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Chapter 8

Peasant agriculture and risk preferences in Northeast Brazil: A statistical sampling approach*

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1. INTRODUCTION

One of the most intriguing problems facing students of rural development concerns the possibility of measuring the degree to which peasants in general and subsistence farmers in particular react to the pervasive uncertainty of their environment. Expected utility theory, originally axiomatized by Von Neumann and Morgenstern (1947), is the most common provider of a framework for measurement. Other theories, based on concepts such as stochastic preferences and cognitive versus adaptive behavior have been proposed by psychologists and statisticians[1] and are also available as alternative models for the experimental measurement of preferences.

In the domain of farmers' decision making analysis, a number of studies have tried to fit individual utility functions using simulated behavior under quasi-laboratorial experimental conditions.[2] All these studies have concentrated on the problem of the existence and measurability of the utility function on an individual basis with a relatively small sample of subjects and a relatively large investment in monitoring individual behavior.

Although some of the studies report systematic comparisons of one or two parameters of the utility function across the members of the sample,[3] they make no attempt at (i) examining the statistical characteristics of the results and (ii) extrapolating the sample estimates to the population. A second major difficulty with the experimental approach concerns the relevance of the points on the utility function yielded by the procedure selected. These points are

*The opinions expressed in this paper are solely the responsibility of the authors.

[1]See, in particular, the papers by Luce and Shipley (1961), Luce (1962) and by Coombs and Pruitt (1958).

[2]Of this type are, for example, the studies by Halter and Beringer (1960), Ellsworth (1968), Officer and Halter (1968), and O'Mara (1971).

[3]See, for example, Ellsworth (1968).

obtained by applying the continuity axiom of the Von Neumann-Morgenstern system, and are based on the certainty equivalents of a generally small and not necessarily relevant number of risky prospects with known *a priori* probabilities.

In this chapter, we investigate the possibility that poor peasants may respond in ways significantly different and not necessarily mutually consistent when confronted with uncertainty, respectively involving or not involving the satisfaction of their subsistence needs. We consider that these responses may have a random component and we attempt to investigate their determinants as well as the characteristics of their distribution using results of a sample survey of small farmers and sharecroppers in Northeast Brazil.

The plan of the chapter is as follows. In Section 2, we examine some of the problems posed by the measurement of the utility parameters and by the specification of appropriate theoretical models. We examine the merits of a number of alternative approaches and briefly describe the ones selected for our study. In Section 3, we briefly outline the characteristics of the sample design and the interviewing procedure adopted. In Section 4, we present the results of the interviews and discuss two alternative models of analysis. These two models are applied in Section 5 to analyze the possible determinants of the different responses, propose alternative explanations and test some related hypotheses. Finally, in Section 6, we present our conclusions and thoughts for further research.

2. THE MEASUREMENT OF UTILITY OF INCOME FUNCTIONS: THEORY AND PRACTICE

Since the publication of Von Neumann and Morgenstern's (N-M) work in 1947, several attempts have been made to obtain a conclusive test of the existence as well as suitable measurements of individual utility functions. The theoretical problems encountered by these attempts can be classified into three basic categories relating to (a) objective versus subjective probabilities, (b) probability and variance preferences, and (c) the adequacy of only considering the mean and variance of the payoff distribution.

2.1. Objective Versus Subjective Probabilities

The N-M model was based on the assumption that individuals maximize the expected value of their utility functions over the known possible states of the world. The probabilities used to calculate the expected values were supposed to be the "true" or "objective" probabilities of the alternative events. Savage (1951) substituted personal or "subjective" probabilities for the objective ones, providing the first realistic framewc.k for measurement. Embedded in the new concept of subjective expected utility, however, was a crucial problem of indeterminancy for empirical work since both the probabilities and the utility were specified as subjective.

Two classical experiments conducted by Mosteller and Nogee (1951) and Davidson, Suppes and Siegel (1957) dealt—with varying fortune—with this basic problem. Mosteller and Nogee organized their experiments in two groups: an "uncertainty" group, where the subjects did not know the true probabilities of the events in the choice set, and a "risk" group, where the subjects were given the true probabilities. In Davidson, Suppes and Siegel's experiment, on the other hand, subjects were provided only with basic information to calculate the true probabilities.

Although the latter experiment tried to take into account the interaction between the gamble and the formation of the subjective probabilities (for example, the effect of particularly improbable sequences of outcomes), the choice of the gambling framework restricted the operational significance of the subjects' calculations to a rather simplistic exercise. Moreover, the participants were always provided with the objective probabilities of the elementary events, so that subjective probabilities were always related to, if not determined by, objective ones.

The empirical studies cited for agriculture modified pragmatically the experimental approach to adapt it to field situations. Thus, both Officer and Halter (1968) and O'Mara (1971), for example, presented their farmers with stated probabilities before asking them to make the choice required by the experiment. Although Officer and Halter, unlike O'Mara, did dispense with the gambling framework in favor of a simulated farm problem, they reported "misuse" of the probabilities due either to probability preferences or to the inability of the subjects to use basic elements of probability calculus.

As casual introspection promptly reveals, the elements of probability calculus are far from being "intuitive".[4] Provision of the probabilities of elementary events is therefore no guarantee that subjective judgment will not be used in the calculation of probabilities of even moderately complex outcomes. This is particularly true for poor peasants, who are likely to have a "cognitive" frame of reference shaped by past experience, fatalistic convictions, superstitions, etc.

2.2. Probability and Variance Preferences

According to a series of experiments conducted by Edwards (1953, 1954a,b,c) and Coombs and Pruitt (1958), two factors not encompassed by expected utility theory are also important in determining choices between bets with varying probabilities: (i) specific preferences among probabilities; and (ii) preferences for variance or gambling *per se*. As an example of the first factor,

[4]Edwards (1954c, 1961) has a good discussion of the "intuitive" character of probability laws.

subjects preferred bets involving a 4/8 probability of winning and consistently avoided bets involving a 6/8 probability of winning. Relative to variance preferences or the utility of gambling *per se*, these experiments also tended to support the argument of Allais (1953)—see also Handa (1971) and Tversky (1967)—that at least the variance and possibly higher moments of the utility distribution may be as important as the mean utility in determining subjects' choices.

Unless they are allowed for, preferences for gambling and for particular probabilities may bias the elicitation of N-M utility functions.[5] This is because the classical N-M experiment is based on the continuity axiom, which states: if outcome x_1 is preferred to x_2 and x_2 is preferred to x_3, then there is a probability $0 < p < 1$ such that the individual is indifferent between the risky prospect $(x_1, x_3; p, 1-p)$ and the sure prospect x_2. Now, if $p = 1-p = 0.5$ is used, the bias due to probability preferences is overcome in the sense that the choice between the bet (x_1,x_3) and the certain event x_2 is not unduly influenced by the fact that the outcomes of the gamble are weighted with differently preferred probabilities. On the other hand, in order to overcome the bias due to utility for gambling, an alternative gamble can be substituted for the certain event x_2. Unless the probabilities of the two outcomes of this gamble are themselves equal to 0.5, the problem of probability preference may reappear.

2.3. Adequacy of Mean-Variance Analysis

The foundations of mean-variance (E,V) analysis in the literature on utility theory can be traced to the classical articles of Markowitz (1952a,b) and Freund (1956). In both cases, the authors argue that a utility function having as arguments the mean and the variance of the random payoff variable may be taken either (i) as a local approximation of a more general form of utility function or (ii) as a proper transformation of such a utility function for a two-parameter distribution. However, although widely used in portfolio analysis and in quadratic risk programming, the utility interpretation of (E,V) analysis has been strongly criticized.[6]

An alternative approach based also on the first two moments uses the normal distribution or the Tchebychev inequality to derive sets of efficient mean-standard deviation $(E,V^{1/2})$ plans for an economic agent facing uncertainty with a safety-first criterion. Pyle and Turnovsky (1970), in particular, demonstrate how a one-to-one correspondence can be found between a utility function of the $(E,V^{1/2})$ type and the safety-first requirement that the payoff be

[5] For a detailed outline of elicitation procedures, see Anderson, Dillon and Hardaker (1976).

