ECONOMIC GROWTH CENTER

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New Haven, Connecticut

CENTER DISCUSSION PAPER NO. 285

ATTITUDES TOWARDS RISK:

EXPERIMENTAL MEASUREMENT IN RURAL INDIA

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June 1978

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Introduction

This paper describes in detail an experiment to measure pure attitudes towards risk. The experiment consisted of offering individuals a set of alternative payoffs which incorporate a tradeoff between expected return and standard deviation. The individual classifies himself into a risk aversion interval by his choice.

A sequence of such games was played with a panel of 240 randomly selected household heads, in rural India, with 80 of their wives and dependent females and a few purposely selected individuals. During the sequence of the game the real payoffs were raised from trivial levels to expected returns which exceeded monthly incomes of unskilled laborers. The sequence of games incorporates tests of its reliability.

The key result of the paper is that virtually all individuals are risk-averse when payoffs exceed trivial levels, but that extreme risk aversion is exceedingly rare as well. Most individuals have very similar levels of risk aversion.

The paper then explores correlations between individual characteristics such as wealth, sex, and age with risk aversion. Wealth appears to have surprisingly little effect on the extent of risk aversion. Schooling tends to reduce risk aversion, while prior luck in the sequence of games consistently reduces risk aversion. Other personal characteristics have less clear impact, and, in any event, given the similarity of risk attitudes, the quantitative impact of most variables on the extent of risk aversion is modest.

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*Hans P. Binswanger is an Associate of the Agricultural Development Council presently stationed at the Economic Growth Center of Yale University. The experiment on which this paper is based was carried out while the author was stationed at the International Crops Research Institute for the Semi-Arid Tropics, Hyderabad, India, and with its generous support. I would like to thank J. G. Ryan, M. von Oppen and Monique Binswanger for valuable ideas during the methodology design stage, and B. C. Barah, R. D. Ghodake, S. S. Badhe, M. J. Bhende, V. Bhaskar Rao, T. Balaramaiah, N. B. Dudhane, Rekha Gaiki, K. G. Kshirgar, Madhu Nath, and Usha Rani who helped in carrying out the experiment.

In this paper the emphasis is on testing the robustness and reliability of the methodology, comparing its results with interview techniques and on the correlation of attitudes towards risk with personal characteristics. In a second paper (Binswanger 1978a) implications of the findings for psychological, economic and statistical theories of behavior under uncertainty are explored.[1]

THE EXPERIMENTAL SEQUENCE AND PRELIMINARY TESTS OF THE METHOD

Prior to experimenting I had become aware of the work of Dillon and Scandizzo (1975) in Brazil in which they attempted to elicit risk attitudes for a large sample of farmers by eliciting certainty equivalents of uncertain prospects via interviews. Their method was adapted to the Indian conditions and tried there on 240 household heads. As discussed in the Appendix, it became clear that the interview results were neither reliable nor replicable; the answers reflected interviewer biases.

After the risk attitude survey had failed, J. G. Ryan and M. von Oppen suggested experimental approaches with real payoffs.[2] Moral problems connected with gambling with poor people can be overcome by first handing out money to them as gifts and putting the maximum possible loss equal to the gifted amount. The experiment described below was designed on this basis. In designing it the following requirements had to be respected: The experiment should be simple so that illiterate farmers and landless

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[1]An earlier paper (Binswanger 1978b) reported some results of this study without describing the methodology in detail but focussing on implications of some of the findings for agricultural development.

[2]Experimental efforts to measure utility functions started with the work of Mosteller and Nogee (1951). Other methods have also been used by Davidson, Suppes and Siegel (1957), Edwards (1955), Becker, de Groot and Marshak(1964). Some of the procedures are quite complicated. For a careful review of this line of work see Luce and Suppes (1965).

laborers could understand it without problem. It should allow each person long periods of time to think about his choices, and, if he so desires, he should be able to consult relatives or friends about them. Most agriculturally relevant decisions are made on an annual or crop-cycle basis with long stretches of reflection time in between, and mutual consultation is important. Furthermore, the payoff and costs should at least reach the range of small agricultural investments.

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. Pure attitudes towards risk were to be measured, i.e., they should not be confounded with any other set of preference such as those for leisure. Nor should the subjects be confronted with any budget constraints ruling 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, one may measure the impact of a cash- or budget-constraint rather than the pure attitudes towards risk.[1] Furthermore, differential ability to perform complicated calculations should not influence the choices. Finally, dealing with simple coin tosses circumvents the problem of measuring subjective probabilities. In short, the choices should reflect risk attitudes and not any set of constraints.

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[1] How apparently "risk-averse" behavior can be induced by budget constraints or by imperfect capital markets is discussed in detail by Robert T. Masson, 1972. Samuelson (1977) has also shown that the failure to consider the effect of budget constraints or potential bankruptcy as an important determinant of choice under risk has been one of the main reasons for the confusion surrounding St. Petersburg Paradoxes.

An initial methodology was designed and pretested on 10 low-income individuals known to the author. The pretest results are not reported here since all the tests except one have now been done on the much larger random sample and are reported below. With minor modification the experiment was then performed with the full samples.

Table 1 explains the basic method. Individuals are given forms (which they can keep) with the numbers of panel A on Table 1. They have to choose between alternatives O to F. Once they have chosen, a coin will be tossed and they get the left-hand amounts if head comes up or the right-hand amount if tail comes up.[1] Thus probabilities are known. An individual who chooses O simply gets 50 Rs. i.e., participation in the game results in an automatic and sure increase in wealth by 50 Rs. An individual choosing C would receive 30 Rs on head and 150 on tail. By not choosing zero he stands to lose 20 Rs, but could gain 100 Rs. Compared to B, which is more relevant, the potential losses and gains in going to C are 10 and 30 Rs respectively. Finally, by choosing F the individual would receive 0 or 200 Rs. F has 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.

With each choice I have associated a name with the degree of risk aversion to simplify the discussion. Note that each of these names corresponds to an interval of partial risk aversion S which is fixed regardless of the level of payoff. Partial risk aversion was independently defined by Menezes

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[1] In the actual game sequence the winning and loosing side of the coins were changed for every new game level.

Table 1: The Payoffs and Corresponding Risk Classification

Choice	Panel A Head Low Payoff	 Tail High Payoff	Risk Aversion Class	S Approximate Partial Risk Aversion Coefficient[a]	$Z = \frac{\Delta E}{\Delta SE}$ [b]
0	50	50	Extreme	∞ to 7.5	1 to 0.80
A	45	95	Severe	7.50 to 1.74	0.8 to 0.66
B	40	120	Intermediate	1.74 .823	0.66 to 0.50
D*	35	125	Inefficient		
C	30	150	Moderate	.823 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 - ∞

[a]For reasons which are explained in Binswanger (1978), a constant partial risk aversion function on gains and losses was used to approximate S for the games. The function has the form $U = (1-S)U^{(1-S)}$.

