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Attitudes toward Risk: Experimental Measurement In Rural India

Hans P. Binswanger

Attitudes toward risk were measured in 240 households using two methods: an interview method eliciting certainty equivalents and an experimental gambling approach with real payoffs which, at their maximum, exceeded monthly incomes of unskilled laborers. The interview method is subject to interviewer bias and its results were totally inconsistent with the experimental measures of risk aversion. Experimental measures indicate that, at high payoff levels, virtually all individuals are moderately risk-averse with little variation according to personal characteristics. Wealth tends to reduce risk aversion slightly, but its effect is not statistically significant.

Key words: India, psychological experiments, risk aversion, semi-arid tropics.

The research reported here was carried out in the semi-arid, tropical areas of India, characterized by high climatic risk for agriculture. It was initiated to determine whether differences in behavior between farmers of different wealth levels are the consequence of different attitudes towards risk or of different constraint sets such as limitations on credit or on access to modern inputs. This question is of considerable policy importance because policy presumably can affect credit and other constraints faced by low income farmers more easily than their attitudes toward risk. The basic approach is experimental. It measures attitudes by observing the reactions of individuals to a set of actual one-period gambles. It must be recognized that extrapolating the findings of such an approach to real farm decisions may face theoretical challenges.[1]

Earlier experimental work on measurements of attitudes toward risk was carried out primarily by experimental psychologists and is reviewed by Luce and Suppes. Where actual gambles were involved, payoffs and sample sizes were small. In this study, payoffs varied from very low levels to levels exceeding the monthly incomes of unskilled rural laborers. The total sample size was 330.

Agricultural economists have measured parameters of utility functions by simulated gambling situations rather than actual ones. Officer and Halter, O'Mara, and Dillon and Scandizzo used approaches based on utility theory and elicitation of certainty equivalents. Kennedy, instead, used a method based on focus loss. Only Dillon and Scandizzo used simulated farming problems rather than pure simulated gambles.

The Experimental Sequence

The experimental method based on one-period gambles was developed after results of a survey using the Dillon-Scandizzo approach suggested that their method was subject to interviewer biases (fourth section).[2] To overcome

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[1] Masson and Roumasset (1978b) point out that under fairly restrictive assumptions, a utility function in "one-period money" may be viewed as an indirect utility function that reflects the interaction of a lifetime utility function of consumption with borrowing and lending opportunities. An individual who is risk-neutral with respect to utility function in lifetime income may exhibit an apparently risk-averse indirect utility function for one-period money because of capital market imperfections, and therefore the attempt to separate attitudes from constraints may be impossible using one-period gambles.

[2] The author is personally indebted to John Dillon and Pasquale Scandizzo for encouraging him to start work on risk aversion with large samples. He is indebted also to J. G. Ryan and Matthias von Oppen for later encouraging a shift to experimental methods.

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moral problems confronting low income people involved in gambling, the gambling was limited so that the worst possible outcome was a zero gain, and it thus involved gifts to the respondents. Because many respondents were illiterate, the experiment had to be simple. Also, because farming decisions are often taken on an annual or crop-cycle basis and in consultation with relatives and friends, the experiment was designed to allow long periods for reflection and opportunities for consultation.

Only minimal theoretical commitments were to be made at the outset. The set of choices should be ranked as more or less risky in a unique way, almost regardless of the definition of risk one might want to adopt. (For a review of problems of defining risk, see Roumasset 1978a.) The subjects were not to be confronted with any budget constraints that would rule out certain choices. One cannot, in measuring pure attitudes to risk, propose games to individuals for which the worst possible loss exceeds their current cash holdings. If one does, he may measure the impact of a cash- or budget-constraint rather than the pure attitudes towards risk (Masson, Lipton). As far as possible, respondents should perceive the same probabilities; therefore, the game was based on coin tosses.

Table 1 explains the basic method. Several days ahead of any given game, individuals were given forms (which they could keep) with the numbers of panel A on table 1. They had to choose from alternatives *O* to *F*. Once they chose, a coin was tossed and they got the left-hand amounts if heads came up or the right-hand amount if tails came up. An individual who chose *O* simply got Rs.50; i.e., participation in the game resulted in an automatic and sure increase in wealth by Rs.50. An individual choosing *C* received Rs.30 on head and Rs.150 on tail. By not choosing *O* he stood to lose Rs.20, but could gain Rs.100. Compared to *B*, which was more relevant, the potential losses and gains in going to *C* were Rs.10 and Rs.30, respectively. Finally, by choosing *F* the individual received either no money or Rs.200; *F* had the same expected return as *E*, but a higher variance, so only a risk-neutral or risk-preferring individual would make the step from *E* to *F*.

At the simplest level the choice of any alternative *O* to *F* classified the individuals into a risk aversion class to which a name was given to simplify discussion. Interpreted in the framework of expected return-variance analysis (which is useful when decision makers are confronted with normally distributed outcomes), the game consisted of offering individuals a set of alternatives within which higher expected returns could only be "purchased" at the cost of higher variance (or standard deviation), and this tradeoff could be measured by the slope *Z* in table 1. Interpreted in a utility framework, risk aversion could be measured by partial risk aversion *S*, which is fixed regardless of the level of payoff (Menezes and Hanson; Zeckhauser and Keeler).[3] To each risk aversion class corresponded an interval of partial risk aversion *S*.