[6] Criticism by economists is summarized by Anderson, Dillon and Hardaker (1976, Ch. 4). For a psychological critique, see Coombs (1972).

not inferior to a minimum with a given probability.

Within the same framework, Baumol (1963) persuasively argues that a better utility representation of safety-first behavior may be given by a function having as arguments the mean E and the one-tail confidence interval $E - KV^{1/2}$ where K is a function of the probability required for the payoff to be above the lower bound. Baumol demonstrates how the set of efficient plans determined according to this criterion is a proper subset of the set of efficient $(E, V^{1/2})$ plans.

The empirical relevance of mean-variance analysis can be discussed with reference to two further topics that have received special attention in the psychological literature: (a) the existence of intuitive statistics and (b) the influence of personality traits.

If human beings are capable of utilizing information on random phenomena by summarizing it into statistical indicators, an index of central tendency and an index of variability are the most likely candidates for intuitive effort. Experiments by Irwin, Smith, and Mayfield (1956) and Becker (1958) provide strong evidence that subjects can perform exceedingly well in the intuitive estimation of sample means. No comparable evidence exists for the estimation of variance or higher moments, but it seems likely that the same intuitive process would yield reasonably good estimates of the coefficient of variation.

In 1957, Atkinson proposed a model of risky decision making where the main determinants are motivation for success (M_s) and motivation against failure (M_f). Given that the incentive value of achieving success is inversely related to the subjective probability of succeeding (P_s) and the incentive value of avoiding failure is the negative of the same probability, the resultant motivation (RM) turns out to be equal to $P_s(1 - P_s)(M_s - M_f)$. Now, if motivation for success is interpreted as the payoff of an outcome with probability P_s and M_f as the payoff of the complementary outcome, the variance V of a bet based on the two alternatives is $P_s(1 - P_s)(M_s - M_f)^2$. Thus, $RM = V/(M_s - M_f)$, *i.e.*, Atkinson's resultant motivation is a linear function of the variance of the motivational determinant. Atkinson's model and related experiments[7] are important as they provide further behavioral justification for the widespread empirical use of mean-variance analysis. This use has recently been growing in the area of mathematical programming related to farm simulations and agricultural sector models.[8] It seems that in most of the practical application, the advantages of specifying decision makers' choices directly in terms of the first two moments of the payoff distribution appear to largely outweigh the loss in rigor, if any.

[7]See Atkinson, *et al.* (1960), Siegel (1957), Brehm (1956), Block and Petersen (1955).

[8]See, in particular, Freund (1956), Dean (1975), Hazell (1971), Hazell and Scandizzo (1974, 1976) and Simmons and Pomareda (1975).

3. CHARACTERISTICS OF THE SAMPLE AND QUESTIONING PROCEDURES

The results reported here are based on two random samples respectively consisting of 66 small farm owners and of 64 sharecroppers in Canindé, a small county located in the interior of the State of Ceará in Northeast Brazil. The interviews were conducted in August of 1975 and the "risk" questions were appended to a larger questionnaire. The overall group of 130 small farmers constituted a panel who were being surveyed for the third consecutive year as part of a broader research exercise on small farmers in various Brazilian regions.[9] Interviews in each year were largely conducted by the same group of five young female research assistants from the University of Ceará's Department of Agricultural Economics, of which they were also graduates. Because of their local background, charm, intelligence and three-time contact, there is no doubt that these interviewers had excellent rapport with the survey panel and were able to make good judgments about the thoughtfulness and credibility of the farmers' responses.

The Canindé sample area is typical of the Sertão, the drought-prone subregion of Northeast Brazil. Here, the environment is extremely risky for agriculture because of the high variability of rainfall. For Canindé, as recorded by Hargreaves (1973), the average yearly rainfall is 745 mm with only a 43 per cent chance of receiving more than the average and with 67 per cent of the rain concentrated in four months. The typical production system involves tree cotton (cash crop), corn and beans grown together for subsistence use, and beef cattle.[10] Small owners or sharecroppers are typically involved in crop production while large landlords are mainly concerned with cattle. As documented by Brooks (1973) and Johnson (1970, 1971), for both small owners and sharecroppers — though not for large landlords — year to year subsistence is desperately risky and can have calamitous implications.

Tables 8.1 and 8.2 report the sample means of various socioeconomic variables. The data in both tables refer to the agricultural year 1972-73 which was average to moderately good for agricultural production and employment in the survey region. As the tables show, the two samples are broadly similar in their characteristics, but the sharecroppers are significantly poorer, less educated and younger than the small owners. In absolute terms, with average

[9] See Patrick and Filho (1975) for a description of this national research project. We are grateful to EMBRAPA (the Brazilian National Agricultural Research Organization), FIPE (the Economics Research Institute of the University of São Paulo), and the Department of Agricultural Economics of the University of Ceará for the opportunity of presenting our risk questions to the Canindé survey panel.

[10] Data from a statistically representative farm survey referring to the agro-economic characteristics of the Sertão are reported in Kutcher and Scandizzo (1976b).

annual per capita incomes of only $153 for owners and $90 for sharecroppers, the families of both groups are extremely poor on an international basis.

Table 8.1

Socioeconomic characteristics of small farmers in Canindé, Northeast Brazil, 1972-73

Variable	Small owners	Share-croppers
Sample size	66.0	64.0
Proportion in the state[a]	0.2	0.8
Ave. age of family head	58.0	49.0
Ave. number of births per family	8.3	9.3
Ave. number of children surviving	6.7	7.7
Ave. size of household	5.7	7.0
Ave. number of years of education	0.2	0.1
Proportion of literates	0.41	0.17
Proportion of immigrants	0.45	0.61
Proportion of people who do not hold another occupation	0.45	0.28

Source: Patrick and Filho (1975) and Campos Mesquita and Dillon (1976).
[a]Based on Kutcher and Scandizzo (1976). Canindé is in the State of Ceara.

The farmers composing the samples had already been objects of an extended interview twice in the prior two years (1973 and 1974). The 1975 interview involved both an extensive set of questions on socioeconomic conditions and a small set of questions regarding (i) subjective probabilities, (ii) attitudes to gambling and the use of signs, and (iii) risk preferences.

Some of the results of the analysis of subjective probability formation and attitudes to gambling are reported by Campos Mesquita and Dillon (1976). The owners and sharecroppers appeared to be able to nominate yield probabilities as chances out of ten and to have, on average, similarly behaved subjective probability distributions for the yield of beans, their main subsistence crop. These distributions were typically less concentrated around the mean than a normal distribution and positively skewed. Attitudes to gambling and the use of signs were investigated by asking the subjects a small set of questions concerning their opinions on gambling, their participation in actual gambles and lotteries, and their use of signs and other omens in farm decisions. Responses indicated little difference between owners and sharecroppers. Some 30 per cent regarded gambling as immoral; 80 per cent

Table 8.2

Average composition and sources of family income of small farmers in Canindé, Northeast Brazil. Agricultural year 1972-73.

Variables	Income (Cr$)[a] Owners	Sharecroppers
Sale of farm products	2,506	1,283
Family consumption of farm products	1,233	663
Other use of farm products on the farm	179	111
Payments in kind or cash for land use	84	643
Inventory changes (crops and cattle)	1,210	669
Gross income from farm	5,212	3,369
Purchase of inputs (including labor)	402	81
Inputs produced on the farm	179	111
Payments in kind or cash for land use	84	643
Net agricultural product	4,547	2,534
Agricultural labor income from outside own farm	263	920
Total agricultural income	4,810	3,454
Non-agricultural income	273	197
Income from other sources	496	316
Family net income	5,579	3,967
Net income per household member	979	567

Source: Patrick and Filho (1975).
[a]US$1 = Cr$6.4.

had never entered a bet or lottery; and 40 per cent specified signs (of which a third were occult) influencing their planting decisions.

Another group of questions concerning risk-bearing attitudes as implied by the farmers' choice between hypothetical but quasi-realistic alternatives forms the basis of the empirical analysis in this chapter. These questions were geared to find the certainty equivalents of risky prospects involving known probabilities.

