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# AN EMPIRICAL ANALYSIS OF THE INTERTEMPORAL STABILITY OF RISK PREFERENCES

by

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Abstract

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Stability of Risk Preferences

The interval measurement approach was used to obtain risk preference measures for 23 Michigan farmers in 1979 and again in 1981. This paper analyzes how the risk preferences of this group of decision makers changed over a two year time period. It finds that risk preferences were most stable near typical personal income levels.

## Biographical Data

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# AN EMPIRICAL ANALYSIS OF THE INTERTEMPORAL STABILITY OF RISK PREFERENCE

Farmers and ranchers continually make production, marketing and financial decisions in the absence of complete knowledge. The consequences of some decisions may not warrant explicit consideration of uncertainty by the decision maker. Yet, economists understand that the costs of making a less right versus a more right decision frequently justify that consideration (Johnson, et. al.). The need to address decision making problems in a perspective of uncertainty has long been realized. Recent advancements in theory and analytical techniques have made it possible for agricultural economists to more seriously consider management decisions under uncertainty (Conklin and Hanson; Lins, Gabriel and Sonka).

The base for much of the recent theoretical progress for decision making under uncertainty is the expected utility hypothesis. The hypotheis states that choices made under uncertainty are affected by the decision maker's preferences and expectations. Despite its wide acceptance as a theoretical model, important operational problems have made the expected utility hypothesis difficult to apply in the analysis of actual decisions.

One problem is that the expected utility hypothesis requires explicit information about the decision maker's preferences. In investigating the possibility of large scale estimation of U.S. agricultural producers' risk preferences, Young, et. al. (p. 14) expressed that, "changing

objectives, information and attitudes could make an individual risk aversion coefficient an elusive moving target." The primary reservations with respect to eliciting risk preferences in the Young, et. al. paper were twofold: (1) the errors inherent in previously used measurement techniques; and (2) the possible intertemporal transitivity of preferences. In reference to the former reservation, King and Robison have presented a promising new methodology, based on stochastic dominance with respect to a function, for measuring risk preferences. Their methodology overcomes many of the problems attributed to use of previously employed measurement procedures. As to the latter reservation, Young, et. al. (p. 25) goes on to note that, "the issue of stability of risk preferences is ultimately an empirical question whose resolution would require longitudinal studies." The need for verification of the proposition of possible intertemporal transitivity of risk preferences is well attested to in the literature (Halter and Mason; Whitaker and Winter).

While the import is understood, to date only two studies collecting longitudinal data on risk preference have been reported. Officer and Halter estimated the utility functions of four Australian wool producers at two points in time. The only conclusion they reached as to intertemporal transitivity of risk preference was that "over a period of a year ...their utility functions, did not change radically" (p. 275). Their own remarks and subsequent literature have revealed significant shortcomings in the reliability of the results (Robison).

A most disturbing intertemporal study of risk preferences was made by Whitaker and Winter who repeated an earlier study by Halter and Mason. In both studies risk attitudes were measured and related to characteristics of the decision makers. For the most part, the signs of regression coefficients relating characteristic to risk aversion coefficients were reversed in the two studies. And while these two studies did not address specifically the question of intertemporal stability of risk preferences, their results could be used to infer instability of risk preferences. However, the author's own skepticism of the viability of the method used to obtain risk preferences precluded such an inference.

This paper presents results from an intertemporal study of farmers risk preferences. The King and Robison interval approach was employed to measure risk preference intervals of 23 mid-Michigan farmers accross four possible ranges of income. In the section that follows, the interval estimation approach is reviewed. Subsequently a description of the sample and empirical data are presented. Finally, the data is analyzed to test the hypothesis that risk preferences are intertemporally stable.

Methodology

The interval approach was developed in response to well documented deficiencies of previously used methods of measuring preferences. The most commonly employed of these methods are those which attempt to directly elicit utility (Anderson, Dillion and Hardakar). Due to shortcomings in the design of elicitation interviews, problems in statistical estimation, respondents lack of precise knowledge about their preferences and the functions being treated as exact representations, empirically estimated utility functions often prove to be an unreliable tool in representing and predicting decision maker preferences.