[b]Z is the slope of the tradeoff between expected returns of and standard deviation of two games.

and Hanson (1970) and Zeckhauser and Keeler (1970).[1] 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

$$S(W + M) = - MU''(W+M)/U'(W+M) \tag{1}$$

where U' and U" are the first and second derivatives of the utility function. Other measures of the risk aversion are discussed in Binswanger (1978a), but S turned out to be the most convenient one. Another measure of risk aversion which is often useful is the Tradeoff Z between expected return and standard deviation.

In the experimental sequence (see Table 2) the individual is not presented immediately with the alternatives of Table 2, which is called the 50-Rs game, but instead goes through a sequence of games and hypothetical questions at various game levels. All game levels are derived from the 50-Rs-game by multiplying all amounts by a constant. In the 5-Rs-game all amounts are divided by 10, in the 0.50-Rs-game by 100 and they are multiplied by 10 for the 500-Rs-game. The sequence starts with 5 games at the 0.50 level to teach participants the rules of the game and to convince them that they will receive the money when promised so. 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. Since Indian coins vary substantially in shape, even illiterate persons could clearly visualize the payoff. The photographs were handed out to each player

[1] Zeckhauser and Keeler called it size-of-risk aversion.

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	One day	50.00	Hypothetical	Shirapur excluded
7	Same day	5.00	Real	All
	Same day	Hand out Rs. 5.00 for next day game		All
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, Kanzara, Aurepalli only
12	Same day	50.00	Real	
13	Same day	50.00	Hypothetical	
14	Same day	50.00	Hypothetical	Kalman, Kinkheda, Dokur only
15	Same day	5.00	Hypothetical	
16	Two weeks	500.00	Hypothetical	Shirapur, Kanzara, Aurepalli only
17	Same day	50.00	Hypothetical	

[a]In many cases these minimum delays were exceeded by a few days.

[b]There are six villages, two each in three districts: Scholapur district: Shirapur and Kalman; Ahola district: Kanjara and Kinkheda; Mahboobnagar district: Dokur and Aurepalli. Each village contains a panel of 40 households and household 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.

and left with them through the entire five to six weeks period of the experiment.

The Study Sample and Methodological Tests

The study was carried out in 240 rural households which constitute the Village-Level Studies of the International Coops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India.[1] These studies are located in the semi-arid (seasonally dry) tropical tracts of Maharashtra and Andrah Pradesh, some of the poorer regions of India. In June 1976 the average net wealth of these households was Rs 21716, i.e. roughly U.S. $2500 per household. The wealth is very unevenly distributed and 47% of the households had less than Rs. 10000 of wealth ($1162). Daily wage rates for unskilled laborers varied from Rs. 3 in the slack season to Rs. 6 in the peak season. The average payoff in the 50-Rs.-game is therefore commensurate with monthly wages. Playing the game with the full random sample was a shocking reminder of their poverty.

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[1]The village level studies of ICRISAT where started in May 1975 under the supervision of J. G. Ryan, N. S. Jodha and myself as a long-term data gathering effort on a panel of 40 randomly selected households in each of the six purposely selected villages and include landless laborers as well as farmers, i.e. a cross-section of the entire rural population. Data are collected on producer and consumer capitals, time allocation, agricultural production, nutrition and income and expenditure as well as some agrobiological observations. Each household is interviewed at 2 to 4 week intervals by resident investigators. For more details see Jodha et al. 1977, Binswanger and Jodha 1976, Binswanger et al. 1977. The studies are now in their fourth year and a considerable portion has been added to the data collection over the past two years.

Up to the 5 Rs 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 3 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 5 Rs level (the dependent female sample). In 5 villages a nonrandom sample of the 3 most "progressive" farmers of the village was added (the progressive farmer sample I).[1] The resident male investigators played the 0.50 Rs game with the household heads and temporary female investigators played them with the dependent females.

The resident male investigators played the 0.50-game. The 5-Rs-games were played by B. C. Barah, Ghodake or myself with the help of the investigators. Assisted by the investigators, I played all 50-Rs-games to ensure uniformity of method and to protect the investigators from objections which might be raised by the villagers if they were disappointed by the outcome. In fact, the stoic way in which all respondents took losses was remarkable. To make sure that each respondent had sufficient time to make a choice, the choices were first ascertained by the investigators, who made pairwise comparisons among alternatives until the respondent stopped switching. The economist who played the game then verified the

[1]Progressive farmers are early adopters of new techniques. They were identified by the resident investigators on the basis of their knowledge of the villages.

choice again by making pairwise comparisons with those alternatives adjoining the chosen one.[1]

In approximately 250 games which I played there were only 2 or 3 instances in which the alternative selected with the interviewers differed from the one verified by me. Once made, choices were firmly adhered to despite the frequent assertions that the respondents could shift as much and as long as they wanted.

Finally, a few impressionistic observations may be reported here: Respondents enjoyed the game and most of them spent much time waiting for their turns, sometimes discussing how much was gained or lost by others. No attempt was made to prevent or encourage this. In fact, this helped in establishing the strictness of the rules of the game and the certainty of the payments. It also prevented any attempt by respondents to argue about the outcomes of the coin tosses. Agricultural decisions and their outcomes are similar public knowledge, since everyone sees them in the field.

The sequence contains a series of tests designed to evaluate accuracy and replicability of the method and to evaluate the accuracy of answers to hypothetical questions. A basic question about the method is whether behavior with given money would be different from the behavior when owned money was a risk. One would hypothesize that, if there were any differences, people would be more cautious with owned money than with given money. While pretesting the experimental sequence with 10 individuals known to me, I did ask them, at one stage, to play the 5Rs game with their own money. Nine out

[1]If an adjoining alternative was inefficient, a pairwise comparison was also made with the next efficient one.

Table 3: Preliminary Tests of the Method

Sample and Villages	Game Number	Extreme	Severe	Inter-mediate	Moderate	Slight to Neutral	Neutral to Negative	Ineffi-cient		Sample Size
	Panel A: Playing with given money versus "own" money									
Household Heads	A Given money No.7, 5Rs	.8	10.2	23.3	39.0	8.9	8.9	8.9		236
All Villages	B "OWN" Money No.9, 5Rs	.8	6.0	24.3	34.0	14.9	10.6	9.4		235
	Panel B: Comparison of Hypothetical versus Real games									
Household Heads	C Hypothetical No.6, 50Rs	10.4	11.7	16.9	25.9	10.4	10.4	14.3		77
Kanzara and Aurepalli	D Hypothetical No.8, 50Rs	10.4	2.6	14.3	38.9	15.6	6.5	11.7		77
	E Real No.12, 50Rs	2.6	3.8	29.4	38.5	10.3	2.6	12.8		78
	F Hypothetical No.13, 50Rs	5.1	3.8	30.8	32.1	9.0	3.8	15.4		78
	G Hypothetical No.17, 50Rs	0	2.6	28.2	56.4	3.8	1.3	7.7		78
Household Heads	H Hypothetical No.11, 500 Rs (Before 50 Real)	1.7	12.7	39.9	27.1	7.6	3.4	7.6		118
Shirapur, Kanzara and Aurepalli	I Hypothetical No.16, 500 Rs (After 50 Real)	2.5	13.6	51.7	28.8	0	0.9	2.5		118
	Panel C: Test of the Central Tendency Hypothesis									
								D*	D	
Household Heads	J No.9, 5Rs Including D	0	6.3	8.9	39.2	19.0	15.2		11.4	79
Kanzara, Kinkheda, Aurepalli and Females of Kinkheda	K No.9, 5Rs Including D*	1.3	1.3	11.8	39.5	21.1	15.8	9.2		79
Household Heads	L No.12, 50Rs Real Including D	2.6	2.6	30.8	43.6	10.2	0		10.2	39
Kanzara, Kinkheda	M No.12, 50Rs Real Including D*	2.6	5.1	28.2	33.3	10.3	5.1	15.4		39