Two types of risky prospects were used, yielding two subsets of responses for each group of farmers. The first type included the possibility of earning less in some years than the amount of money necessary to purchase the food directly produced and consumed in the farm (taken as a proxy for subsistence), *i.e.*, in these questions subsistence was at risk. The second type of risky prospect involved only payoffs above such a subsistence level; in these, while the level of total income was at risk, subsistence was assured.

The probabilities of the two possible outcomes in the risky prospect were provided as frequencies and were maintained constant at 0.75 (3 years out of 4) for the best outcome and 0.25 (1 year out of 4) for the worst outcome. The payoff of the best outcome in the risky prospect and/or of its alternative sure prospect was progressively changed until the subject expressed indifference between the risky prospect and the sure alternative — at which point the sure prospect is the certainty equivalent of the risky prospect.

The verbal formulation of the risky prospects involved not only provision of the probabilities as *de facto* frequencies, but also reference to a definite frame of time. We chose to refer the frequency to four years because this was judged the minimum amount of time required to make the prospect realistic to the subject. As indicated by pilot discussion with some of the farmers and as confirmed by their answers to the direct questions on yield and seasonal prospects, the formal concept of probability *per se* is quite alien to the way of reasoning of the small farmers interviewed.[11] Thus, it is important that the risky prospects presented clearly contain not only a general element of uncertainty (*i.e.*, there is no guarantee that even the expected value of the prospect is achieved over a small interval of time), but also the "distributional" risks (*i.e.*, the possibility that particularly unlucky sequences of bad years materialize). As for the unequal probabilities used, we hypothesize that small farmers display an intuitive reaction to summary statistics of the distribution embedded in a simply risky prospect, rather than possessing any natural mastering of the probability calculus. Since, in a simple two-alternative bet, variance is completely confounded with the range, and skewness is completely confounded with the relative value of the probabilities, it is clear that a risky prospect has to have both unequal outcomes and unequal probabilities to display the minimum characteristics of randomness required to produce a subject's reaction.

It must be emphasized that we do not claim to have a satisfactory model to measure farmers' preference with respect to the implicit moment structure of the random prospects presented and, in particular, we have chosen to present results in this chapter that take into account only the first two moments. (Thus, we measure risk in terms of variance or standard deviation.)

[11]In 1973, a World Bank-SUDENE team working on a much larger farm survey (8,000 farms) in the same geographical area, reached the same conclusion after (failed) attempts at applying a questionnaire on risk attitudes based on questions of the "pure game" type which made no attempt to mimic reality. It is perhaps worth noting that first impressions in pilot discussions with some of the farmers indicated a fatalistic rather than probabilistic approach to uncertainty. Further questioning, however, indicated that probabilities could be elicited though not as easily as, in our experience, with nonpeasant farmers.

But we suggest that, even if farmers have very small or indifferent preferences for skewness or other higher moments, the least detectable difference between a random and a nonrandom event for them involves not only an element of variability but also one of possible asymmetry.

The actual questions asked followed the same basic pattern for each sample group and each risk situation; and though hypothetical, the questions were not of the "pure game" type but were realistic in the sense of involving postulated probabilities and consequences regarded as not infeasible for the region.

With subsistence assured, the initial question to owners was: Which would you prefer —

(A) A farm which gave you every year your family food requirements plus a net cash return of CrS3500;

or

(B) A farm which in three years out of four gave your family food requirements plus a net cash return of CrS4200 and in one year out of four gave your family food requirements plus a net cash return of CrS1400?

If A was preferred to B, the cash return in A was reduced by decrements of CrS500 until indifference or a switch to B was established. If B was preferred to A, the same procedure was repeated but with the cash return in A increased by increments of CrS250.

For sharecroppers, with subsistence assured, the initial cash sum in A was set at CrS2000 and those in B at CrS2400 and CrS800, and increments of CrS200 were used both up and down.

With subsistence at risk, the initial question to owners was: Which would you prefer —

(A) A farm which gave you every year your family food requirements and no additional net cash return;

or

(B) A farm which in three years out of four gave you your family food requirements plus a net cash return of CrS5000 and in one year out of four gave you just half your family food requirements and no net cash return?

If A was preferred to B, the better outcome in B was increased by increments of CrS1000 until indifference or a switch to B was established. If B was preferred to A, the sure prospect was increased by increments of CrS1000 until indifference or a switch to A was established.

For sharecroppers, with subsistence at risk, the initial better outcome in B was set in CrS2500. Otherwise, the questions were the same as for owners with subsistence at risk.

The results for subsistence assured and subsistence at risk are respectively presented in Tables 8.3 and 8.4. To fully understand these matchings of the risky prospects with their certainty equivalents, two further comments are needed. First, when a switch rather than indifference was established between the sure and risky prospects, it is assumed for subsequent analysis that indifference prevails at the midpoint of the incremental change. Second, due to inadvertence arising from lack of prior knowledge, the sequence of questions was regrettably terminated for some subjects before determining certainty equivalence. For the subsistence-assured situation, most of these subjects were extremely risk averse and only a few extremely risk preferring.

4. EMPIRICAL RESULTS AND ALTERNATIVE MODELS OF ANALYSIS

Although the data in Tables 8.3 and 8.4 cannot be compared without recourse to a formal model, a few preliminary remarks are in order. First, there appears to be a qualitative difference between the subsistence assured (S.A.) and the subsistence at risk (S.R.) cases in that no owner and only a minimum number of sharecroppers displayed any risk preference when subsistence was at risk, while a significant number of subjects of both categories appeared to be eager to take risks in the other case.[12] This qualitative difference is also confirmed by the fact that the individuals displaying one type of risk behavior in one case often reversed themselves in the other case.

Second, the small owners appear on the whole to be more conservative than the sharecroppers, especially if subsistence is at risk. Although it is obviously impossible to draw any general conclusion, this result does suggest, *inter alia*, that sharecroppers feel more secure at considerably lower levels of income than do small owners. Perhaps, this is because they are more used to larger fluctuations of returns and/or because, at the same time, they can share their risks with the landlord both through the formal share arrangements and through the informal but traditional patronal (feudal) relation between the landlord and his sharecroppers.[13]

Third, for both tenure types, a relatively stable group of extreme risk averters (ERA's) was singled out by the questions. Unlike the rest of the subjects, who freely switched from a risk averse attitude in the S.R. case to a risk neutral or risk preferring attitude in the S.A. case, most of the ERA's expressed a constant reluctance to bear risk regardless of the subsistence variable.

[12]Without referring to a specific model, here we consider as "willing to take risks" those subjects who were indifferent between a random prospect X and a certainty equivalent C.E. such that $E(X) <$ C.E.

[13]The patronal relation in the region is well described by Johnson (1970).

Table 8.3

Certainty equivalents of risky prospects with subsistence assured

Attitude to risk	Owners[a] Certainty equivalent (S = subsistence)	Owners[a] Frequency Absolute	Owners[a] Frequency Relative (%)	Sharecroppers[b] Certainty equivalents (S = subsistence)	Sharecroppers[b] Frequency Absolute	Sharecroppers[b] Frequency Relative (%)
Risk averse	< S + 2000Cr$	19	33.9	< S + 1000Cr$	14	29.8
	S + 2250	1	1.8	S + 1300	1	2.1
	S + 2750	8	14.3	S + 1700	4	8.5
	S + 3000	1	1.8	S + 1900	9	19.2
	S + 3250	10	17.9			
Risk neutral	S + 3500	5	8.9	S + 2000	3	6.4
Risk preferring	S + 3625	6	10.7	S + 2100	6	12.8
	S + 3875	4	7.1	S + 2300	5	10.6
	> S + 4000	2	3.6	> S + 2400	5	10.6
	Total	56	100.0		47	100.0
	Would not answer	3			1	
	Not available	4			8	
	Excluded[c]	3			8	
	Total interviewed	66			64	

[a]Risky prospect: S + Cr$4200 with probability 0.75 and S + Cr$1400 with probability 0.25.
[b]Risky prospect: S + Cr$2400 with probability 0.75 and S + Cr$800 with probability 0.25.
[c]These respondents were judged by the interviewers either not to have understood or not to have properly tried to answer the questions. In four of these 11 excluded cases, inconsistencies were apparent in the recorded responses.

