A Comparative Analysis of Risk Preference Elicitation Procedures

Using Mail Survey Results

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ABSTRACT

Very little work has been done on the issue of whether there is consistency across alternative risk preference elicitation procedures in a mail survey context. A mail survey of Louisiana and South Dakota cow-calf producers was conducted to determine if there is rank order consistency. Six procedures were compared. A statistical comparison across ordinal rankings indicated very little consistency across elicitation procedures. Probit analysis was also conducted. We regressed economic, lifestyle, and social attributes on the ordinal rankings from five of the six elicitation procedures. Again, there was a lack of consistency across elicitation procedure with respect to which behavioral attributes best explained variation in a particular elicitation procedure's ordinal ranking. The conclusion drawn from the study is: *The simpler the risk elicitation procedure used in a mail survey the better.*

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Mail surveys are often used by agricultural economists to determine the extent of adoption by producers of risk-reducing technologies and marketing options. Analyses typically categorize producers by farm type and size, income, and debt-asset ratio, etc. An important factor that many of these surveys have attempted to measure, but only limited success, has been risk preference. Researchers have used self-ranking (Cardona), interval (Wilson and Eidman), hypothetical choice of specific risk reducing options that could be available to the producer in the future (Fausti), and other methods. Selection of the most appropriate method has depended largely upon the opinions of the researcher. Very little work has been conducted to examine the degree of consistency that exists across alternative elicitation procedures in a mail survey context.

The objective of this research is to determine if there is rank order consistency across elicitation procedures. Six procedures are compared in a mail survey context

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Review of Literature

This review of literature presents a broad array of alternative risk preference elicitation procedures but does not represent the entire set of methods used to date. Early attempts to elicit risk preferences via personal interview used the von Neumann-Morgenstern, Modified von Neumann-Morgenstern, and Ramsey approaches; each was used to estimate a single-valued utility function. The estimated utility function was then used to calculate a measure of risk preference, such as the Arrow-Pratt coefficient of absolute risk aversion. These elicitation procedures were

compared in studies by Officer and Halter and by Knowles,. Generally, the Ramsey approach, while perhaps more difficult for the respondent to comprehend, is superior to the Modified von Neumann-Morgenstern approach because persons who are averse to gambling are generally more willing to answer Ramsey questions. Two recent studies where single-valued utility functions have been elicited are Gillespie and Eidman and by Murphy. The outcomes of these more recent studies have produced mixed results due to the hypothetical nature of the questions, interviewer bias, and respondents' mixed levels of understanding of the questions (Gillespie). We unaware of attempts by agricultural economists to use these methods in a mail survey context.

In an attempt to determine the range of the coefficient of absolute risk aversion in which an individual falls, King and Robison developed the interval approach method of eliciting risk preferences. Respondents are asked to choose between distributions of net returns which vary in average return and variability of returns. A sequential decision tree approach is used in which sequential choices of distributions narrow the range (interval) of the coefficient of absolute risk aversion. The response to the final choice in the decision tree determines the interval of the coefficient of absolute risk aversion in which the respondent falls. Among the earlier application of the interval approach in a mail survey was conducted by Wilson and Eidman. Additional studies were conducted by Tauer and by Schurle and Tierney. Data from these studies indicate that a relatively large number of respondents are identified as being risk prone. Schurle and Tierney compared interval approach results with self-rank and Farley scores and did not find a significant relationship between the interval approach and the other two elicitation procedures.

In mail surveys, economists typically use self-rank elicitation procedures to request that a respondent rate himself, on a scale or categorically, from very risk averse to very risk prone.

Cardona provided a continuous line between the two extremes (risk averse and risk taker) and asked respondents to indicate where they fell on this line. A multivariate logit model then was used to determine whether risk preference influenced Louisiana sugarcane producers' choice of best management practices. Risk preference was not found to be significant in the study.

Decision makers have been asked to choose among alternative hypothetical investment strategies to determine their risk preferences. For instance, Gunjal and Legault asked producers to choose among ten hypothetical investments with differing expected returns and variances. Results allowed them to place individuals in one of ten categories of risk preference. Each category was associated with a specific interval of absolute risk aversion.