Several efficiency criteria were formulated to overcome some of these failings. The criteria include first and second degree stochastic dominance, mean variance efficiency and mean-absolute deviation efficiency. Although the use of efficiency criteria to order choices is in many respects preferable to direct utility elicitation and single value utility functions, they too have several serious faults which limit their usefulness (King and Robison).

Meyer created a more general efficiency criterion, stochastic dominance with respect to a function (SDRF). This criterion is at the same time more flexible and more discriminating than previous criteria. Meyer's criterion can be used to order uncertain action choices for classes of decision makers defined in terms of the absolute risk aversion function $r(y)$ (Pratt) over income $y$. Given upper bound $r_u(y)$ and lower bound $r_\ell(y)$ on a decision maker's absolute risk aversion function $r(y)$, an efficient set of action choices can be found which are consistent with the bounded preferences. King and Robison extended the usefulness of SDRF by developing procedures to measure the appropriate bounds on $r(y)$

Basically the procedure allows an individual to respond to a heirarchy of choices between pairs of carefully selected distributions. For each choice the $r(y)$ space is divided into a more refined interval.

To illustrate, suppose each individual was required to make three choices between pairs of distributions of possible after-tax income. Based on these choices, the individual's risk aversion function could be bounded by one of the following eight intervals: (1) $(-\infty, -.0001)$; (2) $(-.0005, 0.0)$; (3) $(-.00025, .0002)$; (4) $(.0001, .0004)$; (5) $(.0003, .0008)$;

(6) (.0006, .0015); (7) (.001, .005); and (8) (.0025, ∞). Repeating this procedure for each of four income ranges in the neighborhood of $0; $10,000; $25,000; and $45,000, a bounded risk aversion function is found which is graphed in Figure 1. This individual's r(y) is bounded by interval #2 for the neighborhood of $0, interval #5 in the neighborhood of $10,000 and so on for each of the four intervals.

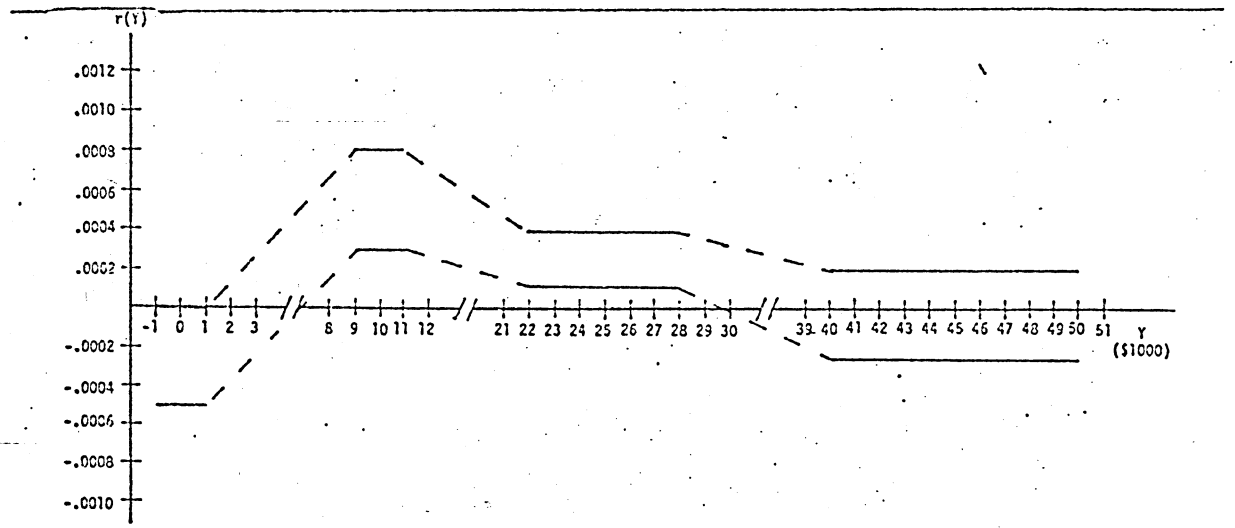


Figure 1. Example of an Interval Preference Measurement.