Table 8.4

Risky prospects and their certainty equivalents with subsistence at risk

Owners				Sharecroppers			
		Frequency				Frequency	
Risky prospect	Certainty equivalent	Absolute	Relative (%)	Risky prospect	Certainty equivalent	Absolute	Relative (%)
0.75(S+7000),0.25(S/2)	<S	18	32.1	0.75(S+7000),0.25(S/2)	<S	1[a]	2.1
0.75(S+6500),0.25(S/2)	≡S	5	8.9	0.75(S+4500),0.25(S/2)	<S	9	19.1
0.75(S+5500),0.25(S/2)	≡S	4	7.1	0.75(S+3000),0.25(S/2)	≡S	10	21.3
0.75(S+5000),0.25(S/2)	≡S	2	3.6	0.75(S+2500),0.25(S/2)	≡S	1	2.1
0.75(S+5000),0.25(S/2)	≡S+500	7	12.5	0.75(S+2500),0.25(S/2)	≡S+500	11	23.4
0.75(S+5000),0.25(S/2)	≡S +1000	1	1.8	0.75(S+2500),0.25(S/2)	≡S+1000	1	2.1
0.75(S+5000),0.25(S/2)	≡S+1500	2	3.6	0.75(S+2500),0.25(S/2)	≡S+1500	4	8.6
0.75(S+5000),0.25(S/2)	>S+2000	16	28.6	0.75(S+2500),0.25(S/2)	>S+2000	10	21.3
0.75(S+2500),0.25(S/2)	>S+2000	1[a]	1.8				
	Total	56	100.0			47	100.0

[a]This owner (sharecropper) was mistakenly asked the set of questions for sharecroppers (owners).

Passing now to a more formal analysis of the results, we first consider the implications of the $(E,V^{1/2})$ model. Assuming that the underlying utility function is locally linear in the expected value and the standard deviation of the payoff, we can write the equation:

$$U(X) = E(X) + \phi[V(X)]^{1/2} = U(\text{C.E.}) \qquad (1)$$

where X represents the random payoff of the risky prospect and C.E. is the certainty equivalent. Equation (1) can be solved to yield estimates of the coefficient of risk preference ϕ. These estimates are functions of the subsistence level when the risky prospect puts subsistence at risk, while they depend only on the cash payoff level when subsistence is not at risk. The risk-attitude coefficient ϕ is zero (reflecting risk neutrality) when the certainty equivalent is equal to the expected value of the payoff, less than zero (reflecting risk aversion) when C.E. $< E(X)$, and greater than zero (reflecting risk preference) when C.E. $> E(X)$. Furthermore, in the S.A. case, since $V(X)$ is constant, ϕ is a linear function of the risk premium C.E. $- E(X)$ and can be interpreted, therefore, as a simple index of the results reported in Table 8.3, without a necessary reference to the utility hypothesis in equation (1).

The two sets of observations can also be combined by making use of the safety first framework suggested by Baumol (1963). In this case, we hypothesize that the subjects respond according to a utility function having as arguments the expected value $E(X)$ of the payoff and the one-tail confidence interval $E(X) - K[V(X)]^{1/2}$. Assuming linearity, we can write:

$$U(X_i) = E(X_i) + \psi[E(X_i) - K[V(X_i)]^{1/2}] = U(\text{C.E.})_i \qquad (2)$$

where $i = 1,2$ respectively, denotes the fact that the equation is supposed to hold, for the same ψ and K, for both the S.A. ($i=1$) and S.R. ($i=2$) situations. We will refer to the model of equation (2) as the (ψ,K) model.

Solving equation (2) for ψ and K yields, after some simplification:

$$\psi = \frac{\phi_1 - \phi_2}{R_1^{-1} - R_2^{-1}} \qquad (3)$$

$$K = \frac{\phi_1 R_2^{-1} - \phi_2 R_1^{-1}}{\phi_1 - \phi_2} \qquad (4)$$

where R_i $(i = 1,2)$ is the coefficient of variation of the ith prospect.

From equation (2) we have

$$\partial U / \partial [V(X)]^{1/2} = -\psi K. \qquad (5)$$

Hence, risk aversion prevails when both ψ and K are of the same sign; risk neutrality if ψ or K are zero; and risk preference if ψ and K are of different sign. The coefficient ψ is somewhat analogous to ϕ as a measure of risk preference since, from equation (2), $\partial U/\partial K[V(X)]^{1/2} = -\psi$ and C.E. $\lesseqgtr E(X)$ $\Rightarrow$ (i) $\psi \lesseqgtr 0$ for $K < R_I^{-1}$ and (ii) $\psi \gtreqless 0$ for $K > R_I^{-1}$. The parameter K, on the other hand, measures another dimension of risk preference since it directly relates to the probability level required by the safety-first component nested in the utility function. In fact, by Tchebychev's inequality, we can estimate the upper bound on the safety-first probability level as

$$\text{Prob}\{X \leqslant E(X) - K[V(X)]^{1/2}\} \leqslant 1/K^2 \qquad (6)$$

As shown by equation (5), by making use of Baumol's criterion we are able to effect a decomposition of the degree of risk preference into two multiplicative components: a standard deviation or variance preference component ψ and a security or safety first component K. This is also apparent if we rearrange equation (2) by a positive linear transformation to a form analogous to equation (1), viz.:

$$U' = E(X) - \psi(1+\psi)^{-1}K[V(X)]^{1/2} = E(X) + \phi'[V(X)]^{1/2} \qquad (7)$$

where U' and $\phi' = [-\psi(1+\psi)^{-1}K]$ denote the transformed representations of U and ϕ.

5. DISTRIBUTION OF THE RISK ATTITUDE ESTIMATES AND HYPOTHESIS TESTING

Given these two simple models of analysis, we consider now the results following from their application.

5.1. The (E,V$^{1/2}$) Model

Table 8.5 summarizes the results from the (E, V $^{1/2}$) model for the case with subsistence not at risk, reporting intervals of estimation for ϕ_I and the corresponding frequencies for owners, sharecroppers and for the two groups combined. The three frequency or probability distribution functions (PDF's) were obtained from the cumulative distribution functions (CDF's) using Schlaifer's fractile rule — see Anderson, Dillon and Hardaker (1976, Ch. 2). Figures 8.1, 8.2 and 8.3 show both the fitted CDF's and the estimated fractiles, and Figures 8.4, 8.5 and 8.6 show the estimated PDF's.

Two striking features emerging from both the table and the graphical representations are (i) the regularity and (ii) the similarity of the distribution of ϕ_I for the two groups of subjects. Also, as inspection of the graphs shows, the two distributions appear to be normal except for the left-hand tail corresponding to the extreme risk averters.

To test this hypothesis of normality, we combined the two groups of non-ERA observations and fitted a normal curve. The result of this exercise is reported in Figure 8.7 and is indeed positive. A normal distribution with a mean of zero and a variance of 0.38 fits the non-ERA observations very well. The Kolmogorov test for normality is also highly significant. The interpretation that suggests itself, at this point, is (i) that two subpopulations appear to be underlying the risk preference distribution and (ii) that they appear to cut across the *a priori* owner-sharecropper tenure distinction. The first

Table 8.5

PDF of ϕ from its CDF with subsistence assured and $U = E(X) + \phi[V(X)]^{1/2}$

ϕ Interval	All owners (%)	All sharecroppers (%)	All combined (%)
−1.75 to −1.50	26.0	21.4	23.2
−1.50 to −1.25	9.2	6.8	6.9
−1.25 to −1.00	5.3	3.6	4.8
−1.00 to −0.75	5.0	2.8	3.7
−0.75 to −0.50	7.5	3.9	4.8
−0.50 to −0.25	11.5	9.5	10.1
−0.25 to 0	17.0	17.8	19.2
0 to 0.25	11.6	15.0	13.9
0.25 to 0.50	4.9	8.0	5.5
0.50 to 0.75	2.0	5.0	3.7
0.75 to 1.00	0.0	4.5	3.0
1.00 to 1.25	0.0	1.7	1.2
	100.0	100.0	100.0
Mean of ϕ[a]	-0.62	-0.35	-0.40
Variance of ϕ_i[a]	0.40	0.49	0.55

[a]From CDF by the fractile approximation formulae of Pearson and Tukey (1965):

$E(\phi) \simeq f_{.5} + 0.185(f_{.95} + f_{.05} - 2f_{.5})$ $\quad V(\phi) \simeq [(f_{.95} - f_{.05})/3.25]^2$

$= -0.62, \qquad\qquad = 0.40,$

where f_j is the 100_j per cent fractile of the ϕ distribution.

