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The level of risk aversion among African farmers – results of a gambling approach

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Abstract

Risk and risk aversion are important variables for small scale farmers' decision making, but methodological difficulties to assess these factors are still important. In order to measure risk aversion of farmers in Northern Benin/West Africa, an experimental gambling approach was applied. Farmers of all included regions and ethnic groups were found to be severely risk averse: if measured as Z-score (level of trade-off between expected gain and its standard deviation) the average risk aversion was 0.5-1. Regional origin, ethnic group and household internal factors were of low importance for the degree of risk aversion. Such strong risk aversion has to be taken into account in any economic assessment if useful predictions of innovation adoption or policy response are to be expected.

Keywords: small farmers, Africa, Benin, risk, risk aversion

Introduction

The search for appropriate technologies and policies for small scale farmers has to take into consideration a large variety of technical, economic and social criteria. Since there are hardly any "perfect" innovations or policies which satisfy all conditions perfectly, and since small scale farmers are not a homogeneous group, often compromises with respect to the fulfilment of these criteria have to be searched for.

Among the economic criteria, it is particularly between profitability and riskiness that trade-offs have to be made - very often both are in competition. In most cases risk averse technology choice or policy options imply income or welfare losses, for instance due to insurance primes, low degree of specialisation, maintenance of over dimensional security networks, etc.. More farmers are risk averse which is usually assumed for developing countries (Valdes, 1981), more they will refuse to accept risk in order to obtain higher income, but such strategy is costly and therefore to be reduced to the necessary extent. If economists want to deal with the assessment of impacts of technologies or support policies on risk-averse farmers, risk aversion should be quantified and handled as one of the variables of farmers' decision making.

There are few ways how to assess risk aversion but all have serious limitations, particularly in developing countries -econometric models are often limited by availability of relevant data; the comparison of programming model outcomes with real farms assume that the models perfectly predict farmers' reactions which is hardly the case; in most developing countries there are no insurance schemes which farmers could use to insure against risk and which therefore could reflect risk aversion; the direct elicitation of risk aversion by asking farmers to choose between hypothetical options with different risk exposure suffers from the observation that people de not answer rationally consistently, because they can not adequately judge the alternatives or the hypothetical situation biases the answers (For a thorough discussion of risk in agriculture see Anderson et al., 1977; Goetz, 1991; or Hardaker et al., 1997).

An innovative alternative was developed in the 1980s by Binswanger (1980, 1982) in India, which consists of letting people gamble under controlled risk conditions and with high payoffs, i.e. risk comparable in dimension to normal decision situations for investments. This approach avoids most weaknesses of the other methods and allows direct measurement of risk aversion. The main disadvantage would be its high costs to offer sufficiently high payoffs which guarantee the seriousness of the participants. In developing countries this disadvantage is obviously less constraining than in developed countries.

The research that is presented in this article is basically a replication of Binswanger's methodology with West African farmers which was not done until that time.

Methodology

75 farmers were made a gift in cash that they could keep or use in a lottery. The farmers belonged to different ethnic groups and agro-ecological situations (food-based southern farming systems, cotton based northern farming systems and mixed systems in the centre) and had participated in a detailed socio-cultural and economic survey during the previous 18 months (for details see Brüntrup, 1997).
The principle of the lottery was to bet on the result of throwing a coin. In case the person rightly predicted the result, he was paid a prime, on the contrary he lost a part of the sum bedded. The pay-offs are chosen in such a way that the expected outcome can only be increased by accepting a higher variability of outcome. From the choice of the accepted risk level, risk aversion can be deduced.

The levels of loss and gain for the first game are shown in Table 1. Whereas a risk-neutral player will chose the alternative E which yields the highest expected (average) gain, a risk-averse player will chose an alternative which is a trade-off between lower gain and lower risk. For instance, a player who chooses C will reduce his expected gain of 100 FCFA (risk-neutral choice D) by 10 FCFA in order to reduce the risk from a standard deviation of 127 to 85, the average/standard deviation trade-off (Z-value) is between 0 and 0.33.