Fausti requested that South Dakota cattle producers choose between two alternative cattle marketing strategies, where one strategy yielded a certain return and the second strategy yielded a variable return. Producers were then asked to indicate the amount of money required for them to switch to the strategy not chosen.

Riley and Chow asked persons to indicate the total value of their assets and the value of their assets that fell into six alternative categories ranging from riskless to high risk assets. A relative risk aversion index was developed as the ratio of high risk asset value to total asset value.

Other studies attempting to measure risk preference using actual decisions include Yaron et al. who used a proxy for a farmer's risk tolerance, which was a function of the amount of land devoted to alternative crops, the yield per hectare of each crop, and the market price of the crop. This data provided an estimate of the variance in the farm's revenue per acre, which has been used in the economics and finance literature as a proxy for measuring risk.

A technique developed by Barsky et al. provided respondents with a hypothetical choice of keeping their current job or taking an alternative opportunity with a 0.5 probability it would double their income and a 0.5 probability it would cut income by a third. A decision tree approach was used in the downside potential of the alternative opportunity showing that income would be cut by 20 or 50 percent, depending upon the answer in the first question. This resulted in an ordinal ranking of risk preferences.

Data and Methods

A mail survey was developed to elicit the risk preferences of cow-calf producers in Louisiana and South Dakota. The questionnaires contained six alternative risk elicitation procedures. These procedures are discussed as follows:

Question I utilized a self-rank elicitation method. Respondents were asked, "Relative to other investors, how would you characterize yourself?" Three possible answers were (1) I tend to take on substantial levels of risk in my investment decisions, (2) I tend to avoid risk when possible in my investment decisions, and (3) I neither seek nor avoid risk in my investment decisions. Ranking risk preference from most risk averse to most risk prone, option (2) would be the most risk averse, while (1) would be the most risk prone. This self-rank question is similar in nature to those presented by Cardona and by Fausti.

Question II presented the following situation:

"(1) Suppose that you are the only income earner in the family, and you have a satisfying job guaranteed to give you the level of income you now maintain every year for life. You are given the opportunity to take a new and equally satisfying job, with a 50-50 chance it

will double your current income and a 50-50 chance that it will cut your family income by 33 percent. Would you take the new job?"

The respondent was asked to answer, "yes" or "no". If the respondent answered "yes", he or she was asked (2). If the respondent answered "no", he or she was asked (3):

"(2) Suppose the chances were 50-50 that the new job would double your family income and 50-50 that it would cut it in half. Would you still take the new job?

The respondent was asked to answer "yes" or "no."

(3) Suppose the chances were 50-50 that the job would double your family income and 50-50 that it would cut it by 20 percent. Would you then take the new job?"

Once again, the respondent was asked to answer "yes" or "no."

Persons who answered "no" to both (1) and (3) were rated as the most risk averse. Those who answered "no" to (1) and "yes" to (3) were rated as the second most risk averse. Those who answered "yes" to (1) and "no" to (2) were the second least risk averse, and those who answered "yes" to both (1) and (2) were rated as the most risk prone. This question was used by Barsky et al. to elicit risk preference.

In Question III, five hypothetical investments with three potential states of nature each were presented to the respondent. The question was phrased as follows:

"Suppose you have $100,000 to invest. Suppose there are five different options in which you might invest your money. These options are illustrated below in both the chart and table. With the first option, you are certain to receive $10,000, or a 10% return. Thus, at the end of the year you will have $100,000 + $10,000 = $110,000. Money in a savings account would be an example of such an investment. However, you can increase your

average net return by increasing the riskiness of your investment. In Option 2, for instance, you have a 1/3 chance of receiving an average net return of $10,600. However, with this investment, you increase the riskiness since you would also have a 1/3 chance of receiving $8,170 and a 1/3 chance of receiving $13,030. Please examine the five options and answer the following questions."

Returns of the five investments are presented in Table 1. These five investments were developed such that their selection would indicate the decision maker fell within one of five alternative intervals of the coefficient of absolute risk aversion, as shown in Table 1. Intervals were chosen according to Babcock et al. Given two lotteries, a non-degenerate lottery of $10,000 and an equal-probability three-element distribution with outcomes $0, $10,000 and $20,000, a 33 percent risk premium would be calculated as $10,000 * 0.33 = $3,333.33; a 67 percent risk premium would be calculated as $6,666.77, etc.