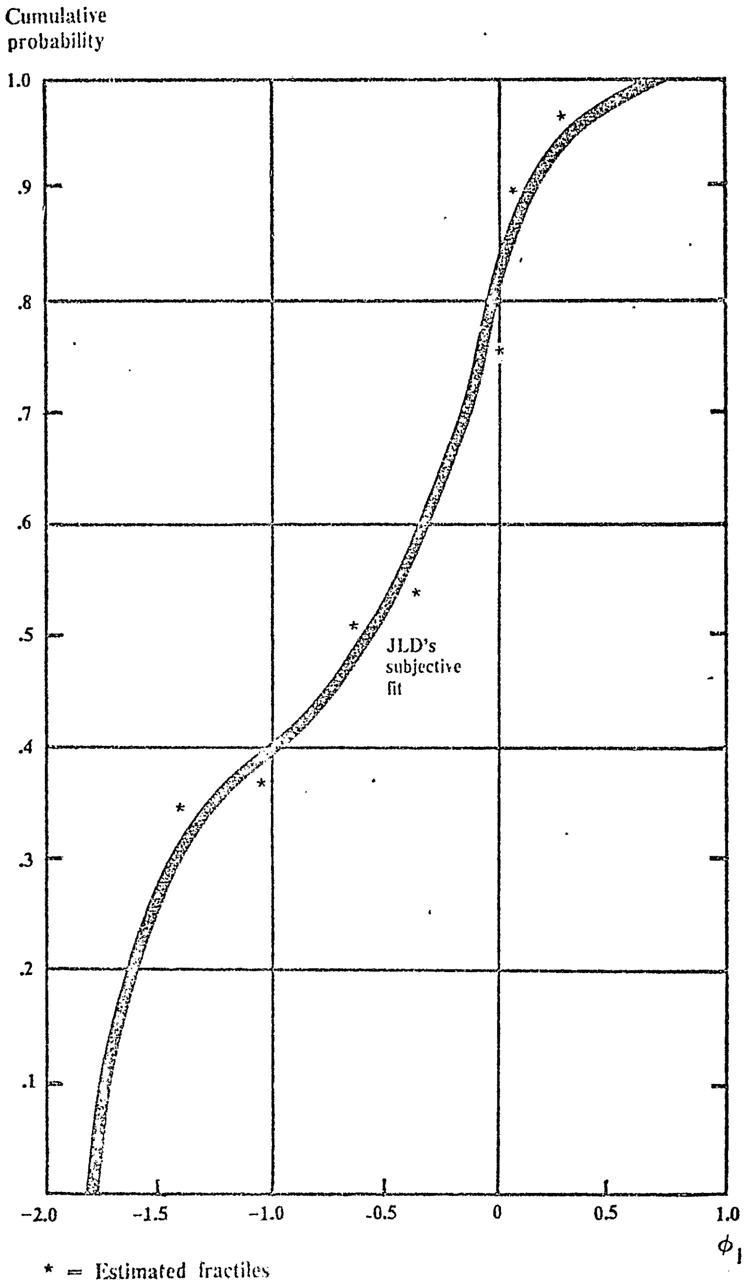
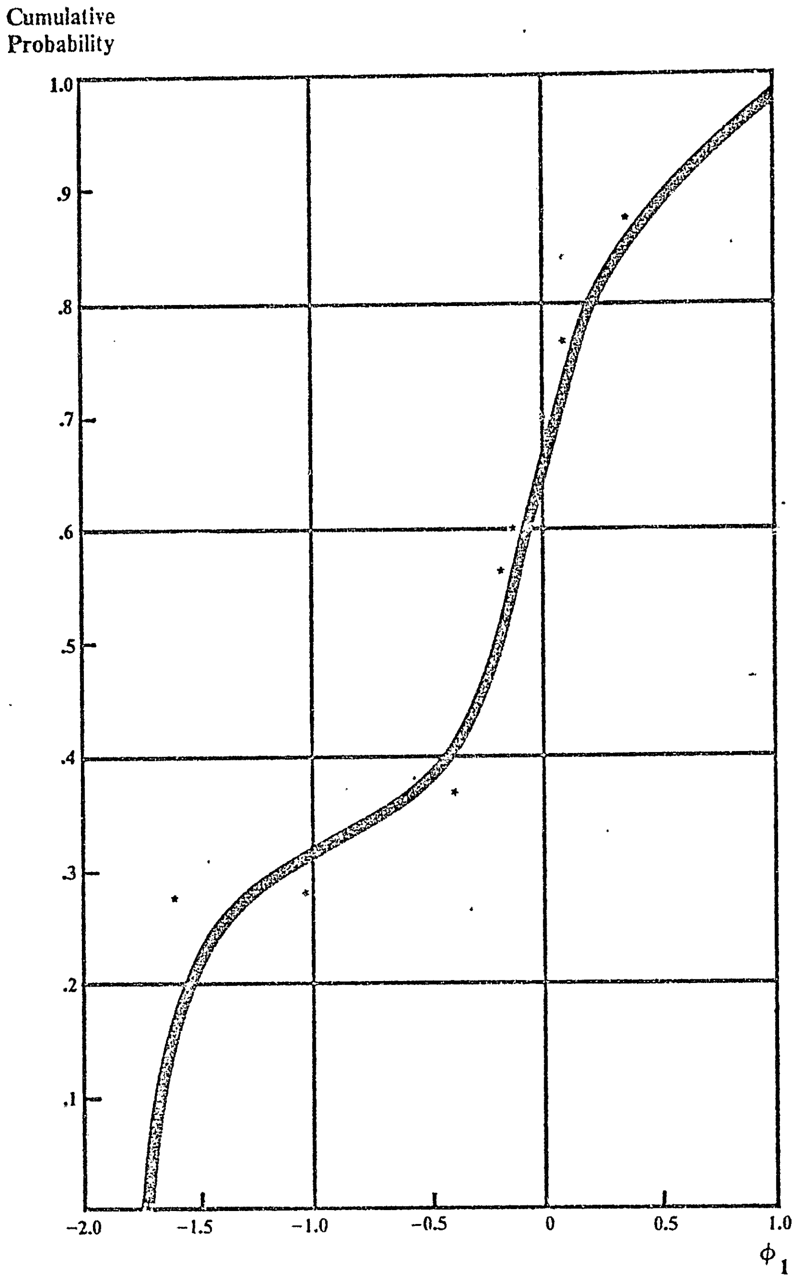