Chi-Square Tests with 6 degrees of Freedom and critical $\chi^2_{0.05} = 12.59$

Distributions Compared	Chi-Square
A vs B	7.37
C vs E	15.02
D vs E	10.16
F vs E	1.59
G vs E	8.48

Distributions Compared	Chi-Square
F vs G	14.12
H vs I	15.91
J vs K	4.16
L vs M	3.31

Note: All numbers in % of a sample size.

of the 10 chose the same alternative as when playing with given money, whereas the 10th shifted towards an alternative which was more risk-averse. In the large-scale experiment the test was performed differently. On the first 5-Rs-game (Number 7) no money was given out before the choice. But 5 Rs were handed out for the second 5-Rs-game (Number 9) on the day preceding the game.

On the day of game 9, individuals had to put that amount of money on the table which their gamble put at risk, if they wanted to play. (Since they had had it for a day it was their "own" money, so to speak.) No pressure whatsoever was applied to play at all. Non-attendance to the game on that day was interpreted as a choice of the riskless alternative zero. As can be seen from Table 3 Panel A, the choices on the two 5-Rs-games did not differ statistically from each other for the household heads. (See Chi-Square value A vs B.) The results for the females is not shown but was similar. Among the males there was a very modest shift towards less risk aversion, which is contrary to the hypothesis that there is any difference in behavior when only gains are considered than when both gains and losses are considered.[1]

The second test concerns the usability of answers to hypothetical games. It was hoped that after playing the full sequence up to the 50 Rs level, individuals would acquire the introspective ability to tell how they would play at the 500 Rs level. One could then use the hypothetical answers

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[1]This finding is further supported by the rationalizations of their choices which individuals were asked to give after the real 50-Rs-game Number 12. Only about 1/4 of the respondents with considerable verbal skills were able to given any explanation at all. But these verbalizations were invariably cast in terms such as the following: "If I choose B rather than A, I lose 5 Rs on head but gain 25 Rs on tail; but if I further shift to C, I lose 10 Rs for a gain of only 30 Rs. Therefore I prefer B." The long sequence of games seemed to teach people to regard the certain amounts as their own, or, alternatively, not to make a difference between "real" gains and losses and opportunity gains and losses.

as if they were real choices. Hypothetical games 6, 8 and 15 at the 50 Rs level were introduced to be compared in 2 villages (Aurepalli and Dokur) with the real 50-Rs-game. The results are reported in Panel B of Table 3. They show that, before playing the 50-Rs-game, (distributions C and D) people believe that they will either act more aversely or less aversely to risk than they actually do in the real game E. The difference between the outcomes in games 6 and 12 is statistically significant. In the second hypothetical game (Number 8), the predicting ability has improved, probably because one game at the 5 Rs level taught people better about their preferences. However, once the 50-Rs-game is played, answers to hypothetical questions are similar to the real game. There is no statistically significant difference between the real choices in game 12 and the hypothetical answers to games 13 or 17, although in game 17 there is a trend towards further concentration into the two central categories. This indicates that predictive power is pretty good after exposure to a game at high stakes. Note also the substantial difference in the answers to the hypothetical 500-Rs-game before the real 50-Rs-game (Number 11) and after the real 50 Rs-game (Number 16). The same trends towards concentration observed at the 50-Rs-game level are repeated. This may be taken as an indication that, at the end of the experimental sequence, people are fairly well able to predict how they would act at payoff levels substantially different from the ones actually played. I will thus treat the answer to game number 16 on par with the real answers, but disregard all hypothetical answers given before the real 50-Rs-game.[1]

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[1]Another reason for accepting the Rs 500 answers is the fact that, despite frequent denials, many respondents continue to hope strongly that the 500-Rs-game will be played in the future and the investigators are frequently asked when that will happen. The prospect is no longer unreal to them.

The third test is to investigate whether individuals, when confronted with a game such as in Table 1, have an automatic tendency towards alternatives in the center of the distribution. Table 2 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 (Kanjara, Kinkheda and Aurepalli) half the respondents were given the game structure containing the alternative D while the other half were given the game structure containing D*. Panel C of Table 3 shows that, at the 5 Rs level (distribution J and K), the frequency of choosing D* is lower than of choosing D, thus contradicting the central tendency hypothesis. At the 50 Rs level (distribution L and M) the frequency of D* is higher than for D. But at both game levels the frequency distributions associated with the two game structures can not be distinguished statistically.

Prior to the experiment with real payoffs we had made an attempt to measure attitudes towards risk via the Dillon-Scandizzo interview procedure but gradually discovered that that procedure was unreliable and non-replicable. Our suspicion of the reliability of the Dillon-Scandizzo interview method was initially aroused by the fact that, within the same region (Scholapur district), Investigator A was recording substantially lower levels of risk aversion than Investigator B in the interviews. We therefore reinterviewed the villagers with the same method but by switching investigators across the villages. From this it became clear that the risk aversion measure of the interviews reflected interviewer biases more than anything else. (see the Appendix for a detailed discussion)

To test whether the experimental method with real payoffs is also subject to investigator biases, the sample in each village of the Scholapur area was split in half and each half assigned for the full experimental sequence to one of the two investigators. No statistically significant differences could be detected between the risk aversion distributions of the two halves of the sample. Thus no evidence of investigator bias could be uncovered for the experimental method.

THE MAIN EXPERIMENTAL RESULTS

The Risk Aversion distributions corresponding to different game levels are given in Table 4, first for those villages where the game was played up to the 50 Rs level (with a hypothetical answer at the 500 Rs level) and then for all the households, including those where the game was played only up to the 5 Rs level.