[3] It is defined on a utility function *U* in terms of certain wealth *W* as follows: let *M* be the certainty equivalent of a new prospect and evaluate derivatives at $W + M$; then,

$$S(W + M) = -MU''(W + M)/U'(W + M),$$

Table 1. The Payoffs and Corresponding Risk Classification

	Panel A			S		
Choice	Heads—Low Payoff	Tails—High Payoff	Risk Aversion Class	Approximate Partial Risk Aversion Coefficient[a]	Z	$\frac{\Delta E^b}{\Delta SE}$
O	50	50	Extreme	∞ to 7.51	1 to 0.80	
A	45	95	Severe	7.51 to 1.74	0.8 to 0.66	
B	40	120	Intermediate	1.74 to .812	0.66 to 0.50	
*D**	35	125	Inefficient			
C	30	150	Moderate	.812 to .316	0.50 to 0.33	
D	20	160	Inefficient			
E	10	190	Slight-to-neutral	.316 to 0	0.33 to 0.00	
F	0	200	Neutral-to-negative	0 to ∞	0 to $-\infty$	

[a] For reasons that are explained in Binswanger (1978c), a constant partial risk-aversion function on gains and losses was used to approximate *S* for the games. See footnote 4 for more details.
[b] *Z* is the trade-off between expected returns and standard deviation of two games.

In the experimental sequence (table 2) the individual was not presented immediately with the alternatives of table 2, called 50-rupees game; instead he went through a sequence of games and hypothetical questions at various game levels. All game levels were derived from the 50-rupees game by multiplying all amounts by a constant, which is 1/100, 1/10, and 10 for the 1/2-rupee, 5-rupee, and the 500-rupee game levels, respectively. The sequence started with five games at the Rs.0.50 level to teach participants the rules of the game and to convince them that they would receive the money when promised. To help illiterate people, the payoff structure was shown as a photograph with the sums of money to be received indicated by coins placed in each field. The photographs were handed out to each player and left with them through the entire 5- to 6-week period of the experiment.

The study was carried out in the 240 rural households included in the village level studies of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India. (For more details, see Jodha, Asokan, Ryan; Binswanger and Jodha.) These studies are located in the semiarid tropical tracts of Maharashtra and Andhra Pradesh, some of the poorer regions of India.

The average physical wealth of the households, approximately Rs.22,000 (US $2,750), is very low by international standards. But there were large variations in wealth in the sample, as indicated by a coefficient of variation of physical wealth of 137%. The average schooling level was only 2.6 years but had a coefficient of variation of 120%. Being a random sample of the entire population engaged in agriculture as laborers or farmers, variation in other personal characteristics was also large.

Up to the Rs.5 level, the sequence was played with all 240 household heads of the sample (of which 20 were women), although temporary absences from villages made some of the sequences incomplete. In three of the six villages (118 households) the full sequence was played. In addition, in two villages the most important dependent female of the household, usually the wife, was also included in the experiment up to the Rs.5 level (the

where U' and U'' are the first and second derivatives of the utility function. Other utility based measures of risk aversion are discussed in Binswanger (1978a) but S was the most convenient one.

Table 2. Sequence of Games and Hypothetical Questions

Game Number	Minimum Delay Since Last Event[a]	Game Level (Rs.)	Real or Hypothetical	Village[b]
1	First Day	0.50	Real	All
2	One day	0.50	Real	All
3	One day	0.50	Real	All
4	One day	0.50	Real	All
5	One day	0.50	Real	All
6	Two weeks	50.00	Hypothetical	Shirapur excluded
7	Same day	5.00	Real	All
	Same day	Hand out Rs.5.00 for next day game		
8	One day	50.00	Hypothetical	Shirapur excluded
9	Same day	5.00	Real	All
10	Same day	5.00	Hypothetical	All
11	Two Weeks	500.00	Hypothetical	Shirapur
12	Same day	50.00	Real	Kanzara
13	Same day	50.00	Hypothetical	Aurepalle only
14	Same day	50.00	Hypothetical	Kalman Kinkheda
15	Same day	5.00	Hypothetical	Dokur only
16	Two weeks	500.00	Hypothetical	Shirapur Kanzara
17	Same day	50.00	Hypothetical	Aurepalle only

[a] In many cases these minimum delays were exceeded by a few days.
[b] There are six villages, two each in three districts: Sholapur district—Shirapur and Kalman; Akola district—Kanzara and Kinkheda; Mahboobnagar district—Dokur and Aurepalli. Each village contains a panel of forty households and households heads were included in all villages. In Kinkheda and Dokur the most important dependent female in each household was also included in the experiment in addition to the head of household who, on occasion, was female.

dependent female sample). In five villages a nonrandom sample of the three "most progressive" farmers of the village was added (the progressive farmer sample). Progressive farmers are early adopters of new techniques. They were identified by the resident investigators on the basis of the investigator's knowledge of the villages. For all games except at the Rs.0.50 level, respondents' choices were ascertained by a first investigator and verified with the respondent by a second investigator. In about 250 games, including all the 50-rupee games, the author was the second investigator. In only two cases did the respondent change his mind. It was clear that the respondents enjoyed the game. No attempt was made to isolate the respondents from their peers except for the second verification. Agricultural decisions are also observable in the village context and their outcomes are known to all.