The game was played several times in front of the whole group, posters with the money stuck on them for each alternative were presented. Farmers were gambling separately to avoid that the "luck"-factor of a successful player would bias results of successive players. In general, farmers had no problems in understanding the game.

Table 1 The payoffs of the risk game for the basic version (50 FCFA) and the risk classification

Choice	Payoff level		Expected gain =E	Std. dev. of gain =SE	Gain/risk trade-off Z-score =ΔE/ΔSE	approximate risk aversion coefficient S**	Risk aversion class	
	heads=low	tails=high					in words	as score
0	50	50	50	0	1 to 0.80	∞ τo 7.51	extreme	1
A	45	95	70	35	0.8 to 0.66	7.51 to 1.74	severe	2
B	40	120	80	57	0.66 to 0.50	1.74 to 0.81	intermediate	3
B*	35	125	80	64			inefficient	3
C	30	150	90	85	0.50 to 0.33	0.81 to 0.32	moderate	4
C*	20	160	90	99			inefficient	4
D	10	190	100	127	0.33 to 0	0.32 to 0	slight-to-neutral	5
E	0	200	100	141	0 to -	0 to - ∞	neutral-to-negative	6

* The alternatives B* and C* are labelled inefficient because they are stochastically dominated by B and C respectively, i.e. their expected outcome can be reached with a lower risk. In sight of the low deviation from efficient alternatives, for the analysis they were considered to belong to the neighbouring efficient choices.

** Classical measure of risk aversion, slope of a concave utility function, according to BINSWANGER (1980) S is derived from a constant partial risk-aversion function of the form $U = (1-s)M^{1-s}$; the author argues that for this game constellation (high pay-off levels), the partial and the absolute risk aversion coefficient are approximately identical.

The main argument against this method of risk aversion measurement (which holds even stronger for mere hypothetical games) is that a game situation may imply that the anti-risk behaviour is lower compared to real decision situations when higher values are at stake and greater hardship must be faced in case of negative deviation from the average, such as income reduction, illiquidity, food deficiency or worse. In sight of this argument, it is important that the payoffs are high enough to be compared to a real income risk (Binswanger 1982). The first round was played with a sum of 50 FCFA, the second with 500 FCFA and a hypothetical game was played with 5000 FCFA. During the period of play (June-August, the hunger period), 500 FCFA is a considerable amount for small farmers, often the cash income of several days. It must, however, be taken for granted that risk coefficients derived from this games only constitute a lower limit of the actual risk coefficients for "serious" decisions.

Results

The first result shown is that 35-45% of the farmers are extremely or severely risk averse at high pay-off rates[1], only a maximum of 10% chose near-neutral risk games (Table 2). For the first game with a low pay-off level, there was a relatively high proportion of risk-neutral players, but with higher stake levels the risk aversion increased.

Risk-inefficient choices B* and C* were rather frequent in the first game, but decreased with higher pay-off rates. In the analysis and following Binswanger (1982), they are merged with the lower neighbouring risk-efficient choices B and C having the same expected values.

Using the risk aversion class scores between 1 and 6, Table 3 shows the risk aversion exhibited by farmers through the choice of the game for different sub-groups. On average, the risk aversion score were 3.6, 2.7 and 2.7 with increasing pay-off levels. The distributions and differences were significantly different between the 50 FCFA on the one hand and

1 In the Indian sample BINSWANGER (1982) found almost 70% of farmers in the risk classes extreme to intermediate at high pay-off levels.

the 500 and 5000 FCFA games on the other[2], the differences between 500 and 5000 FCFA were not significant.