To develop investments to represent the types that a decision maker could face, given the prior choice of interval of the coefficient of absolute risk aversion, a functional form for the utility function must be assumed. The utility function chosen was the exponential constant absolute risk aversion form, as shown in (1)

(1) $$U(x) = -e^{-lx}$$

The average net return for investment 2 was increased by $600 to $10,600. Given two intervals for the coefficient of absolute risk aversion, [8_1, 8_2] and [8_2, 8_3], and a lottery x_1 with elements {a,b,c}, a lottery x_2 with elements {d,e,f} may be determined that would make the economic

agent with a coefficient of absolute risk aversion of λ_2 indifferent between lotteries x_1 and x_2 using equation (2):

(2) $$-e^{-\lambda_2 a} - e^{-\lambda_2 b} - e^{-\lambda_2 c} = -e^{-\lambda_2 d} - e^{-\lambda_2 e} - e^{-\lambda_2 f}$$

Satisfaction of this equation indicates that the certainty equivalents of both investments are equal. This is based upon condition (3):

(3) $$u(\hat{x}) = E[u(\tilde{x})] = \sum_{i=1}^{n} p_i u(x_i)$$

where $u(\hat{x})$ represents the utility of the certainty equivalent $\hat{x}$, $E[u(\tilde{x})]$ represents the expected utility of the lottery $\tilde{x}$, and p_i represents probability. Values for d and f are determined that, when averaged, equal e.

The survey form includes a table in which the values of each of the five investments are listed. A bar graph accompanies the table, further illustrating the average return and dispersion of the five investments. The respondent is asked to choose which of the investments he would choose if investing $100,000. Choice of investment indicates the interval of the coefficient of absolute risk aversion in which the individual falls.

In Question IV, the interval approach is used to determine the interval of the coefficient of absolute risk aversion in which the respondent falls. Respondents are introduced to the question with the following paragraph, similar to the introduction used in King and Robison and by Wilson and Eidman:

"In the following questions, you are asked to compare distributions of after-tax net returns to your cattle operation that could be used for family living expenses, expansion of your farm, and accelerated debt repayment. The distributions should be thought of as alternative levels of possible after-tax net income for next year that can occur under different weather and economic conditions. Three income levels are listed under each choice, and each income is considered to have one chance in three of actually occurring next year. Consider the different income distributions as resulting from different management strategies available to you. Please choose the distribution in each question that you would prefer. Your answers should reflect your own attitudes and your situation."

In the decision tree approach, the interval of the coefficient of absolute risk aversion is narrowed as a series of sequential choices are made. Each distribution has three elements. The average return over all distributions is $10,000. The highest element in any distribution is $19,800 and the lowest element is $0. Program INTID, as developed by King and Robison, was used to develop the pairs of distributions to be compared. Eight potential intervals resulted, as presented in Figure 1. Note that the borders of the intervals are the same as those used in Question III although, due to the condition that final intervals of absolute risk aversion overlap using the interval approach, an interval used in Question III may be included in more than one interval used with Question IV.

In an illustration of the interval approach as shown in Figure 1, the respondent chooses between distribution A and distribution B. The choice of distribution A leads to the choice between distribution C and distribution D. Choice of distribution D leads to the choice between

distribution I and distribution J. Choice of distribution J indicates that the respondent's coefficient of absolute risk aversion falls within the interval [0.000051, 0.000187].

Question V deals with risky versus riskless calf marketing alternatives:

"Assume you have 100 newborn calves on the ground and plan to wean and sell them when they reach 500 pounds. Assume the quality of these calves is consistent and they are of similar quality to those raised by other producers in your area. Assume the cost per head of raising and transporting your calves to market is $275. Thus, once you are ready to sell all 100 of the animals, you will have $27,500 invested in your animals.

With your new calf crop, you are considering how you will market them once they are weaned. Suppose a buyer with a solid reputation has recognized the quality of your calves from past observation and offers you marketing alternative A. He will agree today to pay you $375 per calf once the calves are weaned. Total revenue from the sale of animals under marketing alternative A will be $37,500, for a certain profit of $10,000 ($37,500 - $27,500). This will require you to sign a binding contract with the buyer today for the sale of your weaned calves.

