RISK PREFERENCES OF FARMERS: AN EMPIRICAL EXAMPLE, SOME QUESTIONS, AND SUGGESTIONS FOR FUTURE RESEARCH

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Introduction

The effect of risk on producers' decisions has been of interest to agricultural economists for many years. However, only in the past ten to fifteen years have we as a group of researchers attempted to measure the impact of risk on farmers' decisions. As long as producers are not risk-neutral, we cannot assume that they behave as profit-maximizers. In view of uncertainty concerning the outcome of producer decisions, the risk attitude of individual producers will influence their decisions. An understanding of producers' risk attitudes will then permit imposition of policies with the rewards and penalties necessary to affect individual choices to meet the objectives of the policy.

In order to determine risk attitudes, a utility function for gains and/or losses for each individual producer is necessary. Various techniques for eliciting utility functions have been used in the past.[1] Presently, it appears that a modified-Ramsey technique used by Halter and Mason has some theoretical and practical advantages that make it superior to other techniques presently available, at least given research project budget constraints. The modified-Ramsey technique was used to elicit the utility functions used in this paper.

Although there have been several attempts to measure risk attitudes at a single point in time, there has not been as much research on the dynamics of risk attitudes, i.e., the changes in risk attitudes over time.[2] It is the purpose of this paper to investigate the dynamics of risk attitudes of a group of agricultural producers from a relatively homogeneous area in western Oregon.

Utility functions do not permit interpersonal comparisons concerning risk attitudes. However, Pratt developed a measure of risk aversion that does permit interpersonal comparisons of risk attitudes. Given a utility function for money, $U(X)$, we define this measure of risk aversion as the negative ratio of the second derivative of the utility function to the first derivative of the utility function and call this measure the Pratt coefficient, $r(X)$. That is, $r(X) = U''(X)/U'(X)$. Thus, the Pratt coefficient is a measure of curvature of the utility function and is invariant up to a linear transformation of the utility function for money.

It is usually assumed that utility functions for money are monotonically increasing over the relevant ranges of values, i.e., $U'(X) > 0$. The second

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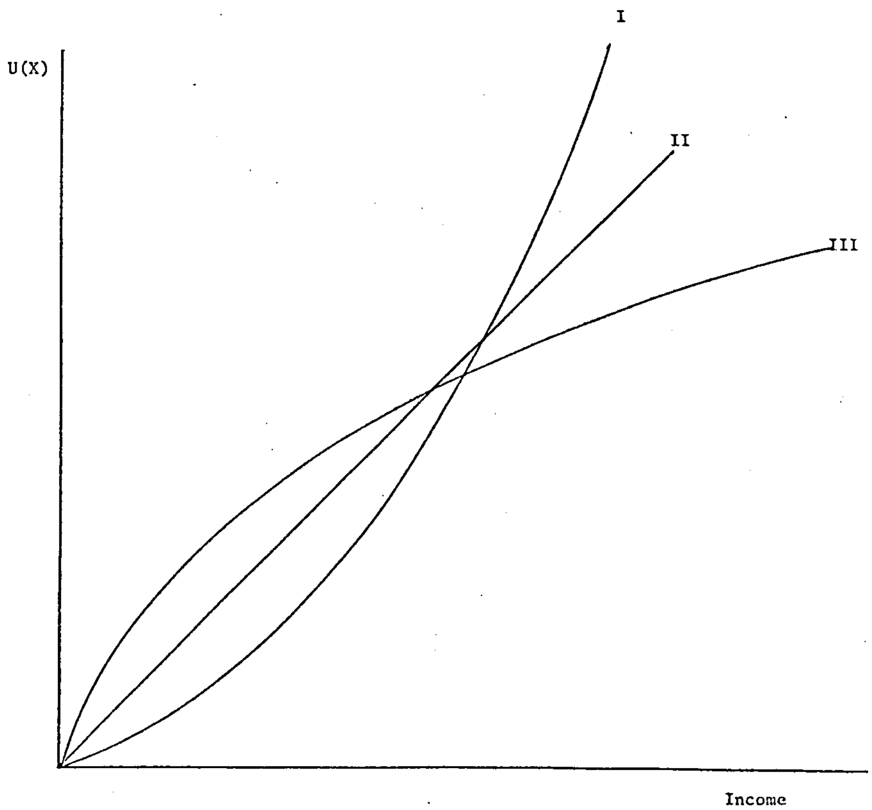
derivative is unrestricted in sign being positive for risk takers, negative for risk averters, and zero for risk neutrals. In view of these relationships, the Pratt coefficient for a specified amount of money is positive, negative, or zero as the individual is risk averse, a risk taker, or risk neutral, respectively (Figure 1).