Reliability Tests

The first test was concerned with whether behavior with gift money differs from behavior with own money. (A fuller account of these tests is given in Binswanger 1978c.) To pretest the method, ten individuals were at one stage asked to play the game with their own money, and nine out of ten chose the same alternative as in the immediately preceding game, while one respondent became more risk-averse. With the household heads of the full sample a different test was carried out: one day prior to game 9, Rs.5 were given to the respondents and they had the choice not to come to play game 9 (such a choice was interpreted as the riskless choice *O*). If they chose to play game 9, they had to pay back any losses relative to the Rs.5 of that bet. If after gift money was in their possession for one day the respondents considered it their "own," comparison of the risk aversion distribution of game 7 and game 9 is a test of differences in behavior with gift and one's own money. A chi-square test of differences between games 7 and 9 in the distribution of choices over the alternatives was not significant at 0.05 level.

The second test concerned the usability of answers to hypothetical games included in the sequence. It was hoped that after playing the full sequence up to the Rs.50 level, individuals would acquire the introspective ability to tell how they would play at the Rs.500 level. One could then use the hypothetical answers as if they were real choices. Hypothetical games 6, 8, and 13 at the Rs.50 level were introduced in two villages (Aurepalle and Kanzara) for comparison with the real 50-rupee game. Chi-square tests at the 0.5 level showed that, before playing the 50-rupee game, people believed that they would act either more aversely or less aversely to risk than they actually did in the real game 12, i.e., the risk-aversion distribution was far more dispersed in the early hypothetical answers than in the real game. However, once the 50-rupee game was played, there was no statistically significant difference between the real choices in game 12 and the hypothetical answers to games 13 or 17. The data also indicate that the ability of respondents to predict their actual behavior in a hypothetical question increases as the game sequence proceeds, even before the 50-rupee game is played. Therefore, from this point on, the hypothetical 500-rupee game number 16 will be interpreted as if it really had been played, albeit with caution.

The third test was to investigate whether individuals, when confronted with a game such as in table 1, had an automatic tendency toward alternatives in the center of the distribution. Table 1 contains two risk inefficient alternatives D and D^*, which are derived from C and F, respectively, and have the same means but higher variance. No risk-averse individual should choose these alternatives, and they were introduced precisely to test whether people could detect stochastic dominance in this simple context.

Note that in a game structure containing D but not D^*, alternative C is the most central alternative and, under the "central tendency hypothesis," should be the most preferred one. On the other hand, if D is deleted from table 1, alternative D^* becomes the most central one. In three villages half the respondents were given the game structure containing the alternative D, while the other half were given the game structure containing D^*. It was found that for both games 9 and 12, the frequency distributions associated with the two game structures could not be distinguished statistically.

There were three potential learning effects in the experiment. The first one concerned the ability to know risk preferences when the participant is faced with a hypothetical question without making an actual decision, which was discussed above. A second potential learning effect was revisions of personal probabilities of heads and tails in coin tosses, which will be discussed later. A third learning effect concerned the rules of the games. How many games did one have to play till one was sufficiently familiar with the rules? A chi-square test of the differences in risk aversion distribution was performed between the successive 0.5-rupee game; these tests were not significant, although there was a trend toward less risk aversion as the games proceeded. Respondents thus appeared to familiarize themselves quickly with the rules.

When using the Dillon and Scandizzo interview method (to be discussed in a later section of this paper), two investigators were identified who tended to elicit substantially different certainty equivalents while interviewing the same respondents. These investigators were assigned to two different subsamples—forty respondents each, twenty in each of two villages—for the entire game sequence. No statistically significant differences could be found between the risk-aversion distributions of the two subsamples and investigator bias appeared to be less of a problem using the game method than with interview methods.

The Main Experimental Results

The risk-aversion distributions corresponding to different game levels are given in table 3, in the first panel for those villages where the game was played up to the 50-rupee level (with a hypothetical answer at the 500-rupee level) and in the second panel for all the households, including those where the game was played only up to the 5-rupee level. Observe that at low levels of the game the distribution was fairly evenly spread across the four classes of intermediate risk aversion to risk neutrality. As the game level rose, the distribution shifted to the right and became more peaked, i.e., risk aversion increased.

Consider the slight-to-neutral and neutral-

Table 3. The Effect of Payoff Size on Distribution of Risk Aversion

Payoff Level and Game Number	Extreme	Severe	Intermediate	Moderate	Slight-to Neutral	Neutral to Negative	Inefficient	Sample Size
	Household Heads: Shirapur, Kanzara, Aurepalle							
A 0.50 No. 2	1.7	5.9	28.5	20.2	15.1	18.5	10.1	119
B 0.50 No. 4 + 5	1.7	8.1	14.5	29.3	21.3	16.6	8.5	235
C 5 No. 7	0.9	8.5	25.6	36.8	12.0	8.5	7.7	117
D 50 No. 12	2.5	5.1	34.8	39.8	6.8	1.7	9.3	118
E 500 H No. 16	2.5	13.6	51.7	28.8	0	0.9	2.5	118
	All Household Heads							
F 0.50 Games 2 + 3	1.7	7.6	18.5	22.7	17.1	18.7	13.7	475
G 0.50 Games 4 + 5	0.9	8.2	12.9	27.5	22.8	18.4	8.3	473
H 5.00 Games 7 + 9	0.8	8.1	23.8	36.5	11.9	9.8	9.1	471