Alternatively, you could select marketing alternative B, which would involve marketing your calves at a local auction. You are uncertain today of the price your newborn calves will bring at the auction once they are weaned. Under marketing alternative B, assume there are three equally likely possible outcomes. Either the price per head will be low, at $300 per calf, medium, at $375 per calf, or high, at $450 per calf."

Respondents are then directed to a table that shows the resulting three possible profit levels under marketing alternative B. Assuming equally probable outcomes and a total cost of

$27,500, the equally probable outcomes of profit are $0, $10,000, and $20,000. Respondents are then provided with the following statements:

> "If you select marketing alternative A today, you will be assured of earning a guaranteed $10,000 profit upon sale of the animals. If you select marketing alternative B, you will have an equally likely chance of making zero profit, a profit of $10,000, or a profit of $20,000 upon sale. When selecting marketing alternative B, your outcome will not become known until after the animals are sold."

Producers are then asked to select between the two marketing alternatives. Selection of marketing alternative A indicates the producer is risk averse, while selection of marketing alternative B indicates the producer is risk prone.

A follow-up question asks respondents the magnitude of the cash payment that would be required for them to choose the marketing alternative not selected. This is a categorical question, with 15 potential answers ranging from $0 to $7,000 and varying in increments of $500. Answers indicate the degree of risk aversion or risk proneness of the respondent; each category corresponds with an interval of absolute risk aversion. For instance, if the respondent were to select Marketing Alternative A and indicated a requirement of $2,000 to change his or her mind, this indicates the interval of the coefficient of absolute risk aversion is [0.000054, 0.000070]. Absolute risk aversion categories were designed according to the ranges indicated in Table 3.

Question VI attempts to use the Modified von Neumann-Morgenstern approach to elicit the respondent's utility function. The authors are unaware of any study in which this method has been used to elicit risk preferences in a mail survey context. Respondents were introduced to this approach in the following manner:

"In this section, you will be presented with six different lotteries that a trusted source offers you. We would like you to tell us how much you would pay this source to play each of the lotteries. The "correct" answer is the amount that you would pay to play each of the lotteries. Let us provide an example:

Suppose a trusted source were to offer you a lottery where a fair coin is tossed. As soon as the coin is tossed, he will pay you according to the following Payout Table. With a "heads", you will receive $10,000 and with a tails you will receive $0.

Outcome	Payout
Heads	$10,000
Tails	$0

How much would you pay your friend to play this lottery? $1,000

Let's assume your answer is $1,000. In this case, in the event of a "heads", you would earn $10,000. You would have spent $1,000, so your net gain would be $10,000 - $1,000 = $9,000. In the event of a "tails," you would earn nothing. You would have spent $1,000, so you would be out $0 - $1,000 = -$1,000."

The survey proceeds by asking respondents to provide amounts that they would pay for six alternative lotteries. These lotteries are shown in Table 2. As in the other questions, outcomes range from $0 to $20,000. The coefficient of absolute risk aversion, θ, may be determined by using the error-in-response model (Knowles). This can be accomplished by estimating θ using equation 3 with nonlinear least squares.

(4) $$r = \frac{-1}{\lambda}\ln(0.5e^{-\lambda x} + 0.5e^{-\lambda y})$$

where x is the outcome under a "heads," y is the outcome under a "tails," r is the response, and θ is the parameter to be estimated. With the negative exponential utility function, θ is the coefficient of absolute risk aversion.

For each of Questions III - VI, the researchers were careful to design questions from which direct comparison of intervals of the coefficient of absolute risk aversion could be made. The four questions each had average net returns of $10,000 and upper and lower net returns in the range of $0 to $20,000, in accordance with issues raised by Babcock et al. Thus, direct comparison of intervals may be made across these four procedures.

This study analyzes survey results in three ways: (1) by calculating Spearman Rank Correlation non-parametric statistics, (2) by determining the consistency of responses for Questions III, IV, V, and VI within the same interval of the coefficient of absolute risk aversion, and (3) by determining the understanding of respondents of questions III, IV, V, and VI as the result of a question requesting that respondents rate their understanding of each of the questions. The responses to question VI were dropped out of the analysis because a large percentage of the individual responses were illogical.