It is clear from the table that the risk aversion distribution shifts very markedly to the left as game levels rise. As can be seen from Table 1, this implies increasing partial risk aversion or increasing risk aversion as measured by the tradeoff Z between expected return and standard deviation.[1]

Consider the Slight-to-Neutral and Neutral-to-Preferred classes: At the 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 500 Rs. In the moderate risk aversion class we initially find around 25% of the individuals. This fraction first rises at the 5Rs and 50 Rs levels

[1] In Binswanger (1978a) it is shown that absolute risk aversion is decreasing while relative risk aversion is first decreasing and then increasing.

because people enter this class when leaving the lower risk aversion classes. But between the 50 and 500 Rs 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 0.50 RS 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 500 Rs level more than 50% of individuals are concentrated in this single class, to which a partial risk aversion coefficient corresponds of 0.823 to 1.74. The 500 Rs game corresponds to payoffs in the order of substantial fertilizer investments for these households, and many are too poor to undertake them. For some households it even exceeds net wealth.

The extreme and severe risk aversion classes together contain less than 10% of the individuals for all levels except the 500 Rs level where this rises to 15%. There appears to be an upper barrier on risk aversion which is exceeded only very slowly at high stakes.

As is shown in more detail in appendix Table A-2, individuals' preferences for a given alternative are not very stable. For example in the two 5-Rs-games (No. 7 and 9) only 40% of individuals chose the same alternative both times. Most of the shifts, however, are into or from neighboring efficient and inefficient alternatives

In any given game, around 10% of individuals choose 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 alternative. These three classes and

Table 4. The Effect of Payoff Size on Distribution of Risk Aversion

Payoff Level & Game Number	Extreme	Severe	Inter-mediate	Moderate	Slight-to-Neutral	Neutral-to-Negative	Inef-ficient	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	CHI-SQR	dF	$X^2_{0.05}$
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

the inefficient one contain 78.5% of individuals. If people would fall into the two inefficient and three efficient classes at random, the two inefficient classes should contain at the very least 1/5 of the 78.5% observations, i.e. 15.7%, but the actual percentage is 9.3%, i.e. a little more than half.

Who chooses inefficiently varies much across games. 287 individuals played all the games from No. 1 to No. 9. Of those 94 or 33% chose one of the inefficient alternatives at least once, i.e. 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 who initially have low risk aversion it tends to rise fairly rapidly as game levels start to rise beyond trivial levels. For individuals who initially have intermediate to moderate levels of risk aversion, it declines slowly or remains fairly constant as game levels rise.

Very few individuals have partial risk aversion coefficients much above 1.74 and even at fairly high stakes that level is exceeded for less than 15% of individuals. As can be seen from the Chi-Square tests, these trends are statistically significant and evident in both the reduced sample as well as the full sample of households.

Interpreted in a utility theory framework, the utility function for money income is nonlinear and risk-averse in money income for all but one out of 118 individuals.[1] At game levels of 50 Rs.

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[1]The one person who—at the 50 Rs level—chose the most risky alternative and indicated willingness to play the same at the 500 Rs level was a tuberculosis patient whom most people expected to die and to whose house we went to play. The other individual who played a most risky 50 Rs game was a boy of 16 years and he did not want to play that game at the 500 Rs level anymore.

and above, three-fourths or more of all individuals fall into only two risk aversion classes, the intermediate and moderate one. This concentration of risk attitudes within a fairly narrow interval is quite remarkable, and implies that in explaining economic behavior of these rural households, risk aversion will be important for virtually all of them. On the other hand it will be difficult to explain differences in behavior among them on account of differences in pure attitudes towards risk.

These results contrast sharply with the results of Dillon and Scandizzo (1977), which are discussed in the Appendix. They also conflict sharply with the distribution of risk attitudes found for the same sample with the same interview technique than Dillon and Scandizzo used.

Correlation of Risk Aversion with Personal Characteristics

Empirically, virtually nothing is known about how personal characteristics of individuals are correlated with risk aversion. The data set collected in India is well suited to explore this issue with multiple regression analysis of personal characteristics on the extent of risk aversion at different game levels. We should note at the outset, however, that individual characteristics, at least at high game levels, cannot be expected to have a massive impact on risk aversion simply because most people have similar attitudes.

Ideally, we would like to know the causal relationships from personal characteristics,such as wealth, schooling, etc., to risk aversion, and the reverse causality from risk aversion to earnings ability and schooling choices. This however, poses formidable simultaneous equation problems which eventually have to be solved by simultaneous equation techniques. As it stands, the data set does not yet contain sufficient truly exogenous variables which can be used as instruments to identify a full simultaneous equation model. However, data gathering to do this has been initiated within the ICRISAT village-level-studies. In the meantime, multiple regression techniques can, for most variables, only indicate correlations corrected for the other individual variables.

A second problem is the choice of the dependent variable and its functional form. Should we use partial risk aversion S[1], or Z, or should we simply assign integers to the alternatives O to F going from 0 to 5 and

[1]Partial risk aversion is a multiplicative transformation of absolute risk aversion at each game level and regressing on partial risk aversion amounts to the same thing as a regression on absolute risk aversion.

use them as indicators of risk aversion? And should these measures be used directly or be transformed into logarithms or other forms? For correlation analysis one would like to choose that variable and variable transformation which is best able to capture the correlations, as long as the choice of different forms does not lead to contradictory results. Therefore, a series of experimental regressions was performed with the following forms and variables: Alternative Number; Z; ln Z; logistic of Z; S ln S; S^k, k = 0.1, 0.2, 0.25, 0.5, 0.66; logistic on S. These transformations had little impact on sign patterns of the coefficients but Z and ln S performed best in terms of $\bar{R}^2$ and gave very similar results. Therefore, the regressions on lnS are reported.

Second, for S and Z, the choices of an alternative only indicate a range of the risk aversion coefficient S or the variable Z. The arithmetic mean of the endpoints of the intervals was assigned to each choice as an estimate of Z. For S, the geometric mean of the endpoints was assigned as the measure of S. The geometric mean was chosen because the interval length for each choice increases markedly as we move to more risk-averse alternatives.[1] Problems also arise in assigning a value for Z and S to alternatives F and O. In the case of F, a value of zero was given to S and Z, 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.[2] For alternative 0, the upper bound for S is equal to infinity, while its lower bound is 7.50. Since the experimental results indicate that very few individuals chose alternative zero,

[1]For alternative E 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.

[2]For logarithmic transformations, a value of zero is inadmissable. It was therefore - rather arbitrarily - set at 0.007.

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. For Z the assignment was less arbitrary. One can show that--for games with equal probabilities--Z cannot exceed 1.[1] Since the lower bound is 0.8, the mean value of 0.9 was assigned to choice zero. Note that at higher game levels very few individuals choose alternatives 0 or F so that the--admittedly arbitrary--choices just described should have little impact on the regression results.