I - Risk taker, Pratt coefficient = $-U''(X)/U'(X) < 0$

II - Risk neutral, Pratt coefficient = 0

III - Risk averse, Pratt coefficient > 0

Figure 1. Relationship between shape of utility function and risk attitude.

The Pratt coefficient is a pure number for a specified money amount and allows interpersonal comparisons of risk attitudes at the specified amount. Note, however, that the Pratt coefficient is not necessarily a constant for a given utility function of different income levels (it is constant for risk neutral individuals). In fact, an individual may be risk averse for some income levels and a risk taker for others.

The Model

To examine the dynamics of risk attitudes, a group of "grass seed" farmers from the Willamette Valley in Oregon were interviewed in 1974 and 1976. Various socio-economic characteristics were solicited during the interviews. In addition, information to estimate utility functions was elicited using the modified-Ramsey technique. From the elicited utility functions, Pratt coefficients were computed for each farmer for 1974 and 1976.[3/] Regression analysis was then conducted with the Pratt coefficient as the dependent variable and the various socio-economic variables as independent variables. The purpose was to explain the individual's risk attitudes (Pratt coefficients) as a function of their socio-economic characteristics.

The variables that were found to be significant were the age of the farmer (AGE), the educational level of the farmer (ED), the educational level of the farmer squared (EDSQ), the percentage of acres farmed that were actually owned by the farmer (PCACOW), an interaction term between the percentage of owned acreage and educational level (POWED = PCACOW x ED), and an interaction term between age and educational level (AGED = AGE x ED).[4/] For greater detail and discussion of the variables, see Halter and Mason and Ahmed.

Empirical Results

In 1974, there were 44 respondents to the survey. By 1976, this number was reduced to 37 due to deaths, retirements, or other reasons. The results of the regression analysis are presented as Table 1. Equation 1 is based on the Pratt coefficient for 1974 which is derived from the 5-point utility function and 44 respondents, hence PRAT 74-5:44 is the dependent variable. The other dependent variables are interpreted similarly. Equation 1 is essentially identical to the model discussed by Halter and Mason.

Table 1. Estimated coefficients and standard errors.[a,b]

Equation	Dependent Variable	ED	AGE	PCACOW	POWED	EDSQ	AGED	CONSTANT	R^2
1	PRAT 74-5: 44	-5.623 (2.427)	-1.946 (.799)	.2175 (.0348)	-.0613 (.0123)	.9089 (.3043)	.5325 (.2423)	9.218 (6.128)	.566
2	PRAT 76-7: 37	3.802 (1.081)	.5569 (.4568)	-.1257 (.0194)	.0380 (.00645)	-.8044 (.148)	-.1377 (.1394)	-4.329 (3.144)	.709
3	PRAT 74-5: 37	-3.065 (2.393)	-.2304 (1.011)	.1566 (.0429)	-.0449 (.0143)	.8631 (.3278)	.0274 (.3085)	1.231 (6.961)	.413

a/ Variables are as earlier defined.

b/ Numbers in parantheses are standard errors.

Equation 2 represents the same variables as Equation 1. The dependent variable is the Pratt coefficient derived from the 1976 utility functions which were estimated from seven data points (rather than five as in 1974). Examination of Table 1 reveals that the sign of every estimated coefficient changed between the 1974 and 1976 models. Is it possible that risk attitudes could change so completely in two years? An example of the meaning of these sign changes is illustrated in Figure 2. The question that immediately comes

