in equation (4). Further, ten points in the utility/income space were available for all the producers included in the analyses of this study as opposed to only four in the study by Halter and Mason. Halter and Mason argued that there was no empirical evidence to suggest that the choice of functional form has any bearing on the nature of risk aversion measures derived from the respective utility functions. Their choice of linear and polynomial functions was mainly based upon the goodness-of-fit related to R^2 values. Based upon R^2 values alone, however, all of the functional forms used in this study were satisfactory for most producers, Table 2. With the exception of the exponential measures, none of the other risk measures related well to the socio-economic variables.

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