Sampling Techniques and Data Acquisition

Using the interval approach described above, risk preferences were measured for 23 central and lower Michigan farmers in 1979 and again in 1981. Table 1 lists some of the measures which characterize the sample of farmers and their farms. Primarily the farmers in this study represent three basic farm enterprises: dairy, cash crops, and beef cash crops. Their median ages was 45 in 1979 and 47 in 1981. Their median total sales was $169,600 in 1979 which increased to $231,900 in 1981 while net farm income increased from $45,500 to $52,500 over the same time period. Other data are described in the Table.

Table 1. Selected Sample Description Measures

| Measure | 1978-79 | 1980-81 |
|---|---|---|
| | Median<br>Range | |
| Total sales: $ | 169,600<br>470,000 to 22,017 | 231,900<br>680,300 to 52,900 |
| Net farm income: $ | 45,500<br>155,340 to -15,161 | 52,500<br>230,500 to -62,200 |
| Tillable acres owned: A | 217<br>608 to 0 | 220<br>698 to 34 |
| Total acres tilled: A | 405<br>998 to 134 | 408<br>1019 to 137 |
| Age: years | 45<br>58 to 20 | 47<br>60 to 22 |
| Net worth/Total assets: $ | .70<br>1.03 to .25 | .73<br>1.02 to .27 |

Data and Analysis

The need to test the stability of individual risk preferences makes cumulative tabulation inappropriate. Because of this, a complete listing of individual data is presented in Table 2.

Table 2 lists the risk intervals which corresponds to each individual measured at four different income levels in 1979 and 1981. The data are arranged so that each individual's preference for the two time periods are on the same line. Farmer 1's risk preference intervals in 1979 over income levels I, II, III, and IV were 3, 1, 1, and 1 respectively. In 1981 these risk preferences over the same income level were 3, 4, 1, and 1.

Several observations can be made about the data in Table 1: (1) risk averting and risk preferring attitudes are represented (as is the possibility of risk neutrality); (2) no clear pattern as to functional shape is evident; (3) while all individuals changed intervals for at least one income level between 1979 and 1981, the sample members demonstrated relatively stable preferences; (4) given the large number of times the risk aversion functions were bounded by interval #3, the assumption or risk neutrality is likely valid for many decisions; and (5) no clear pattern of change is evident between 1979 and 1981.

What can be inferred about the null hypothesis that risk preferences are intertemporally stable? Table 3 presents several measures of risk interval stability. Line A of panel 1 summarizes the percentage of times that risk preferences did not change over time. At income interval III, the income level most likely experienced by the decision maker, risk preferences did not change 43 percent of the time. And as line C of panel 1 indicated, they did not change by more than 2 intervals 82 percent of the time. Risk preference stability at the other income levels was much less.