Distributions tested	χ^2	*df*	χ^2 0.05
A vs. *C* vs. *D* vs. *E*	85.68	18	28.87
C vs. *D* vs. *E*	48.49	12	21.03
A vs. *C*	11.91	6	12.59
B vs. *D*	44.22	6	12.59
D vs. *E*	23.46	6	12.59
A vs. *B*	13.17	6	12.59
F vs. *G*	16.30	6	12.59
G vs. *H*	50.02	6	12.59

to-preferred classes: at the Rs.0.50 level, the percentage in each of these classes is around 15 to 20, and it falls monotonically to near zero as the payoff level rises to Rs.500. In the moderate risk-aversion class, we initially find around 20% of the individuals. This percentage first rises at the Rs.5 and Rs.50 levels because people enter this class when leaving the lower risk-aversion classes. But between the Rs.50 and Rs.500 level, the number of entrants from lower risk aversion is lower than the number of individuals who become more risk-averse and the frequency in this class declines. The intermediate risk-aversion class starts out with 28.5% of individuals in game 2 at the Rs.0.50 level. As that game is repeated people prefer to play at higher stakes. But as the payoff level rises again, more people enter this class from the lower risk-aversion classes and at the Rs.500 level more than 50% of individuals are concentrated in this single class. The 500-rupee game corresponded to payoffs in the order of substantial fertilizer investments for these households, and many were too poor to undertake them. For some households it even exceeded net wealth.

The extreme and severe risk-aversion classes together contained less than 10% of the individuals for all levels except the Rs.500 level, in which the percentage rose to 15. There appears to be an upper barrier to risk aversion that is exceeded only very slowly at high stakes.

In any given game, around 10% of individuals chose one of the inefficient alternatives. This is clearly lower than the percentage of individuals who would choose it on a random basis. Consider game 12. Inefficient alternatives exist between the intermediate and moderate and the moderate and slight-to-neutral alternatives. These three classes and the inefficient ones contain 90.7% of individuals. If people fell into the two inefficient and three efficient classes at random, the two inefficient classes would contain at the very least one-fifth of the 90.7% observations, i.e., 18.1%, but the actual percentage was 9.3.

Who chooses inefficiently varies much across games. Two hundred and eighty seven individuals played all the games from 1 to 9. Of those, ninety-four (or 33%) chose one of the inefficient alternatives at least once, i.e., they did not recognize that they were stochastically dominated, or did not care about it at least once.

The evidence can thus be summarized as follows. For individuals with initially low risk aversion, it tends to rise fairly rapidly as game levels start to rise beyond trivial levels. For individuals who inititally have intermediate to moderate levels of risk aversion, the level increases slowly or remains fairly constant as game levels rise. As can be seen from the chi-square tests (bottom of table 3), these trends are statistically significant and evident in both the reduced sample and the full sample of households.

Interpreted in the utility framework, the evidence suggests that all but one of 118 individuals have nonlinear, risk-averse utility functions, which exhibit increasing partial risk aversion.[4] It has been shown elsewhere (Binswanger 1978c) that the results also imply decreasing absolute risk aversion. Relative risk aversion first decreases and then increases.

Interviews versus Gambling Experiments

The most immediately comparable study to the present one (and the one which initially inspired it) is by Dillon and Scandizzo for a semi-arid tropical region of Brazil. It had a sample size of 103 farmers. Prior to the gambling experiment, the author executed a similar interview-based survey in the Indian SAT villages. In this section the author describes the problems encountered with the Dillon-Scandizzo method and then compares the results of the two surveys with each other as well as with the experimental results.

Dillon and Scandizzo describe their method as follows: "The farmer's risk attitudes were appraised via their choices between hypothetical but realistic farm alternatives involving risky versus sure outcomes. These questions

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[4] To obtain unique measures of partial risk aversion associated with the indifference points between two alternatives, a constant partial risk-aversion function (CPR) of the form $U = (1 - S)M^{1-S}$ was used. Given the evidence of increasing partial risk aversion one might object that an increasing partial risk-aversion function (ICPRA) should have been used (Binswanger 1978b). However, the partial risk-aversion coefficient for any indifference point will then not be unique but will depend on the rate at which partial risk-aversion increases, i.e., on the choice paths across the game scale. Therefore, partial risk-aversion coefficients were computed for each indifference point at each game scale and for each feasible choice path given a smooth ICPRA utility function. Because income varies more across game scales than within each game scale, S values associated with these ICPRA differed by less than 2% from those associated with the CPR functions, except for the indifference point between alternative O and A, where the largest difference was 15%. Because few respondents chose alternative O to A, the results of this paper would not be substantially affected by using S values from an ICPRA function.

form the basis of our empirical analysis and were geared to finding the certainty equivalents of risky prospects involving stated probabilities. Two types of risky prospects were used, yielding two subsets of responses for each group of farmers. The first type involved only payoffs above household subsistence requirements. In these, while the level of total income was at risk, subsistence was assured. The second type of risky prospect included the possibility of not producing enough to meet subsistence requirements. Both types of risky prospect involved only two possible outcomes whose probabilities were specified as invariant frequencies" (Dillon and Scandizzo, p. 427). These frequencies were 0.75 ("3 years out of 4") for the "good" outcome and 0.25 ("1 year out of 4") for the "bad" outcome.

In the Indian study the "good" outcome and the "bad" outcome of the uncertain prospect are fixed so that the expected value of the uncertain prospect was one-half of subsistence income and twice the subsistence income, respectively. Subsistence income previously had been established for each household individually by asking householders, item by item, their minimum annual requirement of all food and clothing. Subsistence income ranged from Rs.462 to Rs.14,117. The certainty equivalent of the prospect was then found by varying the certain income until indifference with the uncertain prospect was attained.