Third, it is not clear how to treat the choices of inefficient alternatives. It would, of course,be best to simply leave out all individuals who chose an inefficient alternative at least once in the sequence. However, that leads to a loss of about one-third of the sample, which is especially harmful at the high game levels, where only 118 individuals played. An alternative would be to leave out, in each regression, those individuals who chose an inefficient alternative in that game. But then each regression would be over a different data set with unknown impact. Finally, one can assume that individuals who choose D* or D have essentially the same attitudes as those who choose B and C the alternatives have the same expected return and only slightly higher standard deviation. To test whether such a treatment has any effect on

[1]Consider two alternatives with a bad and a good outcome of equal probability:

Alternative	Bad luck	Good luck	E	SE
0	5	5	5	0
1	5	7	6	1

For these alternatives $Z = \frac{\Delta E}{\Delta SE} = 1$, but all risk averters who prefer more to less will choose alternative one, hence the largest Z is 1.

the results, such regressions were run and compared to regressions where all individuals who choose inefficiently at least once in the games No. 1 to No. 9 were left out. These regressions differed little from each other and coefficient signs were the same except for coefficients with extremely low t-values. But the added observations resulted in lower standard errors of coefficients and the results reported thus include the inefficient choices as B and C choices respectively.

Fourth, different subsets of the data might lead to different regression results and - for unknown reasons - should not be combined. Therefore, several regressions were performed on different data subsets to test whether this is indeed a problem. The subsets were as follows: The full sample, the household heads of those villages where the full sequence of games was played (Aurepalli, Shirapur, Kanzara), the household heads of the other three villages (Dokur, Kalman, Kinkheda) and finally the dependent females of Dokur and Kinkheda.

F tests indicated that for regressions on Z and log S, the data sets could be combined easily for all games 2, 5, 7 and 9.[1] But because the data for dependent females is not independent of that of the household heads, the final regressions reported include only household heads of all six villages.

Lastly, there are issues of the functional form of the independent variables. Including both linear and square terms of all continuous independent variables resulted in only nonsignificant square terms and

[1]The largest F value for combining the data sets was 1.376 against a critical value at the 10% level of approximately 1.45. All other F values were substantially lower.

was abandoned. Age and wealth (the only variables which had no zero observations) were also included in logarithmic form. But the resulting coefficient led to the same qualitative results as when they were included linearily.

Running so many experimental regressions is justified in an exploratory study in an area where so little is known. It helps to distinguish robust results from spurious ones which can only be demonstrated for particular functional forms or data subsets. The results of these experiments are summarized in Table 5 which shows the sign patterns and patterns of significance of different coefficients for 18 experimental regressions: 8 experiments on functional forms of dependent variables, 2 experiments on including or excluding inefficient choices, 5 experiments to look at different subparts of the data, and 2 experiments on functional forms of dependent variables. Each of the 18 specifications was used for games No. 2, 5, 7, 9, 12 and 16. Game No. 2 was used rather than game one because in game one the rules of the game might not have been fully clear to all individuals.

In Table 5, one plus or minus sign indicates that the coefficient was of the respective sign in more than 3/4 of the experimental regressions. Two plus or minus signs indicate that the sign was the same in all experiments. A question mark means that the sign pattern was not consistent. One star means that the coefficient was statistically significant at the 10% level in at least one of the experimental regressions. Two stars means that the coefficient was statistically significant in at least 2/3 of the cases when it had the indicated sign. Three stars

Table 5 Robustness of Signs of Variables in Different Regression Experiments

Game Level Game Number	0.50 Rs No. 2	No. 5	5 Rs No. 7	No. 9	50 Rs No. 12	500 Rs No. 16
Women	? -*	+ *	-	? ±*[b]	?	-
Progressive	? -*	-- *	--*	? -*	-	--
Working Age Adults per family	?	--	+	+ *	++	++
Salary	+	- *	-- **	--	?	-- *
Land Rented	?	-- **	--	?	?	?
Gamblers	--	--	+	- *	?	+
Age	+ *	+ *	+	+	-- *	--
Schooling	?	-	-- *	? -*	-- *	- **
Assets	-- *	-	-	? -*[b]	+	-
Net Transfers Received	-	- *	- *	-- *	--	?
Luck	-- *	-- *	- *	-- *	-- ***	-- *

Symbols used:

+ (or -)	The coefficient is positive (or negative) in 3/4th or more of all cases.
++ (or --)	The coefficient is positive (or negative) in all cases
?	Sign uncertain
*	The coefficient is significant in at least one case (10%) level.
**	The coefficient in statistically significant in at least 2/3 of the cases when it has the sign indicated (10% level).
***	The coefficient is statistically significant in all cases (10% level).

[a] Total of 18 experiments. Working adults, salary, land rented, and gamblers were included in only some of the experiments.

[b] The contradictions of sign arise in different data subset.

mean that it was always statistically significant.

Overall, the experiments indicate that within any given game the sign patterns are fairly robust. Only in one case (regression No. 9) was the dummy for females statistically significant with opposite sign in different subsets of the data (but not across variable specifications). However, across games the sign patterns are much less consistent. In what follows, the results are discussed variable by variable.

In Table 6 the coefficients of the variables with ln S are given. The following discussion refers to both Table 5 and 6 to judge the coefficients and their stability. To judge the magnitude of the effects implied, Table 7 computes a predicted S for the 5 and 50 Rs 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 in the regression coefficient and a move from the average value of the independent variable to the largest value observed in the sample.[1] This means that we compute the effect of the largest possible shift away from the mean of each independent variable. The table also shows which choice would be implied by the new value ofS.

Thirteen variables were included in the regression, apart from the village dummies, which were included to take account of effects on risk aversion of such variables as agroclimatic differences, etc.

Assets: Economists usually assume that rich people should be more willing to engage in favorable games of a fixed size than poor people, i.e. for any given game level, partial risk aversion S or Z

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[1]Predicted S = $\exp\{\frac{1}{n}\Sigma_i \log S_i\} + \exp\{b_j (X_{j\max} - \overline{X}_j)\}$ where n is the sample size and X_j the j'th independent variable and $\overline{X}_j$ is the arithmetic mean, and b_j is its estimated coefficient.