Figure 8.1. ϕ_1: Owners: Subsistence assured CDF by fractile rule



* = Estimated Fractiles

Figure 8.2. Φ_1: Sharecroppers: Subsistence assured CDF by fracticle rule

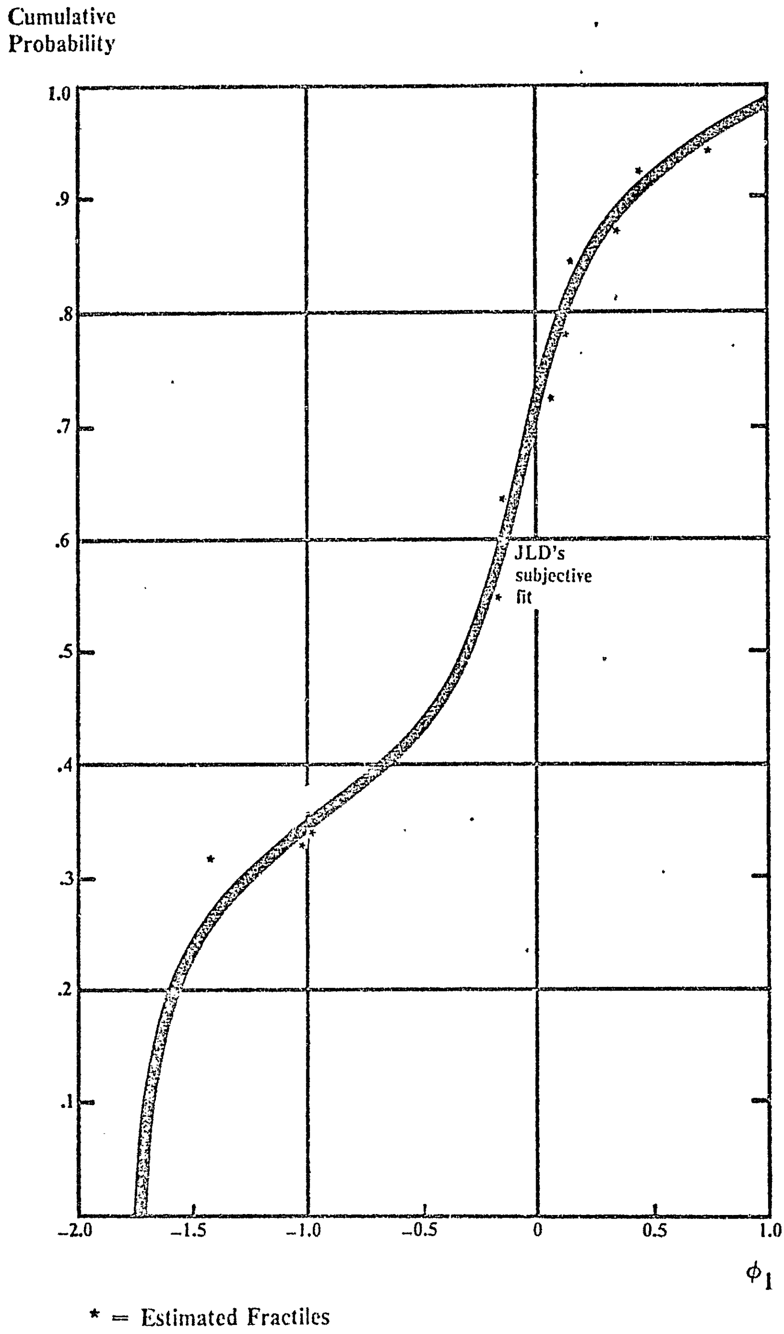


Figure 8.3. Φ_1: Owners and sharecroppers together: Subsistence assured CDF by fractile rule

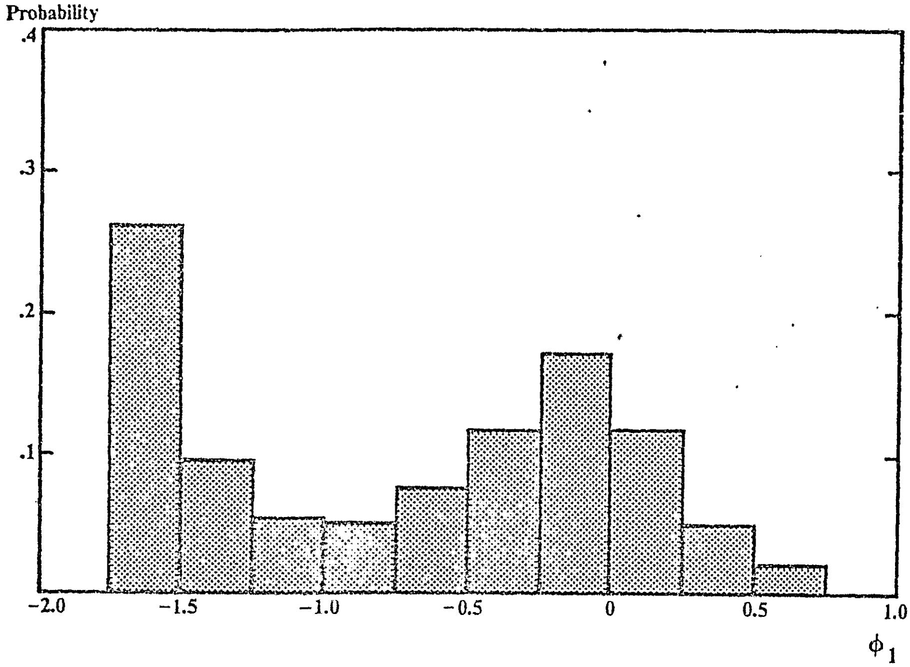


Figure 8.4. ϕ: Owners: Subsistence assured PDF from CDF

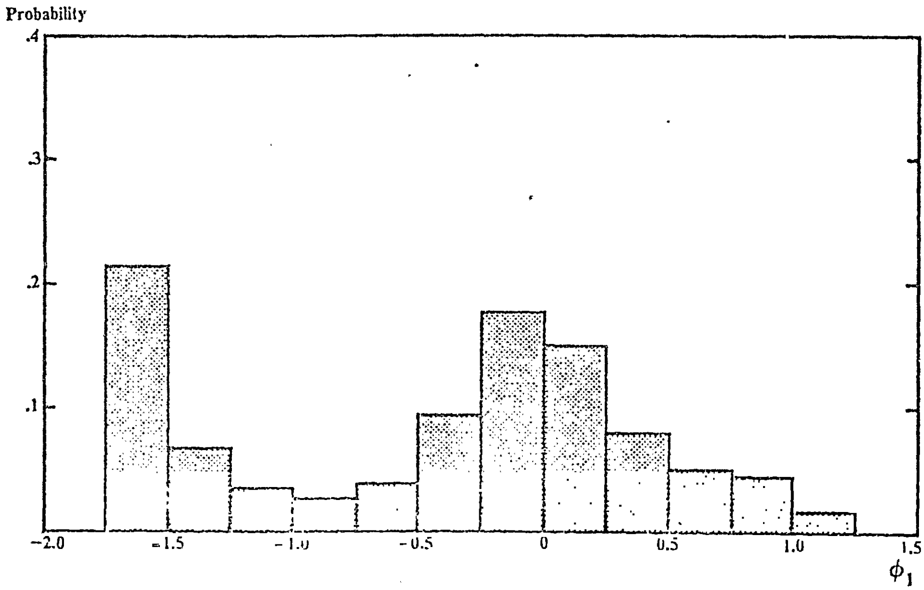


Figure 8.5. ϕ: Sharecroppers: Subsistence assured PDF from CDF.

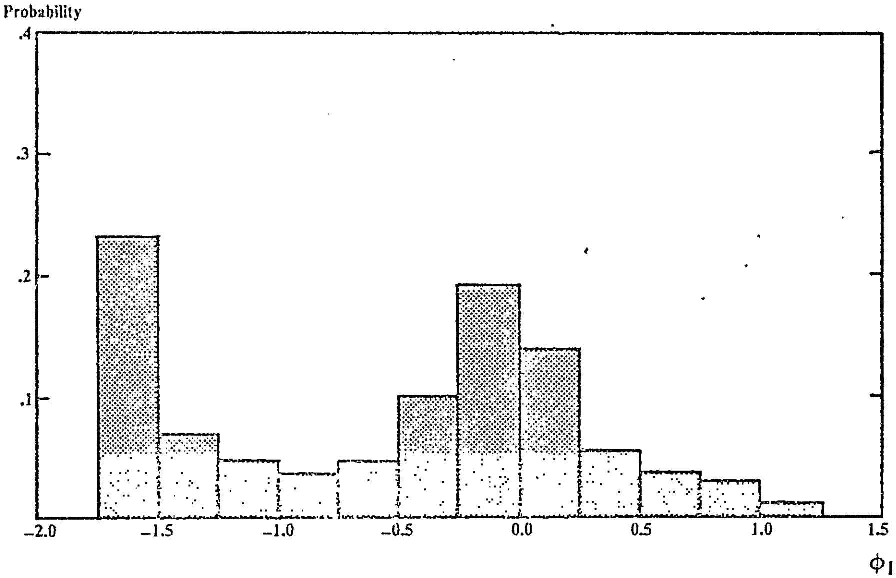


Figure 8.6.Φ: Owners and sharecroppers together: Subsistence assured PDF from CDF

subpopulation, which we may call the risk neutral farmers, appears to account for the majority of the subjects (about 70 per cent of the total) and displays nicely normal distribution behavior around the perfect risk-neutrality point ($\phi_I = 0$). The second subpopulation, on the other hand, is composed of the subjects strongly averse to risk ($\phi_I < -1.25$). As we were able to estimate only a lower bound of ϕ_I for most of these subjects, we do not have sufficient information to say anything on their ϕ distribution, except that it appears to be much more leptokurtic than the normal.