Survey data for each of the five remaining elicitation procedures may be ranked from most risk averse to most risk prone, though there are different numbers of possible outcomes for each of the elicitation procedures. Because we are analyzing rank-order data, a nonparametric statistic that analyzes rank order correlation is appropriate. Thus, the Spearman Rank Correlation nonparametric statistic is used to determine whether there is rank order consistency across the six elicitation procedures (Zar). The Spearman Rank Correlation coefficient r_s is computed as in (5):

$$(5) \qquad r_s = \frac{6\sum_{i=1}^{n} d_i^2}{n^3 - n}$$

where d_i is the difference between X and Y ranks and n is the number of observations. The value of r_s may range from -1 to +1, and it has no units.

The second analysis involves determining the percentage of responses that fall within the same interval for Questions III (investment decisions), IV (the interval approach), and V (the calf marketing question). Table 3 presents the situations under which Questions III, IV, and V would be considered consistent in their measurement of risk aversion.

Third, after each of Questions III - V, the following question was asked:

"Please circle the statement that describes your understanding of the preceding question.

(1) I had difficulty understanding the question.

(2) While I had some difficulty understanding the question, I felt I was able to provide a reasonable answer.

(3) I felt I understood the question fully."

Results of these questions are analyzed. Similar questions were not asked for Questions I and II, due to their simplicity and the assumption that all respondents would adequately understand them.

Surveys were sent to 81 Louisiana and 62 South Dakota cow-calf producers who were involved in extension programs. The Louisiana producers were involved in one or both of the Louisiana Calf-to-Carcass program and the Bull Test Program. The South Dakota producers

were involved with the Retained Ownership program. South Dakota producers had previously been surveyed and had been asked whether they would be willing to fill out a survey involving risk attitudes at a future date. Those who indicated "yes" were sent this survey. They were also told that a drawing would be held of all producers who returned their surveys and the winner would receive a cap from South Dakota State University. Louisiana producers had never been surveyed, and were offered $10 to complete the survey. The authors acknowledge that the producers surveyed do not represent a random sample of all cow-calf producers, but rather a sample of producers who are involved in university extension programs. Thus, they likely represent the more progressive producers in their respective states. Surveys were completed by 102 producers: 49 from Louisiana and 53 from South Dakota, for a 71% return rate. However, only 74 of the surveys were completely filled out – 36 from Louisiana and 38 from South Dakota.

A Test For Rank Order Consistency Across Risk Preference Elicitation Techniques

Respondents appeared able to answer all questions except Question VI, for which few "reasonable" answers were provided. Only Questions I - V are discussed in this section.

Table 4 presents the results of the analysis of the Spearman Rank Correlation Coefficients for each of the five questions analyzed. Results indicate that responses for only Questions I and III were rank-order correlated with one another. One would expect these questions to be correlated because Question I asks respondents how they would characterize themselves relative to other investors and Question III asks the respondent to choose among five investments that differ in expected returns and dispersion. Thus, the questions are framed in the context of investments. However, when the questions were framed in an alternative context, such as with

respect to their jobs or returns to their cattle operations, the results were not correlated. One might expect Questions IV and V to be correlated due to framing since both dealt with net returns to the cattle operation. However, this was not the case.

In determining consistency of Questions III, IV, and V according to Table 3, little consistency was found. Results of Questions III and IV, the investment choice and interval approach, showed consistency in risk preference in only 27 cases, or 36 percent, of the cases. For Questions III and V, the investment choice and calf marketing question, consistency in risk preference was found in only 21 cases, or 28, percent of the cases. For Questions IV and V, the interval approach and the calf marketing question, consistency was found in only 19 cases, or 26 percent,of the cases.

Of Questions III, IV, V, and VI, only Question III, the choice among alternative investments, clearly emerged as the one question that respondents felt they best understood (Table 5); 77.0 percent felt they understood the question fully, 18.9 percent felt they were able to provide reasonable answers though they had experienced some difficulty, and only 4.1 percent had difficulty understanding the question.