Table 6: Regression of Personal Characteristics on Partial Risk Aversion

Dependent Variable[b]	0.5 Rupees No. 2	0.5 Rupees No. 5	5 Rupees No. 7	5 Rupees No. 9	50 Rupees No. 12	500 Rs No. 16
Intercept	-2.317	-2.331	-1.030	-1.825	.174	.426
Village 1	.782 (1.74)*	.724 (1.60)	.489 (1.42)	.568 (1.58)	.270 (1.03)	-.313 (1.80)*
Village 2	1.447 (3.37)*	.418 (.97)	.207 (.63)	.639 (1.87)*		
Village 3	1.397 (3.16)*	1.735 (3.94)*	.919 (2.75)*	0.952 (2.72)*	.451 (1.84)*	-.165 (1.01)
Village 4	.943 (2.19)*	.409 (.94)	.576 (1.74)	.306 (.87)		
Village 6	.207 (.50)	.741 (1.78)*	.689 (2.18)*	-.797 (2.62)*		
Women	.613 (1.36)	.763 (1.69)*	.113 (.33)	-.687 (1.92)*	.0273 (.08)	-.0248 (.11)
Progressive farmer dummy	-.187 (.40)	-.850 (1.83)*	-.772 (2.19)	.0630 (.17)	-.154 (.41)	-.320 (1.26)
Working age Adults (share age 15-59)	.200 (.35)	-.529 (.94)	.126 (.30)	.709 (1.60)	.207 (.49)	.327 (1.17)
Salary (1000 Rs/month)	.171 (.76)	-.0644 (.29)	-.354 (2.08)*	-.198 (1.12)	-.141 (.77)	-.208 (1.70)*
Land Rented (hectores)	-.0526 (.95)	-.156 (2.81)*	-.0343 (.81)	.0145 (.33)	.0476 (.80)	.000758 (0)
Gambler dummy	-.962 (1.00)	-.386 (.40)	.243 (.33)	-.906 (1.18)	-.0379 (.01)	.210 (.58)
Age (yrs)	.00968 (.92)	.0173 (1.65)	.00728 (.91)	.0154 (1.86)*	-.0137 (1.71)*	-.00247 (.46)
Schooling (yrs)	.0430 (.93)	-.0124 (.27)	-.0743 (2.14)*	.0111 (.30)	-.0432 (1.23)	-.0370 (1.58)
Assets (in 1000 Rs)	-.0134 (2.42)*	-.00461 (.84)	-.00376 (.81)	-.00945 (2.16)*	-.00216 (.45)	-.0011 (.34)
Net transfers received (in 1000 Rs)	-.139 (.77)	-.340 (1.90)*	-.265 (1.94)*	-.141 (.99)	-.0463 (.44)	.00482 (.17)
Luck	-.212 (1.69)*	-.209 (3.20)*	-.126 (2.69)*	-.107 (2.37)*	-.115 (2.72)*	-.0425 (1.67)*
$\bar{R}^2$	.100	.171	.192	.212	.055	.088
F	2.644	3.928	4.370	4.818	1.491	1.816
N. obs.	228	228	228	228	111	111

[a]The values in parenthesis are t-value. * indicates that a variable is statistically significant at the 0.1 level.

$t_{0.1,\infty} = 1.645$; $t_{0.1,120} = 1.658$; $F_{0.1,14,\infty} = 1.80$

[b]In terms of partial risk aversion coefficients S, the dependent variable was ln (S/7) for all bets. In terms of A the dependent variable is the following functions of A; 0.50-Rs-games Y = ln (A/10); 50-Rs-game Y = ln (A x 10); 500-Rs-level; Y = ln (A x 100). The intercept term has been converted to reflect the intercept of S.

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

Explanatory Variable	Maximum Minus Mean Value[a]	Predicted S at 5 Rs Level	Choice Implied	Predicted S at 50 Rs Level	Choice Implied
Average S[b]		.483	C	.705	C (→B)[c]
Women	1	.540	C	.724	C (→B)
Progressive	1	.223	E	.604	C
Working Adults (share age 15-59)	0.5	.515	C	.750	C (→B)
Salary (Rs 1000)	Rs 5.069	.080	E	.345	C (→E)
Age	38 Years	.637	C	.418	C
Schooling	12 Years	.198	E	.420	C
Assets (Rs 1000)	185.277	.243	E	–[d]	
Transfer income (Rs 1000)	6.224	.093	E	.528	C
Luck	5	.257	E	.396	C

[a]For dummy variables the value taken was one.

[b]Antilog of average of ln S

[c] Y(→ X) This notation means that the value of S implies choice of alternative Y, but that it is close to the indifference point with X.

[d]Coefficient has wrong sign.

(the tradeoff between expected return and standard deviation) should decrease as wealth rises. In the regressions, wealth is measured by gross sales value of physical assets.[1] In these households, on average 69% of physical wealth is held in the form of land. In the semi-arid tropical environment, land gives rise to highly variable income streams.

The weakness of the relationship between physical assets and risk aversion is very surprising, given the fairly strong effect of the game size. Within a given game and across games, the sign of the coefficient is not consistently negative, although negative signs predominate and only negative signs are ever statistically significant. The largest statistically significant coefficient of -.0116 in game 9 implies that a shift from average wealth to the largest wealth observed in the sample is not entirely sufficient to bring an individual from choice C to risk neutrality. It would not be sufficient to move an individual who initially was indifferent between A and B to choose alternative E.

For the crucial 50-Rs-game, the coefficient is usually of the wrong sign (positive, close to zero and not significant). Contrary to all expectations, wealth has little impact on individuals' behavior at game levels which are commensurate with monthly wage rates.

Schooling: Another form of wealth is human wealth and schooling is a proxy variable for it. Average schooling in the sample is 2 years, but the maximum is 16 years, i.e., the distribution is highly skewed. At low game levels this variable has little influence on risk aversion, but at the 5 Rs level and above, it generally reduces the level of risk

[1]It would have been better to use net worth rather than gross wealth. However, the data on borrowings and lendings is fairly poor, but imply that at higher wealth levels borrowings were a small fraction of gross wealth.

aversion and is often statistically significant, although not generally so in the regressions using log S. But again, the impact of schooling is not massive. In the five-Rs-game, the coefficient size of -0.0432 is sufficient to shift an individual who goes from 2 years to 14 years of schooling from the intermediate risk aversion class to the slight-to-neutral class. At the 50 Rs level, the same shift is not sufficient to shift the individual's risk aversion by an entire class interval.

The interpretation of schooling as a proxy for human wealth is only one interpretation. It is also possible to view the effect as one which affects the utility function itself. Better schooled people could be better able to take risks because (a) they have better information processing capacity or (b) because they have better alternative income opportunities if one risky venture, which they engage in, fails, i.e., they are better insured. The data do not allow us to distinguish these hypotheses.

Two variables which 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 have zero schooling). Thus, schooling could partly determine the access to jobs. Progressive farmers are those whom the resident investigators designated as the early adopters of new techniques (5 in each village). Schooling is again correlated with this variable and can be expected to contribute to it. It is interesting to note that if these two variables are suppressed, schooling does become statistically significant, even in the regressions using ln S as the dependent variable for risk behavior. It will therefore be worthwhile to build and test a model capable of distinguishing whether schooling decreases risk aversion causally or the least risk-averse individuals are moie likely to acquire more education.

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

Luck or past experience: 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. This is a hypothesis which psychologists would be more fond of, and such a view is strongly supported by the experiment. 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 0 when he neither wins nor loses (alternative zero).[1] The coefficient is consistently negative and almost 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 5 Rs level (after 7 games), a person who had consistently won (luck = +7) would tend to shift from playing alternative C to playing alternative

[1] For each game, the luck variable is only defined over the preceding game, i.e., a new luck variable is defined at each successive game.

E compared to 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 Rs game were collected 2 or more weeks after the last game was actually played.[1]

That past experience should have such an impact on risk aversion implies that, after a series of droughts, farmers would be more reluctant to invest (even if they had the same wealth levels as before the drought) than they normally would and should on account of their own average risk aversion.

Age: Age has a fairly consistent positive sign in games up to the 5 Rs level but a consistently negative sign at the 50 and 500 Rs level. At the 50 Rs level it is sometimes statistically significant but not at the 500 Rs 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 the high levels? But at the 50 Rs level the quantitative impact of even 38 years of age difference are not sufficient to shift an individual's choice by an entire class interval.