When analyzing the results of the Indian survey, several problems and inconsistencies were encountered. The most serious was that in two neighboring villages, Shirapur and Kalman, the distributions of risk-aversion coefficients differed sharply. For table 4, the elicited survey results were converted into partial risk-aversion coefficients using a constant partial risk-aversion function (see footnote 4) and grouped into the same classes as those of the experimental study, except that the intermediate and moderate classes were pooled. The second and third line of table 4 (Shirapur First and Kalman First) compare the results for the first survey carried out by investigators A and B, respectively. Shirapur appears to be more risk-averse and the difference is statistically significant.

The villages were then resurveyed, switching investigators, and the results are given in the line 1 and line 4 of table 4. Comparison of line 1 with line 2 and line 3 with line 4 clearly shows that in each village investigator B classifies respondents as more risk-averse than investigator A, and these differences are statistically significant. This cannot be caused by the time lag of more than a month between interviews because the time sequence of investigators was reversed between the villages. Thus, the interview technique is subject to severe interviewer bias. Resurveys also were carried out in other villages. By analyzing all resurvey results, it was found that in more than 20% of the cases individuals were reclassified radically between extreme risk aversion and neutrality or negative and positive risk aversion. In the game results, such radical reclassification in successive games at the same level is rare (Binswanger 1978a).

Table 5, lines A and B, show the distributions for the 50- and 500-rupee games, while lines C and D show the India interview results

Table 4. Survey Results in Shirapur and Kalman

Risk Aversion Distributions Obtained by Different Investigators in Two Villages[a]

Village and Survey	Investigator	Survey or Resurvey	Risk-Aversion Class: Extreme	Severe	Intermediate or Moderate	Slight or Neutral	Negative	Number of Observations
Shirapur (second)	A	Resurvey	10	9	4	5	5	33
Shirapur (first)	B	Survey	20	10	3	0	0	33
Kalman (first)	A	Survey	4	5	5	11	4	29
Kalman (second)	B	Resurvey	11	12	1	2	3	29

Relevant chi-square tests, all significant at better than 0.01 level.
[a] In absolute numbers.

Table 5. Comparison of Interview-Based and Experimentally Based Distribution of Risk Aversion

	Extreme	Severe	Intermediate or Moderate	Slight or Neutral	Negative	Inefficient	No. of Observations
			India				
A. Game no. 12; Rs. 50	2.5	5.1	74.6	6.8	1.7	9.3	118
B. Game no. 16; Rs. 500	2.5	8.2	85.9	0	0.9	2.5	118
C. Interview Subsistence-at-risk[a]	27.0	34.3	18.0	6.3	14.4	n. appl.	222
D. Interview Subsistence-assured[a]	18.2	43.6	15.5	9.1	13.6	n. appl.	220
		Dillon and Scandizzo's Interview Based Results from Brazil[b]					
E. Subsistence-at-risk[a]	26.2	57.3		0	16.5	n. appl.	103
F. Subsistence-assured[a]	32.0	32.1		8.7	27.2	n. appl.	103

(A) vs. (C) or (A) vs. (D) Chi-square > 95; $\chi^2(4,0.05) = 9.49$

Note: Comparisons are in percentage of number of observations.

[a] Subsistence-at-risk and subsistence-assured refer to two different payoff levels. In the first, the "bad" outcome would result in the farmer not being able to meet his subsistence income while in the second case the bad year outcome would exceed the level.

[b] Computed from tables 2, 3, and 4 by combining the data for sharecroppers and small farmers. The 103 respondents do not include 15 respondents who were not willing to answer the questions or whose answers were internally inconsistent, as judged by the interviewers. Similarly, the 222 farmers in the Indian interview studies excludes roughly 10 respondents on similar grounds.

for the Rs.50 and Rs.500 levels, which come closest to the usually higher payoff levels used in the interviews. The interview results classify more than 50% of individuals as extremely or severely risk-averse and close to 15% as neutral or negative. This is in sharp contrast to the game results for the same households. Dillon and Scandizzo give explicit data on the slight-to-neutral and negative classes of risk aversion, but not on the "extreme" classification. In table 5, lines E and F show individuals in the extreme class who opted for the highest possible certainty equivalent in their study. Interestingly, the interview results for Brazil are somewhat similar to those for India, identifying substantial proportions of individuals with extreme and negative risk aversion. Other interview-based studies also appear to find higher dispersion of risk-aversion coefficients than those identified here (O'Mara, Kennedy).

Given the clearly documented interviewer biases and high instability of interview results relative to game results, one is tempted to dismiss the interview studies as unreliable and potentially misleading. Some caution may be necessary, however, because the interview methods differ in significant ways from the game method. First, the interviews about an income stream from assets or occupations, while the game results are about one-period gambles. In the light of footnote 1, it is conceivable that the two methods measure different concepts. Second, the distribution of outcomes is skewed in the interviews but symmetric in the games.

On the other hand, one should not underestimate the problems associated with any interview method. In the third section, it was shown that at the early stages of the game sequence the respondents' replies to hypothetical questions at the Rs.50 level differed significantly from the real choices and implied much more dispersed risk-aversion distributions. Furthermore, the distributions also were more widely spread at the very low game level of one-half-rupee than at high game levels. Interview methods are inevitably faced with the problem that individuals may not be able to reveal their attitudes towards decisions they have never taken or seriously contemplated. And even if the payoffs discussed in hypothetical questions are high, there are no real payoffs or penalties associated with revealing a preference which may or may not correspond to how one would act when faced with real choices, i.e., true payoffs are even lower than those in the one-half-rupee game.