Both the calf marketing question (V) and the von Neumann-Morgenstern question (VI) yielded similar results on this issue, with the calf marketing question being rated as slightly more understandable. However, examination of results of the von Neumann-Morgenstern question indicates that respondents had very little understanding of the questions at hand. The vast majority of responses included answers that would be considered as irrational. An example would be the following: Suppose that the trusted source offered you a lottery with a Heads outcome of $15,000 and a Tails outcome of $10,000. How much would you pay your source to play this

lottery? Many responses fell below $10,000. Certainly, the range of rational responses for individuals who prefer more to less has a lower bound of $10,000. Thus, these responses were not analyzed and the authors do not recommend this procedure for use in a mail survey context. This is not surprising, given past difficulties of authors in eliciting risk preferences using this method and similar ones in personal interviews (e.g., Gillespie).

The question that appeared to pose the greatest amount of difficulty for the respondents was Question IV, the Interval Approach. Only 40.5 percent of the respondents fully understood the questions, while 24.3 percent had difficulty understanding the questions. While this analysis does not necessarily indicate general inferiority of the Interval Approach, it does indicate that its use in a mail survey context requires careful framing of the questions, adequate instructions on the procedures, and careful pre-testing of the survey.

A Test For Robustness Of Risk Preference Elicitation Results Using Behavioral Attributes

The literature on the consequences of risk on human behavior goes beyond attempts to measure the curvature of an agent's utility function. There are numerous empirical studies that have investigated the relationship between social, economic, and lifestyle attributes and an individual's tolerance for risk in the Knightian sense.[1] In the literature on human behavior, psychologists have studied the psychological and social-economic factors relevant to investment decision making e.g. (Snelbecker et. al.). Factors affecting risk tolerance include age, gender, expectations, wealth, etc. In the economics and finance literature, social, economic, and lifestyle

[1] Knightian risk is defined as those uncertain events whose outcomes alter the decision maker's well-being.

attributes include age, education, wealth, income, wealth portfolio allocation, occupation, etc (Friend and Blume, Riley and Chow). In the agricultural economics literature, social, economic, and lifestyle attributes include age, income, education, debt ratio, net worth, size of farm operation, degree of diversification, off farm income, years of experience, etc (Wilson and Eidman, Schurle and Tierney).

Each of the risk elicitation methods discussed above allowed an ordinal risk preference ranking of the survey group to be determined. The ordinal risk preference ranking allowed an ordered probit procedure to be used to analyze the robustness of the relationship between the ordinal risk preference rankings and the mail survey data collected on human behavior of the survey group.

Survey data collected contained information on participant behavior in a number of areas: A) economic and financial, B) social, and C) lifestyle. Economic and financial information categories are 1) hypothetical long- and short-term investment allocation questions; 2) annual household net income, 3) debt to asset ratio, 4) percentage income from off farm employment, 5) percentage of portfolio allocation of wealth among different types of assets, 6) forage management practices, 7) size of cowherd, and 8) use of extension services. Social information categories are 1) education, 2) age, and 3) location of farm or ranch. Lifestyle information categories are 1) gambling behavior, 2) tobacco use, 3) alcohol use, 4) seatbelt use, 5) driving practices, 6) exercise habits, and 7) product warrantee purchase behavior .

The statistical analysis was conducted using SAS. Six models were estimated using all of the behavioral attributes listed above. The probit procedure used a SAS “stepwise” model

selection procedure to select the best model. A summary of the statistical analysis is provided in Table 6.

Model I's dependent variable is the ordinal ranking of the *self ranking* risk assessment question responses. Behavioral attribute variables had the greatest explanatory power for explaining the variability in the ordinal ranking produced by this elicitation procedure (-2logL = 40.5). The independent variables were able to predict the correct ordinal ranking 81.2% of the time. Significant independent variables with correct sign are 1) debt to asset ratio, 2) tobacco, 3) alcohol, 4) and extension. Significant independent variables with the incorrect sign are 1) net income, 2) cowherd size, and 3) forage management.

Model II's dependent variable is the ordinal ranking of the *new job* risk assessment question responses . Behavioral attribute variables provided the second best fit for explaining the variability in the ordinal ranking produced by this elicitation procedure (-2logL = 28.8). The independent variables were able to predict the correct ordinal ranking 75.6% of the time. The only significant independent variable with the correct sign is net income. Significant independent variables with the incorrect sign are: 1) driving speed, and 2) age.