A comparison of average risk scores by ethnic groups revealed few significant differences for the (most comprehensive) 500 FCFA game: only the Nago farmers, an allochthone group active in agriculture and off-farm activities, were clearly less risk averse than Bariba, the dominant ethnic group of the study region which is basically active in agriculture. Gando, former slaves which practise a mix of agriculture and livestock raising, accepted more risk than their former masters, the Peul who are more involved in livestock than all other groups. In contrast, the location of villages does not seem to change the risk aversion, although farmers in the northern village gain on average 4 times more cash than their counterpart farmers in the south.

Table 2 Distribution of farmers' choices in risk game by pay-off level (% of farmers)

	Farmers' choices								
game	0 (1)	A (2)	B (3)	B* (3)	C (4)	C* (4)	D (5)	E (6)	sum
50 FCFA	8.5	8.5	19.7	15.5	21.1	15.5	0	11.3	100
500 FCFA	26.8	9.9	26.8	7.0	28.2	0	1.4	0	100
5000 FCFA	23.9	21.1	21.1	9.9	12.7	1.4	7.0	2.8	100

In brackets risk aversion class expressed as score, including the inefficient choices in the nearest neighbouring risk class

Table 3 Average risk aversion scores[1)] by farm household system and pay-off levels

	village 1 (south) food-based			village 2 (centre) mixed			village 3 (north) cotton based		
game	Bariba	Nago	Peul	Bariba	Gando	Peul	Bariba	Gando	Peul
50 FCFA	3.6	5.0	4.0	3.4	4.6	3.2	3.9	3.2	1.0
500 FCFA	2.4	3.0	2.6	2.2	3.4	2.6	3.4	3.0	1.0
5000 FCFA	2.1	4.0	3.0	2.1	3.0	2.8	3.2	3.0	1.0

1) From 1 (extremely high) to 6 (risk neutral-to-negative)

2 Wilcoxon-test for related samples, t-test for paired samples:
50 FCFA compared to 500 FCFA game: Z=-4.43***, t=5.11***;
50 FCFA compared to 5000 FCFA game: Z=-4.34***, t=5.11***.

These results indicate clearly that most farmers depreciate risk passionately or, synonymously, rather strongly prefer risk reducing strategies. It appears that there are few differences between ethnic groups or ecological and economic conditions.

In the following, it will be searched for other explanatory variables for the detected risk aversion. A multiple regression model was used to find factors influencing farmers' risk aversion. The numbers 1 to 6 were maintained as regressors for the discrete risk-aversion classes. Binswanger (1982) reported little impact of other, more refined scaling (Z-trade-off and partial risk aversion coefficient S, see Table 1) on regression results. In addition, the high number of cases in the extreme risk class made the adoption of Binswanger's S-coefficients less useful since in the extremely risk averse class one of the class limits of the coefficient is $-\infty$, thus a mid-point has to be fixed arbitrarily which could introduce an artificial bias in the regression analysis.

The variables assumed to be relevant for risk attitudes are age, wealth (represented by total cash income) and ethnic group (dummies). Villages (dummies) are used to represent agro-ecological and general "environmental" influences such as economic or ecological factors. A "luck" variable from the result of the previous game (dummy) was included which turned out to be the only significant variable in the Indian trial (Binswanger 1980). This is a short-term psychological factor as the probabilities of the independent games actually have no influence on each other.

Table 4 shows that the explanatory power of the independent variables is low particularly for the decisive 500 FCFA-game, signs of single variables are partially contradictory across games: The northern cotton farmers' significant risk aversion in the first game is not repeated in the other ones. With higher pay-off levels, only ethnicity (Nago farmer are less and Peul are more risk averse than the average), age and off-farm income had a significant impact on risk aversion. In addition, the variable "luck" in the hypothetical 5000 FCFA game for a previous successful game was highly significant. However, the highly significant value of the constant risk aversion component decreases with growing pay-off level from 2.93 to 1.78, confirming absolute increase of risk aversion.[3]

Table 4 Determinants of risk aversion (regression, dependent= risk aversion score)