Bimodality and brachi- versus leptokurtic characteristics of opposite segments of a distribution are characters quite frequent in populations in transition under natural selection stress (Huxley, 1953). We might speculate that such a stress is migration or, as in natural selection, the increasing hardship imposed by population growth in a resource-scarce climatically-unsure environment. The structure of the population, originally based on risk neutrality, is perhaps being skewed in favor of the risk averters since they are the more likely to survive and "stay on" in the face of the increasing attraction of the urban sector.

Perhaps an idea of the characteristics of the ϕ distribution of the ERA group or of the future overall distribution of risk preferences of small farmers in the Sertão can be given by the estimates of ϕ for the case of subsistence at risk. The results of this analysis, reported in Table 8.6, show very skewed, unimodal distributions centered around -1.2 for small owners and -0.9 for

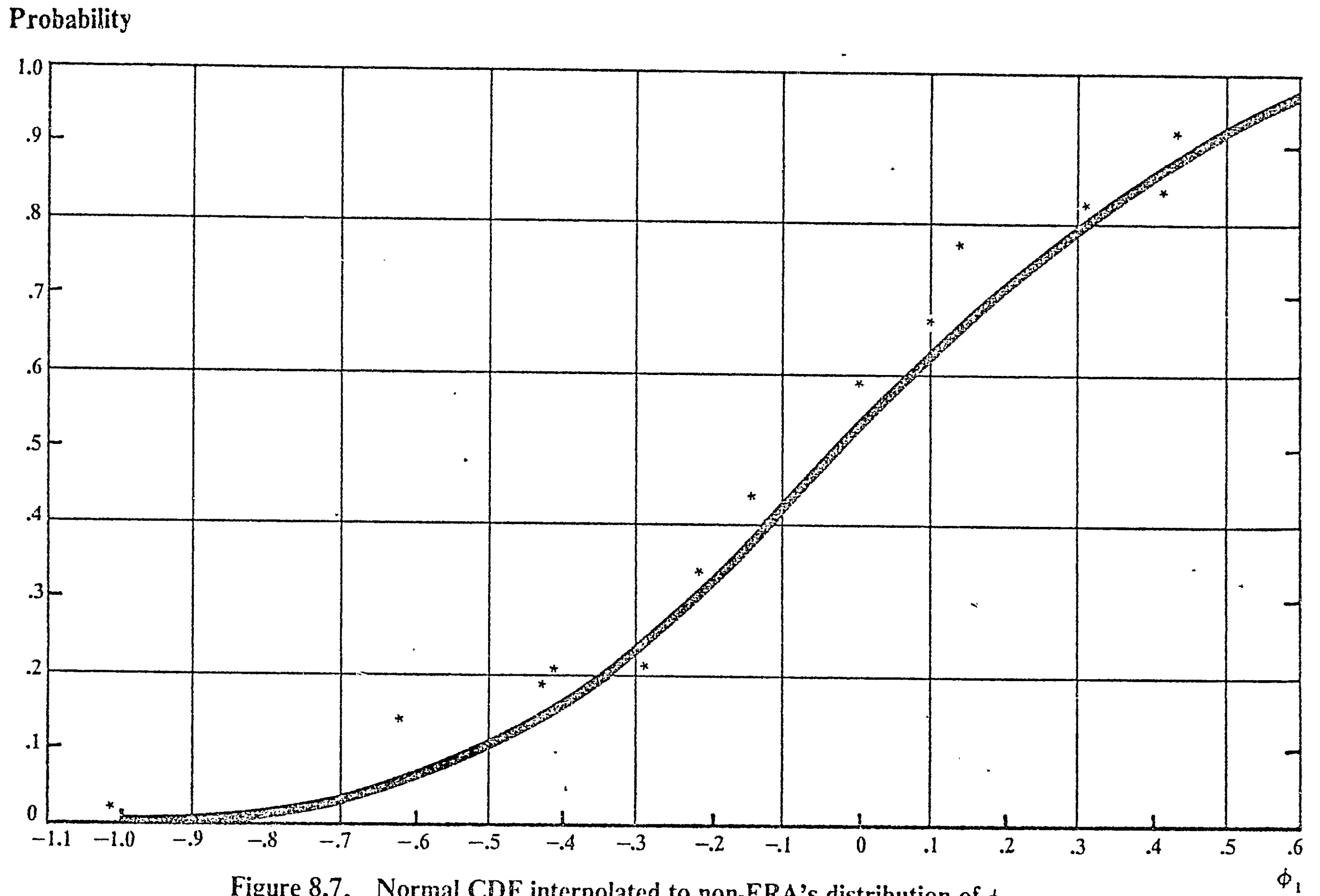


Figure 8.7. Normal CDF interpolated to non-ERA's distribution of ϕ_1

sharecroppers. It is interesting to notice how very close these values are to the ones selected by parametric iteration for use in risk-oriented agricultural sector models as developed by Hazell and Scandizzo (1976) and Kutcher and Scandizzo (1976a), and to the values estimated by econometric methods by Moscardi (1975) and Scandizzo (1975).

An alternative explanation of the nonnormal shapes of the ϕ distributions might lie in the influence of other population variables giving rise to variations in risk preference between individual subjects. To this end, we considered the following variables, all measured by the socioeconomic survey:

A = Age of subjects in 1975 in years.
Y_a = Agricultural net income of the household in 1974 in Cr$'000.
Y = Total net income, *i.e.*, Y_a plus nonagricultural net income, in Cr$'000.
S = Value of home produced food consumption, average of 1972-73 and 1973-74 in Cr$'000.
H = Household size, *i.e.*, number of persons living in the house as a family unit, in 1973.

Summary statistics for the above variables are listed in Table 8.7. We also specified three dummy (1,0) variables to represent three additional dimensions:
D_1 = Membership in ERA group; 1 if in the group, 0 otherwise.
D_2 = Ethical convictions against betting. This variable was based on the question: "Do you think that betting is immoral?" "Yes" was coded as 1, "No" as 0.
D_3 = Inconsistent subsistence data. Perhaps due to evaluation problems, the data for the S variables for 1972-73 and 1973-74 often appeared inconsistent with each other. D_3 was defined as follows:

$$D_3 = \begin{cases} 1 \text{ if } \left| \dfrac{S_{73} - S_{74}}{S_{73}} \right| \geqslant 0.40 \\ 0 \text{ if } \left| \dfrac{S_{73} - S_{74}}{S_{73}} \right| < 0.40. \end{cases}$$

Attempts to find any significant correlation between the estimates of ϕ and the variables considered were, on the whole, unsuccessful. For the case of subsistence at risk, however, the three equations presented in Table 8.8 display some statistical significance.

Table 8.6

PDF of ϕ from its CDF with subsistence at risk and
$U = E(X) + \phi[V(X)]^{1/2}$

ϕ_2 Interval	All owners	All sharecroppers
−1.75 to −1.50	22.0	0.0
−1.50 to −1.25	31.0	33.0
−1.25 to −1.00	17.5	16.2
−1.00 to −0.75	11.5	11.8
−0.75 to −0.50	9.0	10.2
−0.50 to −0.25	6.5	8.3
−0.25 to 0	2.5	7.3
0 to 0.25	0.0	5.5
0.25 to 0.50	0.0	4.7
0.50 to 0.75	0.0	3.0
	100.0	100.0
Mean of ϕ_2 [a]	-1.23	-0.93
Variance of ϕ_2 [a]	0.40	0.60

[a] See footnote to Table 8.5.