Sex: The women dummy variable exhibits very inconsistent coefficient signs, being as often positive as negative. At high game levels it

[1] Psychologists working experimentally in the area have found that individuals exhibit preferences for heads or tails in coin tosses. Since the winning sign of the coin was changed 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 whether a person had a winning or losing streak on one side of the coin.

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 the average--women are 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 do not have equal access to education as men. Not a single woman in the sample ever attended school.

Working age adults: This variable 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 15 and 59 years divided by the weighted sum of family members.[1] 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 the wrong sign.

Land rented: A portion of the new literature on tenancy assumes that share tenancy is used to spread the riskiness of farming (Bardhan and Srinivasan 1971). The reasoning is not based on differential risk aversion between landlords and tenants, but it would be considerably strengthened if tenants were generally more risk-averse than landlords. The "Land Rented" variable measures the net area leased in by a household. It is negative for landlords and positive for tenants. At low game levels there is some indication that tenants are less risk-averse

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

than landlords, not vice-versa. At high game levels, there appears to be no difference.

Net transfers received measures the net amount of income transfer received from relatives and other sources between July 1, 1975 and June 30, 1976. (It is negative for those who send transfers.) It has a fairly consistent 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, but the best which can be done at this stage.

Gamblers: The individuals who liked to gamble (by buying lottery tickets or playing cards, with and without money) were identified. Less than five percent of individuals were so identified and the variable leads to contradictory results.

To briefly summarize the conclusions: Past luck with a random process makes people distinctly less risk-averse when again confronted with it. Physical assets tend to reduce risk aversion but neither strongly nor very consistently. Schooling tends to reduce risk aversion fairly consistently. Salary employment and income transfers from others both tend to reduce risk aversion slightly, possibly indicating an insurance effect of more reliable income sources than agriculture. Progressive farmers tend to be slightly less risk-averse than average farmers, but the effect is weak at high game levels and can probably not account for their higher willingness to accept new techniques. The following variables have contradicting signs and seem not to be strongly correlated with risk aversion: Sex, working age adults (dependency ratio), amount of land rented, and age. Again, emphasis has to be placed on the weakness of all these correlations. Massive changes in the "independent" variables are required to lead to substantial changes in the measured risk aversion.

Appendix 1

Interviews vs. Experiments to Elicit Attitude Towards Risk

This appendix discusses the reliability of interview based methods to elicit attitudes towards risk and compares the results of interviews with those derived from the game with real payoffs. The interview based method was taken from Dillon and Scandizzo (1977) and slightly adapted to fit the conditions in the study area. 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 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 provided as frequencies and were maintained constant at 0.75 ("3 years out of 4") for the 'good' outcome and 0.25 ("1 year out of 4") for the 'bad' outcome."

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 had previously been established for each household individually by asking them - item by item - their minimum annual requirement of all food and clothing which they considered necessary. Subsistence income ranged from Rs 462 to Rs 14117). The certainty equivalent of the prospect was then found by varying the certain income until indifference with the uncertain prospect was attained.

The questions were made meaningful to the farmers by expressing them as a choice between unirrigated land as the risky prospect and irrigated land as the sure prospect. For landless laborers the certain income was a steady job and the uncertain income the daily labor market. We soon discovered that, when expressing the prospects in this way, the choices often did not reflect attitudes towards risk but also other preferences: cultivating irrigated land is much more time consuming and many farmers preferred unirrigated land because it gives them more leisure. In such cases the interviewers pointed out that the income streams from both kinds of land were net of labor cost and asked the farmer to abstract from their leisure preferences. If the interviewer felt that the respondent was unable to abstract from other preferences, he presented the same questions but in the form of different income streams such as animal husbandry versus crop enterprises or trading versus fixed employment. I see no other way of getting around the problem of confounding, except to go back to pure betting questions; but farmers do not understand why pure betting questions are asked in the first place.

The method was pretested at the same time as the investigators were trained. All investigators have a master's degree in agricultural economics and--with one exception--had worked in their villages collecting data for more than one year. It is unlikely that one could find better qualified and trained investigators. During this entire phase all of us involved had the feeling that most respondents were taking the questions seriously and making an effort at providing a reasonable answer. Otherwise we would not have continued. The first suspicion of unreliability arose when the results from one village showed that one investigator could not have understood the method properly. The answers he obtained depended on whether he started to approach the certainty equivalent from below or above. The next suspicion arose when the data for the two neighboring villages Shirapur and Kalman were analyzed. They are shown in Table A-1. The certainty equivalents were converted into partial risk aversion coefficients using a constant risk aversion function approximation and grouped into the same classes as those of the experimental study, except that the intermediate and moderate classes were pooled. (The interval of partial risk aversion coefficients covered by these two classes were so small relative to the variability in interview answers that the frequency of observations in each class was small.)

The second and third lines in Table A-1 (Shirapur First and Kalman First) compare the results in the two neighboring villages of the first survey which was done by two different investigators, A and B. Shirapur shows much more risk aversion than Kalman although both villages are very similar. The difference between the distributions of attitudes is statistically significant.

We then reinterviewed all households in four of the six villages. In the villages of Akola district, each investigator interviewed half of the respondents in his own village and half of the respondents in his

Table A-1

Reliability of Survey Results in Shirapur and Kalman

I. Risk Aversion Distributions Obtained by Different Investigators in Two Villages*

Village and Survey	Investigator	Survey or Resurvey	Risk Aversion Class: Extreme	Severe	Intermed. 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			33
Kalman (first)	A	Survey	4	5	5	11	4	29
Kalman (second)	B	Resurvey	11	12	1	2	3	29

II. Analysis of Switches in Classification

On Resurvey as compared to Survey	Number	Percent of sample size
Remained in same class	21	62.9
Switched into neighboring class	18	
Changed by two classes on risk aversion side	10	16.1
Changed from extreme risk aversion to slight or neutral	7	21.0
Changes from risk averse side to negative risk aversion (excluding shift from slight or neutral to negative)	6	

Shirapur first vs. Kalman first — Chi Square = 27.71

Shirapur first vs. Shirapur second — Chi Square = 15.91 — $\chi^2_{4,0.05} = 9.49$

Kalman first vs. Kalman second — Chi Square = 13.53

*In absolute numbers

neighboring village. In those villages not much systematic difference between investigators or between rounds could be observed, although the two answers of many individual respondents were quite different. In Shirapur and Kalman each investigator reinterviewed the households of the other village and the results are given in the first and fourth line of Table 3. It is clear that in each village investigator B classifies respondents as much more risk-averse than investigator A. The differences between investigators are statistically significant. The shift to more pronounced risk aversion must be an investigator bias and cannot be caused by the time lag of more than a month between interviews, since the time sequence of interviewers was reversed in each village. Clearly the interview technique is subject to severe investigator bias, despite the fact that both interviews tried not to influence the respondents.