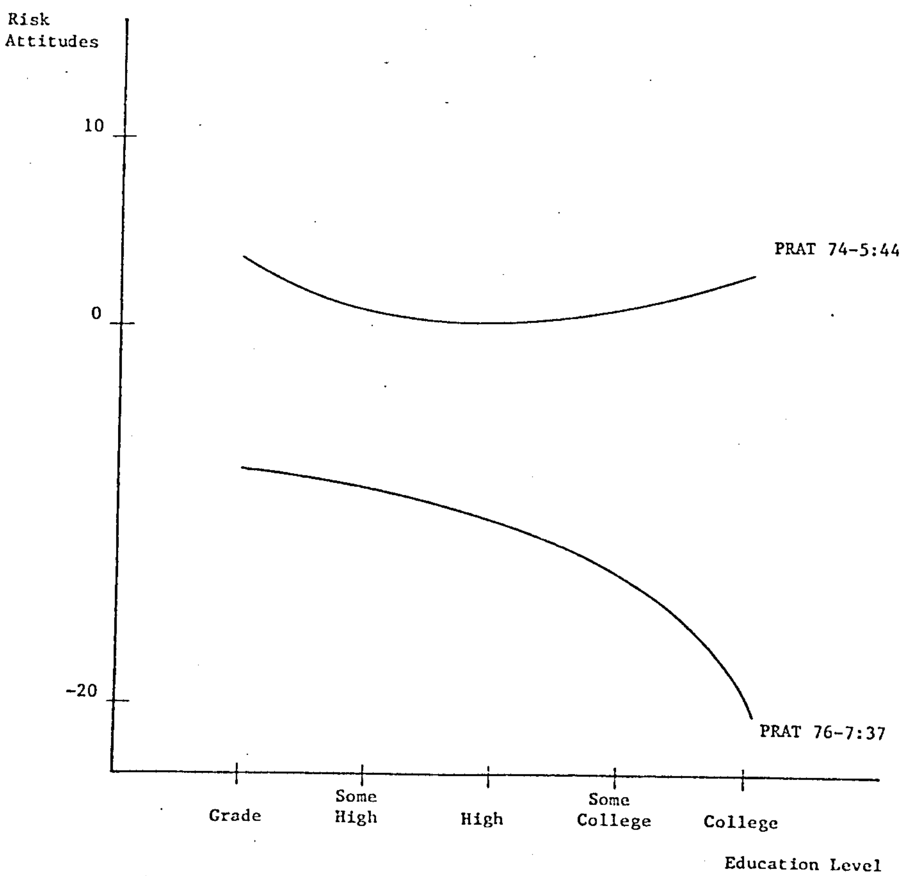


Figure 2. Relationship Between Education Level and Risk Attitude Holding Other Variables at Their Means.

to mind when examining these two models is "what happened?" It was hypothesized that the different samples may have been responsible for the complete reversal of signs. To test this, the seven observations that were "lost" between 1974 and 1976 were removed from the 1974 data and the 1974 model was re-estimated with the same 37 observations that were used for the 1976 model. The results are reported as Equation 3 in Table 1. Notice that the two 1974 models have identical signs on every coefficient and are the opposite of every sign on the 1976 model. However, a good deal of the explanatory power of the 1974 model was lost with the removal of the seven observations as is evidenced by the reduction in R^2 and significance levels.

At this point in a paper of this type, the implications of the empirical results are usually discussed. However, given the discrepancies between the results of this study and those of Halter and Mason's study, a discussion of the implications of our results seems a bit heroic if not downright arrogant. Instead, the remainder of this paper will consist of two parts. First, a discussion of possible reasons for the discrepancies between this research and that of Halter and Mason will be presented. Second, suggestions for future research using an extended version of this data set will be discussed.

Reasons for Discrepancies

One possible reason for the discrepancies between this study and Halter and Mason's lies in the change in the number of observations from 44 (Halter and Mason) to 37. Using all 44 observations, the mean income midpoint of the farmers increased from $147 thousand in 1974 to $148 thousand in 1976, a negligible change. However, when only the 37 observations of this study are included, farmers' mean income midpoint increased from $154 thousand to $176 thousand an increase of over fourteen percent. The means of all other variables used in the study were virtually identical when calculated using 44 and 37 observations. The difference between equations 1 and 3 in Table 1 tends to suppress the probability of nonrandomness of the seven observations deleted between 1974 and 1976, but the change in mean income midpoint does raise some questions.

Between 1974 and 1976, the mean Pratt coefficient (based on 37 observations) decreased from 0.40 to -0.29 (i.e., slightly risk averse to slightly a risk taker). This change in risk attitude during the two year period may be a clue to the discrepancies between this study and that of Halter and Mason. It is very unlikely that the change in the Pratt coefficient is attributable to the change in income discussed above. All estimated utility functions of farmers are polynomials of order one, two, or three. An increase in income will have no effect on the Pratt coefficient of a linear utility function, will increase the Pratt coefficient of a quadratic utility function, and may increase or decrease the Pratt coefficient of a cubic utility function.[5/] To further test the hypothesis that the change in the average Pratt coefficient between 1974 and 1976 was caused by the change in income between 1974 and 1976, the change in the Pratt coefficient was regressed on the change in income for the 37 observations. The R^2 was .002 and the estimated coefficient was only one third the size of its standard error. Therefore, the change in the Pratt coefficients of farmer respondents between 1974 and 1976 must have been caused by some exogenous variable.

One likely cause of the change in the Pratt coefficient is a change in political uncertainty surrounding the field burning issue. The farmers interviewed in this study are all predominantly grass seed producers. Currently, field burning is the least cost method for disease control and residue removal. Public concern about the air pollution accompanying field burning began to increase in the 1960's and the first public control measures were enacted in 1969. In 1974, there was considerable political uncertainty surrounding the field burning issue. By 1976, it appeared that the grass seed farmers were in a sense winning and field burning restrictions would not be as great as thought earlier. This change in legislation could have caused farmers to be less risk averse (or more generally, all Pratt coefficients would have decreased), but whether or not a change in political climate had a major effect on the factors affecting the Pratt coefficient is pure speculation (see Conklin and Bradshaw for a thorough discussion of the field burning issue).