Model III's dependent variable is the ordinal ranking of the *investment choice* risk assessment question responses. Behavioral attribute variables had the second lowest level of explanatory power for explaining the variability in the ordinal ranking produced by this elicitation procedure (-2logL = 21.0). The independent variables were able to predict the correct ordinal ranking 71.6% of the time. Significant independent variables with correct sign are 1) debt to asset ratio, and 2) driving speed. Significant independent variables with the incorrect sign are 1) net income, 2) cowherd size, 3) education level, and 4) forage management.

Model IV's dependent variable is the ordinal ranking of the *interval approach* risk assessment question responses . Behavioral attribute variables had the poorest fit for explaining the variability in the ordinal ranking produced by this elicitation procedure (-2logL = 4.0). The independent variables were able to predict the correct ordinal ranking 58% of the time. There were no significant independent variables with the correct sign. The only significant independent variable with the incorrect sign is driving speed.

Model V's dependent variable is the ordinal ranking of the *calf marketing decision* risk assessment question responses . Behavioral attribute variables had the fourth best fit for explaining the variability in the ordinal ranking produced by this elicitation procedure (-2logL = 22.5). The independent variables were able to predict the correct ordinal ranking 75.2% of the time. Significant independent variable with the correct sign are 1) income; and 2) age. The only significant independent variable with the incorrect sign is tobacco use. Farm location was also found to be significant. The implication is that Louisiana cow/calf operators are less risk averse than South Dakota cow/calf producers.

Model VI's dependent variable is the ordinal ranking of the *calf marketing decision plus premium* risk assessment question responses . Behavioral attribute variables provided the third best fit for explaining the variability in the ordinal ranking produced by this elicitation procedure (-2logL = 28.4). The independent variables were able to predict the correct ordinal ranking 72.4% of the time. Significant independent variables with the correct sign are 1) net income, and 2) age. Significant independent variables with the incorrect sign are 1) tobacco use, and 2) driving speed. Farm location also was found to be significant. The implication is that Louisiana cow/calf operators are less risk averse than South Dakota cow/calf producers. This result agrees with

model V. This is expected, given that the information for models V and VI is derived from the same survey question.

Conclusions, Limitations, and Future Research

Results of this study show little rank order consistency between the five risk preference elicitation procedures tested. Only Questions I and III had a statistically significant degree of rank-order consistency. These results support previous studies that have underscored the importance of *framing* in eliciting risk preference. Both questions were framed in the context of choice of investment. We find no evidence to suggest that the remaining four questions measure the same preference for risk. Furthermore, when Questions III, IV, and V were checked for consistency of risk preference measurement, little consistency was found.

The above conclusion is also consistent with the probit analysis results. The *self assessment* risk preference elicitation procedure provided the most consistent rank ordering when evaluated with the behavioral attribute responses. The interval approach proved to be the most inconsistent. The other four models were tightly grouped and only slightly inferior to the self assessment model. Net income was a significant attribute variable in five of the six models. Net income, however, did not have a consistently correct sign across models. Comparing across models on the basis of global fit, the conclusion is that: *The simpler the risk elicitation procedure used in a mail survey the better.* While the self-ranking model had the highest global test statistic, the incorrect *income* coefficient sign is troubling. The probit estimates from the calf marketing question models (V, VI) are more consistent with *apriori* parameter sign assumptions. Again, the simpler calf market model is as robust as the more complicated version.

While inconsistency across elicitation procedures does not necessarily lead to the conclusion that only one or, at maximum, two of the elicitation procedures will lead to valid results, one can conclude that interchanging the questions for use as general income risk preference elicitation procedures is not valid.

Further research needs to be conducted to examine which of the procedures leads to the best characterization of risk preference. Further research could examine the correlation of each of the risk preference elicitation procedures with actual decisions involving risk. Such actual decisions might include investment and insurance strategies.

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Table 1. Returns of Investments of $100,000 in Question III.