Table 8.7

Summary statistics for the variables used in the regression analysis of ϕ

Variable	Owners Mean	Owners S.D.	Sharecroppers Mean	Sharecroppers S.D.
A	58.57	12.02	50.38	13.02
Y_a	4.002	2.909	3.190	1.494
Y	4.847	2.971	3.794	1.651
S	1.619	1.251	0.952	0.564
H	5.91	3.00	7.11	2.56

Table 8.8

ϕ_2: Regression estimates for the subsistence risk case[a]

For owners:

$$\phi_2 = \underset{}{1.103} - \underset{(0.104)^{***}}{0.539D_1} + \underset{(0.010)^{***}}{0.0975D_2} \qquad R^2 = 0.39,\ \text{d.f.} = 53$$

For sharecroppers:

$$\phi_2 = -0.668 - \underset{(0.230)^{**}}{0.679D_1} + \underset{(0.198)}{0.373D_2} \qquad R^2 = 0.27,\ \text{d.f.} = 44$$

$$\phi_2 = -0.609 - \underset{(0.229)^{**}}{0.712D_1} + \underset{(0.200)}{0.328D_2} + \underset{(0.221)}{0.350S} - \underset{(0.082)}{0.116Y_a} \qquad R^2 = 0.31,\ \text{d.f.} = 42$$

[a]The numbers in brackets are standard errors. Asterisks indicate significance level: *** = 0.1% or less; ** = 1% or less; * = 5% or less.

5.2. The (ψ,K) Model

Consider now the results of combining our S.A. and S.R. observations using the framework developed in equations (2) to (7). Based on equations (3) and (4), Tables 8.9 and 8.10, respectively, report the distributions of ψ and K by intervals of estimate. In both cases we find very flat distributions almost of the uniform type.The distribution of the estimated K's reported in Table 8.10 appears to be bounded by quite reasonable values. Since we can assume that varying values of the payoff may affect ψ but not K, this distribution is indeed particularly interesting as it implies quite plausible values for the probability level of the safety first element. Based on equation (6), which is the most conservative form of Tchebychev's inequality, the average upper bound on the safety first probability level is 32 per cent for small owners and a more conservative 16 per cent for sharecroppers. If the payoffs were symmetric, the stronger form of Tchebychev's inequality PL = $\frac{1}{2}K^2$ implies halving these probability limits. The data, therefore, suggest to us that, for Northeast Brazil, reasonable estimates of average safety first probability level — as distinct from an upper limit — lie in the ranges of from 12 to 24 per cent for small owners and 6 to 12 per cent for sharecroppers. These values agree remarkably well with the typical estimate of 10 to 20 per cent used in safety first studies such as those of, *e.g.*, Roumasset (1974) and Webster and Kennedy (1975).

Using average values of ψ and K, we can also calculate an estimate of the mean risk preference parameter ϕ' of equation (7). This yields values of -0.16 for owners and 1.41 for sharecroppers, respectively, indicating risk aversion

Table 8.9:
PDF of ψ estimated from its CDF

ψ Interval	All owners %	All sharecroppers %
− 4 to −3	10.7	5.2
− 3 to −2	12.3	17.0
− 2 to −1	11.5	17.6
− 1 to 0	11.9	19.7
0 to 1	16.5	15.3
1 to 2	11.1	12.2
2 to 3	14.5	10.0
3 to 4	11.5	3.0
Total	100.0	100.0
Mean of ψ	0.10	-0.36
Variance of ψ	2.24	1.83

and risk preference. Thus, while the $(E,V^{\frac{1}{2}})$ model indicated negative risk preference but with owners more strongly so than sharecroppers, the (ψ, K) model has discriminated more sharply between them and, within the context of an embedded security constraint, implies positive risk preference for sharecroppers.

Considering the same set of potential explanatory variables as used before, we also found that at least in the case of some small owners, a statistically significant relation could be estimated for K. The results of this estimation are presented in Table 8.11. For sharecroppers and for ψ, we had no success.

6. CONCLUSIONS

The results that we have reported concern research conducted in the field, in very little time, and as an addendum to a larger socioeconomic research project concerned with small farmers in Brazil. Because of the constraints that time, logistics and human factors imposed, our approach was

Table 8.10:

PDF of K estimated from its CDF and associated values of the safety first probability limit

K Interval	Probability limit (PL) (from Tchebychev's inequality)	All owners (%)	All sharecroppers (%)
0.0 to 0.50	1.00	7.0	10.5
0.50 to 0.75	1.00	5.2	3.4
0.75 to 1.00	1.00	6.7	4.7
1.00 to 1.25	1.00 to 0.64	6.6	6.2
1.25 to 1.50	0.64 to 0.44	6.6	8.8
1.50 to 1.75	0.44 to 0.32	7.9	11.4
1.75 to 2.00	0.32 to 0.26	9.5	12.0
2.00 to 2.25	0.26 to 0.20	12.5	10.8
2.25 to 2.50	0.20 to 0.16	16.9	10.2
2.50 to 2.75	0.16 to 0.14	8.9	7.4
2.75 to 3.00	0.14 to 0.12	5.3	4.6
3.00 to 3.25	0.12 to 0.10	3.8	3.0
3.25 to 3.50	0.10 to 0.08	1.9	2.6
3.50 to 3.75	0.08 to 0.07	1.2	1.6
3.75 to 4.00	0.07 to 0.06	0.0	1.3
> 4.00	< 0.06	0.0	1.5
	Mean of K	1.75	2.50
	Variance of K	6.05	11.70
	Mean of PL	0.32	0.16
	Variance of PL	0.04	0.008

Table 8.11

K: Regression estimates for the owners subsample[a]

$$K = -0.126 + \underset{(0.475)^{*}}{0.829D_1} + \underset{(0.525)^{*}}{0.968D_2} - \underset{(0.182)^{***}}{0.778S} + \underset{(0.182)}{0.288Y_a} + \underset{(0.120)}{0.142H} \qquad R^2 = 0.46,\ \text{d.f.} = 14$$

$$K = -1.753 + \underset{(0.470)}{0.725D_1} + \underset{(0.513)^{*}}{1.027D_2} - \underset{(0.366)^{*}}{0.843S} + \underset{(0.187)^{*}}{0.369Y_a} + \underset{(0.118)}{0.122H} + \underset{(0.0112)^{*}}{0.0253A} \qquad R^2 = 0.52,\ \text{d.f.} = 13$$

[a] See footnotes to Table 8.8. These equations have been estimated after excluding the observations for which $D_3 = 0$ and/or $\psi < 0$.

necessarily pragmatic. By necessity, we had to dispense with most of the sophistications that utility measurers have developed since Von Neumann and Morgenstern first presented the expected utility model. In consequence, we cannot be sure that biases due to probability preferences and aversion or love for gambling may not have distorted our empirical analysis.

Nonetheless, the pragmatic approach did have, we feel, the advantage of permitting the collection of a sizeable sample of worthwhile observations on peasants' risk preferences. Though the questions we used were necessarily hypothetical, they were geared to obtaining farmers' responses in the context of relatively realistic situations and were not confined to the game-type framework typical of most other studies of risk preference.

The estimates obtained strike us as quite reasonable and appealing both to common sense and to our direct perception of the behavior and motivation of small farmers in the semiarid Brazilian Northeast. Although some of the values of the risk preference parameter ϕ for the risky prospects with subsistence assured run counter to the conventional wisdom that all peasants are rather risk averse, their distribution suggests that the conventional wisdom values indeed characterize one of the modes of the population. For the case with subsistence at risk, on the other hand, the values estimated for ϕ match about exactly those estimated with econometric and mathematical programming techniques both for Brazil and for Mexico.

Furthermore, although we were unable to find any really adequate explanation for the variance of ϕ in the $(E,V^{1/2})$ model beyond the randomness of a natural distribution; we did succeed in relating K, the safety first parameter in our (ψ,K) model, to a number of socioeconomic variables of the population.

The overall picture provided by our data appears to validate the qualitative hypotheses advanced for risk preferences of subsistence farmers[14] and, in particular, the hypothesis that they are likely to follow some type of safety first approach whenever the satisfaction of basic needs may be at risk. The variable most used to measure subsistence showed, however, such a large variation that it was impossible to determine what is the critical element that the farmer considers in determining his survival level. This conclusion calls for a better understanding of the interaction between the production and consumption behavior of peasant households. Though this endeavor will be the subject of another study, the present paper will hopefully be instrumental in suggesting some of the relevant questions that research has to face in this field. Not the least, we hope that our analysis has shown that it is possible via simple but purposive questioning to elicit meaningful information on peasant attitudes pertinent to rural development.

[14] See, for example, Johnson (1971).