Variable	pay-offlevel 50 FCFA	500 FCFA	5000 FCFA
village 1 (south) (dummy: 1=yes)	-0.11	-0.04	-0.16
village 3 (north) (dummy: 1=yes)	-0.86**	0.33	0.11
Bariba (dummy: 1=yes)	-0.39	-0.41	-0.28
Nago (dummy: 1=yes)	1.07	-0.26	1.50*
Peul (dummy: 1=yes)	-1.00*	-1.01*	-0.64
total cash income (million FCFA)	-0.01	0.74	1.49
cash off-farm income (million FCFA)	-0.24	-0.40	-0.76***
age (years)	0.024**	0.01	0.02*
cotton prod. (share in total farm area)	0.004	-0.004	0.002
education (years of school)	0.08	-0.04	0.13
luck 1. game (dummy: won=1)[1)]	-	0.49	0.93***
luck 2. game (dummy: won=1)[1)]	-	-	-0.25
(Constant)	2.93***	2.34***	1.78***
R^2adj	0.18	0.01	0.25
F-value	2.58**	1.04	2.93**

1) Some farmers took the initial money without gambling, for these the luck game variable was substituted with the mean of the entire sample

Conclusions

The methodology proved to be a viable and convincing way to measure farmers' risk aversion. The exercise can be easily integrated into all types of farm household studies. In sight of the importance of risk aversion in decision making, the costs of the approach seem to be adequate, in addition the money pay-offs can substitute other forms of payment for survey participation which are often disbursed.

3 A similar study carried out in Thailand (Grisley and Kellog, 1987) found that risk aversion was significantly decreasing with farm size, and that risk averse farmers were more engaged in multiple cropping, but in general also this research could only explain few of the variability of risk aversion.

The results of the risk game clearly show that risk aversion is a strong motivation in farmers' decision making. In contrast, the impact of HH-internal factors on risk aversion was found to be low.
It can be concluded that differences in investment behaviour most likely are due to external factors such as traditions or access to credit, marketing, extension.

Thus, risk-aversion is a general phenomenon of farmers as is underlined by the high significance of the constant in the regression analyses which is decreasing with higher payoff levels. For real economic choices under risk with much higher values involved and longer time horizons, for instance mineral fertiliser purchase, investment in animal traction equipment or even abandonment of subsistence production, it can be expected that risk aversion will be even higher (Timmer, 1989).

Whether in technology development or for policy formulation, the high risk aversion of farmers must be taken into account. This is particularly true in developing countries, where no insurance schemes are operational. Quantification of risk aversion is desirable and possible, and there are ways that permit the incorporation of risk and risk aversion into economic tools such as gross margin calculation, regression analysis or farm modelling.

Literature

Anderson, JR, Dillon, JL and Hardacker, JB (1977) Agricultural Decision Analysis, Iowa State Univ. Press, Ames.

Binswanger, HP (1980) Attitudes towards risk: Experimental measurement in rural India. American Journal of Agricultural Economics: 395-407.

Binswanger, HP (1982) Empirical estimation and use of risk preferences: Discussion. American Journal of Agricultural Economics: 391-393.

Brüntrup, M (1997) Agricultural price policy and its effect on production, income, employment, and the adoption of innovations: a farming systems based analysis of cotton policy in Northern Benin. Development economics and policy (9). Lang, Frankfurt.

Goetz, R (1991) Der Einfluß witterungsbedingter Ertragsschwankungen auf die landwirtschaftliche Betriebsplanung - Ein Ertragssimulations- und Risikoanalysemodell. Vauk, Kiel.

Grisley, W and Kellog, E (1987) Risk-taking preferences of farmers in Northern Thailand: Measurements and Implications: Agricultural Economics 1: 127-142.

Hardaker, JB, Huirne, RBM and Anderson, JR (1997) Coping with risk in agriculture, CAB International, Wallington and New York.

Timmer, CP (1989) Food price policy - The rationale for government intervention: Food Policy 14 (1):17-27.

Valdes, A (ed) (1981): Food security for developing countries. Westview, Boulder.