Investment	Lowest Net Return Prob = 0.33	Average Net Return Prob = 0.33	Highest Net Return Prob = 0.33	Interval, Coefficient of Absolute Risk Aversion	Associated Interval, Risk Premium, %
1	$10,000	$10,000	$10,000	[0.000317, +∞]	[66.7, +∞]
2	$8,170	$10,600	$13,030	[0.000109, 0.000317]	[33.3, 66.7]
3	$6,420	$11,200	$15,980	[0, 0.000109]	[0, 33.3]
4	$5,420	$11,200	$16,980	[-0.000109, 0]	[-33.3, 0]
5	$3,440	$10,600	$17,760	[-∞, -0.000109]	[-∞, -33.3]

Table 2. Lotteries Provided in Question VI.

State of Nature	Lottery 1	Lottery 2	Lottery 3	Lottery 4	Lottery 5	Lottery 6
Heads	5,000	10,000	15,000	50	10,000	5,000
Tails	0	5,000	10,000	0	20,000	15,000

Table 3. Table to Be Used to Determine Whether Consistency Exists Between Questions III, IV, V and VI.

If this Investment Is Chosen In Question III	These Interval(s) Could Be Chosen in Question IV	These Marketing Alternatives Could Be Chosen in Question V[1]
1 [0.000317, +∞]	G [0.000187, 0.000660] or H [0.000317, +∞]	A; Premium = $7,000.
2 [0.000109, 0.000317]	G [0.000187, 0.000660] or I [0.000109, 0.000318] or J [0.000051, 0.000187]	A; ($3,500 < Premium < $6,500)
3 [0, 0.000109]	J [0.000051, 0.000187] or L [0, 0.000109] or K [-0.000051, 0.000051]	A; ($0 < Premium < $3,000)
4 [-0.000109, 0]	L [0, 0.000109] or K [-0.000051, 0.000051] or M [-0.000109, 0]	B; ($0 < Premium < $3,000)
5 [-0.000109, -∞]	N [-0.000051, -∞]	B; ($3,500 < Premium < $7,000)

1. The letter denotes either Marketing Alternative A or B, followed by the premium required to switch to the other marketing alternative.

Table 4. Matrix of Spearman Rank Correlation Coefficients.

	Question I Self-Rank	Question II Job Opportunity	Question III Investments	Question IV Interval Approach	Question V Calf Marketing
Question I Self Rank	1.000	-0.016	0.339**	0.118	-0.032
Question II Job Opportunity		1.000	-0.070	-0.024	0.053
Question III Investments			1.000	0.000	0.101
Question IV Interval Approach				1.000	-0.036
Question V Calf Marketing					1.000

Table 5. Results of Analysis Regarding Understanding of Questions III, IV, V, and VI.

Response	Question III	Question IV	Question V	Question VI
I had difficulty understanding the questions.	4.1	24.3	5.4	10.8
While I had some difficulty understanding the questions, I felt I was able to provide reasonable answers.	18.9	35.1	28.4	23.0
I felt I understood the questions fully.	77.0	40.5	66.2	66.2

Table 6. Ordered Probit Results.

Table 6. ORDERED PROBIT MAXIMUM LIKELIHOOD ESTIMATES

	MODEL I	MODEL II	MODEL III	MODEL IV	MODEL V	MODEL VI
	L=40.5, p=.0001, c=.812	L=28.8, p=.0001, c=0.756	L=21.0, p=.0018, c=.716	L=4.0, p=.0481, c=.582	L=22.5, p=.0004, c=.752	L=28.4, p=.0005, c=.724
VARIABLE						
DEBT TO ASSET	-0.28***	-0.10	-0.18***			
NET INCOME	-0.31***	0.23**	-0.20**		0.21*	0.19*
COWHERD SIZE	-0.28***		-0.16***			
TOBACCO USE	1.17***				-1.21**	-1.18***
ALCOHOL USE	0.37*					
EXTENSION USE	0.50**					
GAMBLING	0.12*				0.11	
DRIVING SPEED		-0.77***	0.44**	-0.33**		-0.49***
SEATBELTS						
EDUCATION			-0.19*			
FORAGE	-0.26***		-0.14*			
AGE		0.31***			-0.27*	-0.26**
LOCATION					0.88**	1.14***
EXERCISE						0.19

*** Pr> Chi Square = .01 or less
** Pr> Chi Square = .011 to .05
* Pr> Chi Square = .051 to 10

Figure 1. Decision Tree Used in the Interval Approach