Table 2. Individual Interval Measurements: 1979 and 1981

| Year | 1979 | | | | 1981 | | | |
|---|---|---|---|---|---|---|---|---|
| Level | I | II | III | IV | I | II | III | IV |
| Mean Income: $ | 0 | 10000 | 25000 | 45000 | 0 | 10000 | 25000 | 45000 |
| Farmer # | Interval* | | | | Interval* | | | |
| 1 | 3 | 1 | 1 | 1 | 3 | 4 | 1 | 1 |
| 2 | 3 | 6 | 6 | 4 | 2 | 5 | 4 | 4 |
| 3 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 2 |
| 4 | 3 | 4 | 1 | 1 | 7 | 1 | 1 | 2 |
| 5 | 1 | 1 | 1 | 7 | 8 | 1 | 2 | 8 |
| 6 | 3 | 3 | 1 | 1 | 4 | 3 | 1 | 5 |
| 7 | 3 | 4 | 2 | 1 | 1 | 2 | 4 | 4 |
| 8 | 3 | 3 | 2 | 3 | 1 | 3 | 2 | 3 |
| 9 | 3 | 2 | 1 | 1 | 3 | 4 | 1 | 1 |
| 10 | 1 | 3 | 2 | 5 | 3 | 3 | 2 | 3 |
| 11 | 1 | 4 | 3 | 4 | 1 | 5 | 1 | 1 |
| 12 | 2 | 4 | 2 | 2 | 4 | 2 | 3 | 4 |
| 13 | 1 | 8 | 7 | 1 | 8 | 3 | 2 | 8 |
| 14 | 3 | 1 | 4 | 2 | 1 | 1 | 4 | 2 |
| 15 | 5 | 5 | 3 | 3 | 1 | 5 | 4 | 2 |
| 16 | 3 | 5 | 4 | 3 | 3 | 1 | 4 | 5 |
| 17 | 2 | 5 | 4 | 3 | 6 | 8 | 8 | 8 |
| 18 | 5 | 6 | 2 | 2 | 1 | 5 | 1 | 1 |
| 19 | 2 | 3 | 3 | 3 | 1 | 2 | 2 | 7 |
| 20 | 1 | 1 | 4 | 7 | 1 | 8 | 4 | 2 |
| 21 | 3 | 4 | 4 | 5 | 3 | 4 | 1 | 2 |
| 22 | 3 | 3 | 3 | 3 | 2 | 1 | 3 | 3 |
| 23 | 1 | 5 | 8 | 8 | 3 | 4 | 1 | 1 |

*See page 4 for definition of interval boundries.

Table 3. Measures of Interval Change and Related Test Statistics

| | (Panel 1) | | | |
|---|---|---|---|---|
| Income level | I | II | III | IV |
| Measure | Percentage | | | |
| A. No interval change | 26 | 30 | 43 | 26 |
| B. No change or change to adjacent interval | 48 | 52 | 70 | 48 |
| C. No change beyond two adjacent intervals | 74 | 74 | 82 | 61 |
| D. Change from risk averse to risk preferring (from 1 or 2 to 4-8) | 9 | 17 | 4 | 17 |
| E. Change from risk preferring to risk averse (from 4-8 to 1 or 2) | 9 | 17 | 13 | 17 |
| | (Panel 2) | | | |
| Chi-square for measure A. (alpha) | 3.45 (≈.1) | 6.13 (≈.025) | 18.78 (<.005) | 3.45 (≈.1) |
| Chi-square for measure B. (alpha) | 1.72 (>.1) | 3.07 (≈.1) | 12.27 (<.005) | 1.72 (≈.1) |

A statistical test is also possible using the Chi-Square statistic. We could, for example, construct a test that frequency of interval change was a random occurence. If this hypothesis cannot be rejected, then the stability of the risk preferences is no better than a random event. The hypothesis that interval changes were a random event could only be rejected at the 1 percent level for income level III using either one interval change (line A panel 1) or at best a two interval change (line B panel 1).

On the surface then, the Chi-Square test results reject the hypothesis of intertemporal stability of risk preferences except at the experienced income level. However there is some caution warranted in interpreting these results. Due to the interval nature of SDRF criterion, it is not known specifically where within an interval an individual's risk aversion function lies. This is not a problem using the technique to order choices, but because intervals overlap, an individuals risk preference near a border could actually be in two intervals. This fact and the relative narrowness of the bounded intervals suggests that preferences are actually more stable than suggested by the Chi-Square statistic. Indeed the percentages of individuals whose risk preference intervals changed 2 or less adjacent intervals was 74, 74, 82, and 61 percent at income levels I, II, III, and IV respectively (line C panel 1).

Concluding Remarks

Our study suggests that while risk preferences may not be intertemporally stable over wide ranges of income, for incomes close to those typically experienced risk preference are relatively stable.

The findings of the study demonstrate that stability over time is definitely a factor to be considered in estimating risk preferences and any subsequent prescriptions based on the estimates. Further study on intertemporal stability is desirable, especially for more than two time periods.

Finally, socioeconomic characteristics of the sample members were also collected in 1979 and 1981. Results of grouping farmers into risk aversion classes based on these characteristics will be reported at a later date.

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