Another possible cause of the discrepancies between the results of this study and those of the study of Halter and Mason is model misspecification. There are several forms misspecification could take. One is a measurement error in the dependent variable. Conceptually, the correct measure of the dependent variable would be utility of net worth of the firm (long run) or utility of net income (short run). Halter and Mason evaluated the Pratt coefficients using gross income, which could cause misleading results due to different debt commitments, production practices or even crops produced among the various farmers. In defense of gross income, data are easily obtained, and since the sample was relatively homogeneous, gross income might not be too bad an approximation of net income.

Another relevant question is whether a point measure of risk preference can adequately represent risk preference at all. Another possible specification error is of course omission of a relevant independent variable. The omission of variables representing percent debt are especially noticeable. The variable, debt as a percent of farm value, was included in the regressions, but its estimated coefficient was not statistically different from zero. Nonfarm wealth variables could exert a significant effect on risk preference, but no data on variables of this type were available.

In summary, some possible reasons for the discrepancies have been suggested. However, given the data currently at our disposal, the discrepancies will remain a mystery.

Suggestions for Future Research

Given the discrepancies between this research and that of Halter and Mason, the following question arises: do the possible benefits of future research in the area justify additional research expenditures? Although we are somewhat skeptical, we suggest they do. The cost of interviewing the 37 farmers in the data set is minimal. Some of the information missing in the earlier data sets (nonfarm wealth and income, net worth, and net income for example) could likely be collected and perhaps part of the questions raised in this study could be answered. In addition, a third observation in time would be obtained so that a more extensive look at the dynamic factors surrounding risk preference could be taken. If future research is to be conducted using an extended version of this data set, it will be used primarily to address the following questions (these questions closely follow those of Young et. al., and the quotation is from their paper, page 29):

1. Does the sensitivity of the results to changes in the model structure make information gathered from this attempt using direct utility elicitation totally suspect?

2. "Which hypotheses concerning relationships between risk preferences and producer attributes should be tested?

3. "What promising methodologies are available for measuring risk preferences and establishing relationships between risk preferences and producers attributes?"

This paper indicates extreme sensitivity of the results of risk preference research. Future research would analyze this sensitivity of the results to various sets of independent variables as well as to the point where the Pratt coefficient is evaluated. Relevant questions along these lines include: are the results sensitive to evaluation of the Pratt coefficient using net income or net wealth instead of gross income and how much do the results change when the Pratt coefficient is evaluated at mean income plus or minus one standard deviation rather than mean income?

The hypotheses to be examined need to be considered. Are financial variables important? Can the political climate surrounding the field burning issue be incorporated into the analysis in some manner? Should nonfarm wealth variables be included? What other relevant socio-economic variables were omitted? What additional data should be collected? Hopefully, these questions can be at least partially addressed in future research.

Finally the whole issue of whether the Pratt coefficient is an adequate measure of risk preference should be addressed. Is any "point" estimate of risk preference adequate for empirical analysis? What alternatives exist for representing risk attitudes?

It is certain that future research using an extended version of this data set will leave many questions unanswered. It is the opinion of the authors, however, that such research does provide a "least cost" attempt to answer some of the doubts (one way or another) raised by Young et. al. concerning relative costs and benefits of direct elicitation of utility functions.

Footnotes

1/ A discussion of the various techniques is not presented here. The reader is referred to Dillon or any text in decision analysis.

2/ Officer and Halter did analyze risk attitudes at two points in time. However, as noted by Lin, Dean, and Moore, it appears that Officer and Halter may have arbitrarily affected the shape of the utility functions they estimated due to the elicitation technique that they used.

3/ The 1974 utility function was estimated from five data points. The 1976 utility function was estimated from seven data points. The Pratt coefficients were estimated at the gross farm income level of the respondent.

4/ For statistical purposes, AGE was coded as: 1= under 25, 2 = 25-29, 3= 30-34, 4 = 35-39, 5 = 40-44, 6 = 45-49, 7 = 50-54, 8 = 55-59, 9 = 60-64, and 0 = 65 and over. ED was coded as: 1 = grade school or less, 2 = some high school, 3 = completed high school, 4 = some college, and 5 = college completed.

5/ This fact can be demonstrated easily by differentiating the Pratt coefficient with respect to income. If an increase in income (I) is to decrease the Pratt coefficient of a cubic utility function of the form $U = a+bI+cI^2+dI^3$, then the following condition must hold: $18d^2I^2 + 12cdI + 4c^2-6db<0$.

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