Correlation of Risk Aversion with Personal Characteristics

Empirically, virtually nothing is known about how personal characteristics of individuals are correlated with risk aversion. This section is concerned with correlations of risk aversion with personal characteristics regardless of the causal nature of the relationship and therefore can look at personal characteristics that may be determined jointly with risk aversion. In order to use multiple regression, a number of scaling decisions have to be made to assign risk-aversion "numbers" to the discreet classes. At the simplest level, numbers zero to five are given to the choices *O* to *F*, and they are used as regressors. Other scales are based on the tradeoff *Z* and on partial risk aversion *S*. A substantial number of regressions were performed using these three variables and functional transformations thereof. These variables and transformations had little impact on the sign patterns of the coefficients, but the regressions using ln *S* had, on an average, the highest $\bar{R}^2$, and are therefore retained. Furthermore, the full data set was divided into subsets of different villages and for males and females separately. *F*-tests indicated that these sets could be combined for all games, i.e., coefficients did not differ significantly across data subsets. The regressions in table 6, however, exclude the dependent females data because their observations are not independent of those of the household heads. Signs and significant levels of coefficients were fairly

Table 6. Regression of Personal Characteristics on Partial Risk Aversion

	0.5 Rupees		5 Rupees		50 Rupees	500 Rupees
	No. 2 (1)	No. 5 (2)	No. 7 (3)	No. 9 (4)	No. 12 (5)	No. 16 (6)
Intercept	-2.975	-1.894	-0.238	-3.498	0.202	0.421
Village 1	0.734	-0.018	0.320	1.859	0.404	-0.314
	(1.194)	(0.032)	(0.696)	(3.792)*	(1.295)	(1.804)*
Village 2	1.569	-0.526	-0.776	1.809		
	(2.663)	(0.873)	(1.766)*	(3.851)*		
Village 3	1.576	1.286	0.252	2.343	[illegible]	-0.165
	(2.620)*	(2.112)*	(0.567)	(4.938)*	(1.965)*	(1.010)
Village 4	0.918	-0.484	-0.304	1.378		
	(1.563)	(0.797)	(0.686)	(2.880)*		
Village 5	-0.387	-1.165	-0.918	1.254		
	(0.692)	(2.051)*	(2.222)*	(2.838)*		
Women	0.810	1.100	0.204	-0.878	-0.073	-0.027
	(1.337)	(1.1785)*	(0.456)	(1.832)*	(0.184)	(0.122)
Progressive farmer dummy	-0.245	-1.187	-1.141	0.088	-0.193	-0.320
	(0.391)	(1.869)*	(2.473)*	(0.179)	(0.424)	(1.259)
Working age adults (weighted share age 15–59)	0.452	-0.761	0.092	1.070	0 081	0.328
	(0.594)	(0.992)	(0.167)	(1.794)	(0.161)	(1.167)
Salary (Rs.1000/month)	0.232	-0.051	-0.493	-0.294	-0.141	-0.208
	(0.769)	(0.164)	(2.213)*	(1.232)	(0.645)	(1.700)*
Land rented (hectares)	-0.092	-0.233	-0.049	0.012	0.053	0.0008
	(1.232)	(3.072)*	(0.891)	(0.210)	(0.748)	(0.000)
Gambler dummy	-1.087	-0.591	0.381	-1.300	-0.125	0.210
	(0.837)	(0.447)	(0.397)	(1.268)	(0.195)	(0.583)
Age (years)	0.017	0.023	0.009	0.021	-0.016	-0.0025
	(1.202)	(1.573)	(0.848)	(1.894)	(1.648)	(0.465)
Schooling (years)	0.061	-0.027	-0.105	-0.012	-0.038	-0.037
	(0.984)	(0.424)	(2.311)*	(0.241)	(0.915)	(1.586)
Assets (in 1000 Rs.)	-0.019	-0.0055	-0.0041	-0.012	0.0032	-0.001
	(2.491)*	(0.735)	(0.744)	(2.068)*	(0.568)	(0.345)
Net transfers (received in 1000 Rs.)	-0.247	-0.502	-0.388	-0.241	-0.055	0.005
	(1.021)	(2.048)*	(2.176)*	(1.265)	(0.437)	(0.071)
Luck	-0.240	-0.269	-0.156	-0.145	-0.133	-0.043
	(1.428)	(3.015)*	(2.549)*	(2.399)*	(2.641)*	(1.672)*
$\bar{R}^2$	0.110	0.179	0.202	0.205	0.034	0.088
F	2.762	4.096	4.598	4.653	1.302	1.814
N observations	228	228	228	228	111	111

Note: Asterisks denote significance at the 10% level of probability.

robust in these experiments with functional forms, and, where that was not the case, it will be signalled in the text.[5]

For the partial risk-aversion coefficient S, the following scaling decisions are involved. The choices of an alternative indicate a range only for S. The geometric mean of the end points is assigned as the measure of S.[6] In the case of alternative F, a value of zero is given to S although it could be negative. Given the result that practically no one prefers risk at high game levels, a value of zero is not unreasonable.[7] For alternative O, the upper bound for S is equal to infinity, while its lower bound is 7.50. Because in the experiment very few individuals chose alternative O, it is reasonable to assume that their partial risk aversion should not exceed 7.5 by very much, and this value was increased by 12% to give a value of 8.4. It is easy to find fault with any of these scaling decisions, and they can be defended only by the apparent insensitivity of results to alternative scalings.