Panel II shows the stability of the answers from individual respondents between the two rounds and thus accounts for offsetting shifts of two respondents between classes of risk aversion. 62.9% of individuals remained in the same class or shifted into a neighboring class. Particularly disturbing is the fact that between interviews more than 20% of individuals are radically reclassified, either between extreme risk aversion and neutrality or between positive and negative risk aversion.

A similar analysis of shifts has been performed in Table A-2 for the experimental game. Note that, at the high payoff levels, radical reclassifications must be very rare because the extreme and the neutral-to-negative risk aversion groups contain only very small proportions of the population. The classifications for the shifts in the game results are

Table A-2

Analysis of Frequency of Shifts Among Classes of Risk Aversion in the Game*

	Those who chose								
	Only efficiently						Inefficiently		No. of
Games Involved	Unchanged	Shift by 1	Shift by 2	Shift by 3	Shift by 4	Shift by 5	Once	Both Times	Obser-vations
1 and 2 0.50 Rs	15.7	37.4	14.5	5.5	1.3	1.3	23.0	1.3	235
4 and 5 0.50 Rs	32.2	33.5	12.7	2.5	1.3	.9	15.3	1.7	236
7 and 9 5 Rs	39.6	26.8	15.3	1.3	0.4	1.7	14.9	1.7	235
12 and 17[a] 50 Rs.	62.7	19.5	5.1				11.0	1.7	118

[a]Game No. 17 is hypothetical

*In percent of number of observations

also somewhat finer because the intermediate and moderate groups are treated as separate categories. If preferences were very stable, people should remain in the same class or, at most, shift by one class if they previously were indifferent between two games. Between the first and the second 0.50-Rs-game only 53.10% of individuals remain stable in this sense, the other shifting by two or more classes or choosing inefficient alternatives at least once. This level of instability is roughly comparable with the interview results in Table A-1. However, as payoffs increase, answers become more stable. At the 50 Rs. level over 60% of individuals do not change their choice and an additional 19.5% switch only to a neighboring alternative which is consistent with indifference. Note that game 17 is only hypothetical and it is possible that choices would have been more or less stable if the game had really been played. Of course, at the 50 Rs level, switching is severly constrained by the fact that very few individuals are observed in the extreme and neutral-to-negative classes of risk aversion so that the observed stability is likely to be reliable.

At the lower game levels, much of the increased stability could be caused by learning. The answers from games 4 and 5 are not less stable than from games 7 and 9, despite the higher game level of the latter two.

Table A-3 compares our own interview results with the game results and the interview results of Dillon and Scandizzo. The intermediate and moderate class of risk aversion have again been combined. Dillon and Scandizzo give explicit data on the slight-to-neutral and negative classes of risk aversion, but not on the "extreme" classification. I chose to put only those individuals into the extreme class who opted for the highest possible certainty equivalent in their study. In comparing interview results with

Table A-3

Comparison of Interview Based and Experimentally Based Distribution of Risk Aversion*

	Extreme	Severe	Intermediate or Moderate	Slight or Neutral	Negative	Inefficient	No. of Observations
A. Interview Subsistence-at-risk[a]	27.0	34.3	18.0	6.3	14.4	n. appl.	222
B. Interview Subsistence-assured[a]	18.2	43.6	15.5	9.1	13.6	n. appl.	220
C. Game No. 2; 0.50 Rs	1.7	5.9	48.7	15.1	18.5	10.1	118
D. Game No. 12; 50 Rs	2.5	5.1	74.6	6.8	1.7	9.3	118
E. Game No. 16; 500 Rs	2.5	8.2	85.9	0	0.9	2.5	118
Dillon and Scandizzo's Interview Based on Results from Brazil[b]							
F. Subsistence-at-Risk[a]	26.2		57.3	0	16.5	n. appl.	103
G. Subsistence-assured[a]	32.0		32.1	8.7	27.2	n. appl.	103

(A) vs (C) CHI-SQUARE = 96.87 $\chi^2_{4,0.05} = 9.49$. All other chi-square values for interview versus games exceed the above value of 96.87

*In percent 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 that 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 my own interview studies excludes roughly 10 respondents on similar grounds.

game results, also note that in the game the favorable and unfavorable prospects had 50% probabilities each, while for the interview methods these probabilities were 75% and 25% respectively, i.e., the distribution of outcomes was skewed.

The interview results of Dillon and Scandizzo are similar to my own.[1] A large proportion of individuals seem to be extremely risk-averse (18.2% to 32%) which is in sharp contrast to all the experimental results. Also all interviews find a sizable proportion of risk preferers of between 13.6% and 27.2%. Such a high proportion of risk preferers is found only in the 0.50 Rs game but at higher payoffs the fraction is insignificant. Note that in the interviews the payoffs were roughly equal to or exceeded the payoffs of the 500-Rs.-game.[2]

The interview results also identify more individuals in the severe risk aversion class than the game. In my own interview results the severe and extreme risk aversion classes combined contain 61% of the population (at both levels of payoff) while in the 500 Rs game these classes contain only 11.7% of the respondents. All the differences between the interview and the game results in India are statistically significant.

Of a total of 118 farmers available for interview, Dillon and Scandizzo excluded 15 because they either did not want to answer or because their answers were internally inconsistent. In the game all those present

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[1]The only qualitative difference is that the proportion of individuals with negative risk aversion is roughly constant in my study while it increases substantially in the study by Scandizzo and Dillon.

[2]Kennedy (1976) used an interview technique based on focus loss with Australian farmers. Of 27 farmers who gave consistent answers, eight or 29% were found to prefer risk and one was risk neutral. Unfortunately, I cannot compute the number or extreme risk averters from his results. Also, note that Kennedy disregarded the results of nine farmers (out of 36) because of inconsistencies in their answers.

want to play, but even there inconsistencies with "rational" behavior can arise, such as choosing risk-inefficient alternatives.

The question arises why the interview results so radically mismeasure the real extent of risk aversion. There seems to be a tendency for interview results to particularly exaggerate the extent of severe and extreme risk aversion. But it cannot only be such a systematic bias because the interviews also exaggerate the extent of risk neutrality and preference. Furthermore, the only reason for the misleading results does not seem to be the absence of real payoffs because the 0.50 Rs game shows more individuals to be risk-neutral or preferring than the interview, but fails to show as many severe or extreme risk averters. The mismeasurement must also result from the fact that--in an interview--a respondent usually has less than one-half hour to reflect and understand the complicated question of how much expected return he is willing to give up for a reduction in risk. In the game reflection times are much longer and no interviewer is present who would be pleased if the respondent gave his answer quickly--a fact which the respondent also knows. Agricultural production decisions, and many other real life decisions, are taken with much longer lead times than one-half hour from the time that they are first considered. <u>We therefore must conclude that evidence on risk aversion from pure interviews is unreliable, nonreplicable and misleading</u>, even if one is interested only in a distribution of risk aversion rather than a reliable individual measurement.

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