In table 6, the coefficients of the variables with ln S are given. To judge the magnitude of the effects implied, table 7 computes a predicted S for the Rs..5 and Rs.50 levels and compares it with the geometric average S in the sample (first line, underlined values). The predicted S is computed as follows: add to the average S the shift implied by the regression coefficient for a move from the average value of the independent variable to the largest value observed in the sample.[8] Table 7 also shows which choice would be implied by the new value of S.

Thirteen variables are included in the regressions, apart from the village dummies, which are included to take account of effects on risk aversion of such variables as agroclimatic differences, and others.

In the regressions, wealth is measured by gross sales value of physical assets. It would have been better to use net worth rather than gross wealth. However, the data on borrowings and lendings are scanty, but imply that at higher wealth levels borrowings were a small fraction of gross wealth. In these households, on an average, 69% of physical wealth was held in the form of land. The weakness of the relationship between physical assets and risk aversion is surprising, given the fairly strong effect of the game size. Across games the sign of the coefficient is consistently negative, but not always statistically significant. The (statistically not significant) coefficient of −0.0041 in the 5-rupee game 7 implies that a shift from average wealth to the largest wealth observed in the sample is just sufficient to bring an individual from choice C to risk neutrality. It would not be sufficient to move an individual

[5] A decision also had to be taken as to what to do with the "inefficient choices" D and D^*. Leaving out everyone who chose an inefficient alternative at least once would have drastically cut the sample. A comparison of regression where they were left out with regressions where choice D was treated as its neighboring choice B and choice D^* as choice C revealed no differences in sign patterns and coefficient sizes but reduced standard errors. The results reported thus include the inefficient choices.

[6] For alternative F at one of the endpoints, $S = 0$ and the geometric mean of both endpoints would be zero. Therefore, the arithmetic mean was chosen in this case.

[7] For logarithmic transformations, a value of zero is inadmissible. It was therefore rather arbitrarily set at 0.0007.

[8] Predicted

$$S = \exp\left[\frac{1}{n}\Sigma_i \log S_i\right] + \exp\left[b_j(X_{j\max} - \bar{X}_j)\right],$$

where n is the sample size, and X_j the jth indpendent variable, $\bar{X}_j$ is the arithmetic mean, and b_j is its estimated coefficient.

Table 7. The Largest Possible Shifts in Choices Implied by the Regression Results

Explanatory Variable	Maximum Minus Mean Value[a]	Predicted S at Rs.5 Level	Choice Implied	Predicted S at Rs.50 Level	Choice Implied
Average S[b]		0.483	C	0.705	C
Women	1	0.592	C	0.758	C
Progressive	1	0.154	E	0.581	C
Working adults (share age, 15–59)	0.5	0.506	C	0.734	C
Salary (Rs 1000)	Rs.5.069	0.040	E	0.345	C
Age	38 years	0.680	C	0.384	C
Schooling	12 years	0.137	E	0.447	C
Assets (Rs.1000)	185.277	0.226	E	—[c]	
Transfer income (Rs.1000)	6.224	0.043	E	0.501	C
Luck	5	0.221	E	0.363	C

[a] For dummy variables the value taken was one.
[b] Antilog of average of ln S.
[c] Coefficient has wrong sign.

who initially was indifferent between A and B to choose alternative E.

For the crucial 50-rupee game, the coefficient is usually of the unexpected sign (positive, close to zero, and not significant). Contrary to expectations, wealth has little impact on individuals' behavior at game levels that are commensurate with monthly wage rates or small agricultural investments.

Another form of wealth is human wealth and "schooling" is a proxy variable for it. Average schooling in the sample is two years, but the maximum is sixteen years, i.e., the distribution is highly skewed. At low game levels this variable had little influence on risk aversion, but at the Rs.5 level and above, it generally reduced the level of risk aversion and was often statistically significant, although not generally so in the regressions using log S. But again, the impact of schooling was not massive. In the 5-rupee game, the coefficient size of -0.0432 implies that an individual who has fourteen years of schooling rather than one would fall into the slight-to-neutral class rather than the intermediate class. At the Rs.50 level, the same difference is not sufficient to shift the individual's risk aversion by an entire class interval.

Two variables that are correlated with schooling are the amount of income received in the form of salary (i.e., from a secure job) and a dummy variable for progressive farmers. Salary employment, with some exceptions, is restricted to individuals with schooling, and totally illiterate individuals have no access to it (58% of the household head sample had no schooling). Progressive farmers are those whom the resident investigators designated as the early adopters of new techniques (five in each village). Schooling is again correlated with this variable and can be expected to contribute to it. Note that in regressions where these two variables were suppressed, schooling did become statistically significant.

"Salary employment" by itself tended to decrease risk aversion, the sign being fairly consistently negative, although it was not statistically significant at the Rs.50 level. Similarly, the progressive farmer dummy had a fairly consistent negative sign, but at the high game levels its coefficient was so small that it was not significant.

Economists would not usually expect that past experience with a random process, which is as transparent as flipping a coin, would have a strong impact on a person's next choice over alternatives defined on it. Psychologists, on the other hand, would not find this surprising, and the present experiment suggests a strong impact of prior luck. Past experience, or luck, is defined as $\sum_i X_i$, where i is the game number 1, 2, 3, 4, 5, 7, 9, and 12, and X takes a value of 1 when the person wins, -1 when he loses, and zero when he neither wins nor loses (alternative O). The coefficient is consistently negative and always statistically significant. Note also that its size tends to decline as the game level rises, i.e., its impact is weaker the higher the stakes. Nevertheless, at the Rs.5 level (after seven games), a person who had consistently won (luck = +7) would have a greater tendency to shift from playing alternative C to playing alternative E than a person who had had an equal number of gains and losses. Finally, past experience does not wear off rapidly. The answers to the 500-rupee game were collected two or more weeks after the last game had actually been played.

Whether the influencing of this variable reflects revision of personal probabilities, or learning about them, or some other effects cannot be answered by this experiment.[9] Because "luck" in this experiment is a random variable uncorrelated among individuals it has impact on individual choices but not on the risk-aversion distributions. However, farmers in a given area face highly correlated weather outcomes. That past experience should have such an impact on risk aversion suggests that farmers would be more reluctant to invest after a series of droughts (even if they had the same wealth levels as before the drought) than they normally would on account of their own average risk aversion.

Age has a positive sign in games up to the Rs.5 level but a negative sign at the Rs.50 and Rs.500 level. At the Rs.50 level it is statistically significant but not at the Rs.500 level. Is it possible that young people are more willing to engage in risky games at low stakes, whereas older people having dealt much more in risky economic games at high stakes might be more willing to take risks at high levels? But at the Rs.50 level, the quantitative impact

[9] Psychologists working experimentally in the area have found that individuals exhibit preferences for heads or tails in coin tosses. Because the winning sign of the coin was charged for each game level, such preference cannot account for the observations on the luck variable. But it is possible that the preferences for one side of the coin seen in earlier experimental work might be caused by a person having had a winning or losing streak on one side of the coin.

of even thirty-eight years of age difference is not sufficient to shift an individual's choice by an entire class interval.

The "women" dummy variable exhibits inconsistent coefficient signs. At high game levels it does not appear to affect behavior at all. Clearly, there is little support for the hypothesis that women are less willing to take risks than men, once adjustment is made for variables such as schooling. In tabular analysis it was noted that, on an average, women were slightly more risk-averse than men (means not significantly different). At best, one can explain this by the fact that, in the environment studied, women did not have equal access to education as men. Not a single woman in the sample ever attended school.

The variable "working age adults" approximates the proportion of productive individuals in a household: it varies on the unit interval, i.e., it is the weighted number of adults between the ages of fifteen and fifty-nine years divided by the weighted sum of family members.[10] The lower this ratio, the higher the proportion of individuals whom the working age adults have to support. One would thus expect the variable to have a negative sign by saying that those with few dependents can afford to take more risk. This hypothesis is not supported by the data. The coefficient shifts in sign and is hardly ever significant. At higher game levels it is consistently positive, i.e., of unexpected sign.

A portion of the new literature on tenancy assumes that share tenancy is used to spread the riskiness of farming (Bardhan and Srinivasan). The reasoning is not based on differential risk aversion between landlords and tenants, but it would be strengthened considerably if tenants were generally more risk-averse than landlords. The "land rented" variable measures the net area leased by a household regardless of the form of contract. It is negative for landlords and positive for tenants. At low game levels there was some indication that tenants were less risk-averse than landlords, not vice-versa. At high game levels there appeared to be no difference.

"Net transfers received" measures the net amount of income transfers received from relatives and other sources between 1 July 1975 and 30 June 1976. It was negative for those who sent transfers. It usually had a negative sign, which is consistent with the hypothesis that the possibility to rely on income transfers reduces risk aversion because it insures against adversity. It is not a good measure of "insurance" via transfer mechanisms because it measures what has actually been received rather than what can potentially be received, yet it is the best that can be done at this stage.

The individuals who liked to gamble (by buying lottery tickets or by playing cards, with and without money) were identified. Less than 5% of individuals fell in this category, and the variable leads to contradictory results.

Table 5 shows that coefficient sizes were generally smaller at the Rs.50 level than at the Rs.5 level. This is not surprising because the distribution of risk-aversion coefficients is more concentrated at the Rs.50 level than at the Rs.5 level.

Gambling Results and Farming Decisions

As measured by the gambling experiment, the main conclusions of this study are as follows: (*a*) At very low payoff levels, risk aversion is fairly widely distributed from intermediate levels to risk neutrality or preference. (*b*) At payoff levels in the neighborhood of monthly labor incomes or small agricultural investments, risk aversion is highly concentrated at the intermediate and moderate levels, and risk neutrality virtually disappears. (*c*) At these high payoff levels, wealth does not appear to influence risk aversion significantly, although at low game levels such an effect appears to exist.

If these results can be extrapolated to farming decisions, they suggest that differences in investment behavior observed among farmers facing similar technologies and risks cannot be explained primarily by differences in their attitudes but would have to be explained by differences in their constraint sets, such as access to credit, marketing, extension, etc. It is not the innate or acquired tastes that hold the poor back but external constraints. Policy in support of poor farmers and landless laborers will have to be geared toward removing these constraints rather than being risk-specific.

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[10] In computing the ratio, adult males (above 15 years of age) were given a weight of 1; adult females, 0.8; and children, 0.5.

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